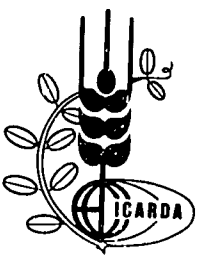
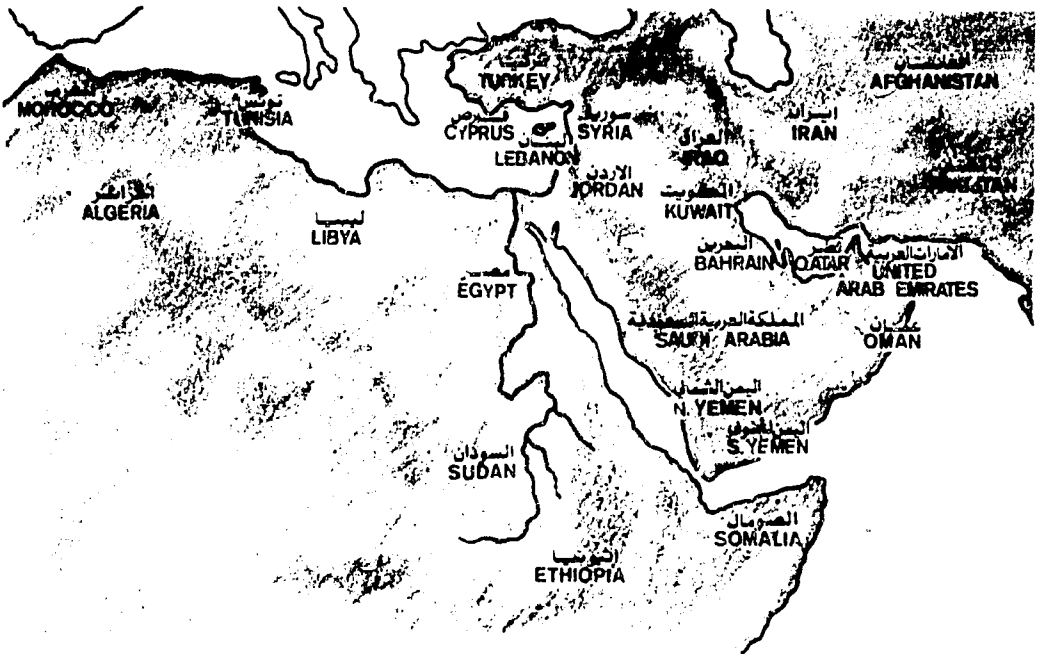
# ICARDA—A PARTNER IN CEREAL IMPROVEMENT






ICARDA's principal geographic area of concern involves countries of West Asia and North Africa with a population of more than 300 million people.

## FOREWORD

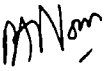
*Any discussion of agricultural improvement in North Africa and West Asia must acknowledge two facts: the dominant role of wheat and barley in the agricultural economy and the massive imports of wheat and barley into the region. Currently wheat imports represent 30% of the total wheat consumed by people. In the five countries of North Africa fully 65% of the total demand is met through imports. This is putting a heavy debt on national accounts. Concerned governments recognize that growing more wheat and barley at home is the only way to stem imports and reduce their debts.*

*Since the CGIAR established ICARDA in 1977 it has become a major partner to national cereals research programs in the region, providing unprecedented levels of research and training support to institutions and scientists working on wheat and barley. ICARDA is now a fully fledged member of the team of international and regional organizations cooperating with national programs to achieve increased cereal production.*

*As research is but one of the many steps necessary to raise cereal production and ICARDA is but one of many organizations tackling this complex problem, it does not claim to have all the answers. Moreover, over the thousands of years wheat and barley have been cultivated in the Fertile Crescent, farmers have selected varieties that are resilient in their harsh environments and meet their families' taste preferences. These cultivars will be hard to improve upon. Yet our research results show that significant improvement in yield can be achieved.*

*Thus, while ICARDA scientists are bringing resources, expertise and tireless energy to bear on farmers' problems, they themselves continue to learn from the experiences of farmers and from their research colleagues in the national programs.*

*The purpose of this small publication is to acquaint interested readers with the kinds of services ICARDA, and in particular its Cereal Improvement Program, offers to national cereal programs and some of the joint accomplishments emerging from their work together. ICARDA takes special pride in the relations it has developed with national programs. It is indeed this active partnership between international and national scientists, based on mutual respect and trust, that makes me look forward optimistically to major cereal gains in this region in the future.*



*Dr. Mohamed A. Nour*
*Director General*
*ICARDA*

## ACRONYMS USED

ALAD—Arid Lands Agricultural Development Program
CGIAR—Consultative Group on International Agricultural Research
CIDA—Canadian International Development Agency
CIMMYT—Centro Internacional de Mejoramiento de Maiz y Trigo
CNR—Consiglio Nazionale delle Richerche (Italy)
GTZ—Deutsche Gesellschaft für Technische Zusammenarbeit (FR Germany)
IBPGR—International Board for Plant Genetic Resources
ICARDA—International Center for Agricultural Research in the Dry Areas
ICRISAT—International Crops Research Institute for the Semi-Arid Tropics
IDRC—International Development Research Center (Canada)
NSERC—Natural Sciences and Engineering Research Council (Canada)
ODA—Overseas Development Administration (UK)
UNDP—United Nations Development Program
USAID—United States Agency for International Development

# CONTENTS

# HIGHLIGHTS

## A CEREALS TIME BOMB— THE NEED TO INTENSIFY RESEARCH ON WHEAT AND BARLEY

* Countries in North Africa and West Asia have the highest wheat consumption in the world (150-200 kg per person each year) and among the highest population growth rate.
* Since 1972 wheat imports are increasing 10% every year. Production is only rising at the rate of 2% a year.
* In 1983 regional wheat and barley production was 60 million metric tons. Twenty-six million tons were imported, representing 30% of total consumption.
* In North Africa fully 65% of wheat consumed per person is imported.
* Barley production alone is increasing at a rate of only 1.5% a year, while imports are jumping 31% each year to feed the rapidly growing livestock population.
* The cost of cereal imports is a major item in the national debts of countries in the region.

## PROBLEMS FARMERS FACE

* Wheat and barley are the most important crops in the region. They cover 70% of the land devoted to annual food crops.
* Most cereal crops are not irrigated. The majority of wheat and barley is grown in lc .s than 400 mm annual precipitation.
* Drought, heat and cold, and the uncertainty of when they occur during the growing season are the major limitations to rapid cereal production gains.
* The use of unimproved, disease-prone local landraces, poor crop management and the lack of proper inputs are additional constraints.
* Government support for investment in the higher rainfall areas is leading to sustained production increases, primarily in wheat. However, serious environmental degradation in the drier areas due to overcropping and overgrazing could jeopardize overall gains.

## ICARDA'S ROLE

* ICARDA is working hand in hand with national cereals programs and government policymakers, as well as with its sister institute CIMMYT to increase wheat and barley production.
* ICARDA has principal responsibility in the CGIAR to work with developing countries around the world on barley improvement and has regional responsibility for durum and bread wheat in cooperation with CIMMYT.
* Besides its recognized role in training, germplasm development and crop improvement through new farming methods, ICARDA is playing an important catalytic role. Within the region it is promoting more joint research among countries and the sharing of research results. It is also encouraging leading research institutions around the world to focus resources on the complex problems of dryland farming in the erratic environments of the region.

## THE ICARDA CEREAL IMPROVEMENT PROGRAM

* The Cereal Improvement Program is charged with improving productivity of wheat and barley and with training. It has a team of researchers working on breeding, pathology, agronomy, physiology, grain quality, training and other fields.
* The work to increase cereal production cuts across ICARDA's programs, involving the Farming Systems Program, Pasture, Forage and Livestock Program and Genetic Resources Unit as well as the Cereal Program.
* Close partnership with national cereal scientists is the basis of the Cereal Program's activities. Some key accomplishments emerging from this partnership and joint work are:

1. ICARDA has formal cooperative agreements with 12 countries in the region. The Program has informal, productive working relations with all the other countries in the region and several others in Latin America, Asia and Africa.
2. Over 300 scientists have been trained in courses organized by the Cereal Program. They now form an enthusiastic network of alumni. Many hold senior research administration posts.
3. Since 1977 ICARDA has organized nine major workshops and conferences in the region, jointly with agricultural ministries, universities and CIMMYT. These conferences serve to bring together senior scientists from the region and the rest of the world to focus on the region's research problems.
4. The Cereal Program has developed an extensive germplasm testing network offering national scientists a range of products, including parental and early generation materials for breeding programs and fixed lines adapted to their environments. In 1984 700 nursery sets were requested by 46 countries.
5. To the best of ICARDA's knowledge, about 15 bread wheat, 17 durum wheat and 11 barley cultivars have been identified and selected by national cereal programs as improved varieties and are under multiplication and distribution to farmers. It takes 10-12 years from crossing and testing to variety release. ICARDA-developed germplasm is still in the testing stage, but it appears to be tailormade to the region's agroclimatic conditions. The currently released varieties have come from many sources— national programs, ALAD and CIMMYT—and have been selected and tested by ICARDA scientists in the region and through ICARDA's international nursery system.
6. The new cultivars being adopted by national programs give yield increases of 20-50% depending on whether agronomic practices are used.
7. Besides adopting new varieties, national programs are also adopting the Cereal Program's breeding strategy for more stable production in stress environments and significant increases in favorable environments.

* The Cereal Program has contracts with 14 advanced research institutions in North America and Europe to work on more basic research problems.

## INTRODUCTION

ICARDA was set up by the CGIAR in 1977 specifically to work in partnership with researchers of North Africa and West Asia to help the region's farmers grow more food— a pressing need in light of explosive increases in human and livestock populations and food imports. The most important crops in the region are wheat and barley. They cover most of the land farmed. However, around 97% of durum wheat, 65% of bread wheat and essentially all of barley is grown without irrigation. This means plants get their total moisture from rain and snowfall during winter and spring months, averaging 200-600 mm a year. Consequently, the scientific breakthroughs in irrigated cereal growing of the 1960s that increased wheat and rice production so dramatically in other parts of the world left much of this region untouched. Many farmers today still grow their crops in the same way their fathers, and in some cases even grandfathers, did. In seven countries, Algeria, Iraq, Morocco, Saudi Arabia, Syria, Tunisia and Yemen Arab Republic, over 50% of the economically active population is involved in agriculture, yet agriculture contributes only about 15% to the countries' gross domestic product. Clearly, improving productivity of the region's farmers depends largely on achieving higher cereal yields.

In the past government officials and researchers have tended to neglect the problems of dryland farming in favor of irrigated food production where results are

**In North Africa and West Asia cereal production increases lag far behind the growing demand for wheat and barley. Many farmers still grow their crops just as their fathers and grandfathers did.**

quicker and the payoff higher. ICARDA was set up expressly to redress the balance between research on irrigated and dryland farming.

The ICARDA region encompasses 27 countries and two major types of climates. One is a coastal Mediterranean climate with cool, wet winters and hot, dry summers. The second zone includes highlands over 1000 meters where winters are long and severe and summers short and hot. Snowfall is the major source of moisture. Half the bread wheat in the region is grown in mountainous areas over 1000 meters.

In these environments bread wheat, durum wheat, barley, lentils, faba beans and chickpeas are the major crops grown for food and animal feed. As CIMMYT and ICRISAT were already working on wheat and chickpeas respectively, the CGIAR assigned ICARDA principal responsibility for barley, lentil and faba bean improvement and regional responsibility together with its sister centers on wheat and chickpeas. Thus ICARDA is not merely a

1/ North Africa: Algeria; Djibouti; Egypt; Ethiopia; Libya; Mauritania; Morocco; Somalia; Sudan; Tunisia. West Asia: Afghanistan; Bahrain; Cyprus; Iran; Iraq; Jordan; Kuwait; Lebanon; Oman; Pakistan; Qatar; Saudi Arabia; Syria; Turkey; United Arab Emirates; Yemen Arab Republic; Yemen People's Democratic Republic.

regionally oriented center. It is expected to work as well with countries of Africa, Asia and Latin America. However, given the need for a small, well focused program in the early years, and more recently due to budget limitations, ICARDA's first priority has been to have an impact in the region. Gradually, though, it is extending more support to other barley growing countries.

Rather than studying each crop in isolation, ICARDA's philosophy of crop improvement is to define goals for breeding and more productive crop management within the totality of the farm and farming activities. This involves investigating the interactions among crops, the links between crops and livestock, and the role of such factors as income, labor, nutrition, taste and food preparation. Ecological conservation is also considered a critical issue. Research at ICARDA is divided into three commodity improvement programs: Cereals; Food Legumes; and Pasture, Forage and Livestock. A Farming Systems Program not only integrates and evaluates their research results but works with the commodity programs to make sure their objectives reflect farmers'actual needs and resources. It also conducts basic applied research on increasing water and nutrient use efficiency through better production practices.

At ICARDA, the Cereal Improvement Program has specific responsibility for carrying out research and training related to wheat and barley improvement together with colleagues from CIMMYT and national cereals programs. Within ICARDA itself, it works closely with the Farming Systems and Pasture, Forage and Livestock Programs. In environments where rainfall is so uncertain better tillage systems, improved crop establishment, correct use of fertilizer and suitable weed control are necessary for improved cereal cultivars to demonstrate their full potential. The Pasture Program assists the cereal breeders in evaluating the straw quality of new cereals, a vital factor in livestock nutrition.

ICARDA's Cereal Program is a successor of the Arid Lands Agricultural Development Program (ALAD), a Ford Foundation sponsored project intended to introduce and develop new wheat and food legume cultivars into the dry areas of the Middle East. The ALAD program and staff were absorbed by ICARDA when it started in 1977. From this nucleus of activity ICARDA's Cereal Improvement Program rapidly expanded contacts with individual countries and intensified the level of cooperation to develop a dynamic network of cereals researchers. This has led to an active transfer of research technology and knowledge.

This publication is divided into two parts. The first describes in more detail the urgency for directing resources to cereals research in the ICARDA region. It also examines the environmental as well as socio-economic constraints to better harvests and discusses how ICARDA is tackling these barriers and its progress to date. The second part is a series of country and project profiles highlighting ICARDA's joint activities with its national partners and advanced research institutions.

Throughout this booklet, the term «cereals» refers to bread wheat, durum wheat and barley and the expression «ICARDA region» encompasses the 27 countries of North Africa and West Asia.

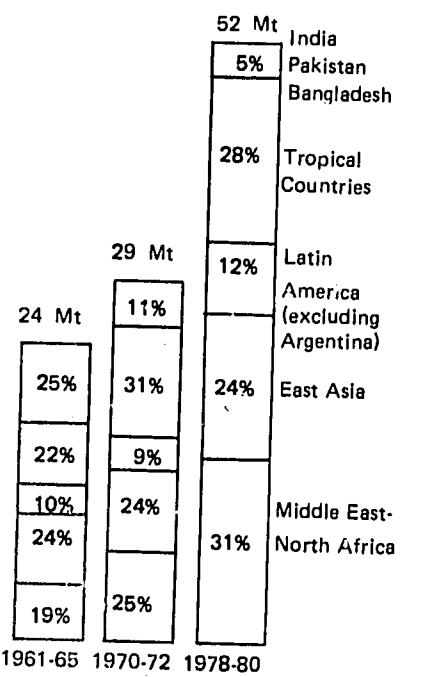
# THE CEREALS TIME BOMB

The dominant role of cereals in the economy of North Africa and West Asia cannot be exaggerated. Wheat and barley are planted on 70% of the land devoted to annual food crops. Wheat consumption per person is the highest in the world at about 150 kg/yr. This compares with 14 kg/yr for subSaharan Africa, 45 kg/yr for developing countries in general and 58 kg/yr on average for developed countries. Wheat provides over half the calories consumed by people in the region and sometimes half the protein.

In all the ICARDA countries, except Turkey, cereal deficits are chronic and acute. Although cereal production has been increasing almost 3% a year over the last 15 years, cereal imports—over 80% bread wheat—accelerated at 26% a year, from 2 million tons in 1968-70 to about 21 million tons in 1978-80. During this time Egypt, Iraq, Morocco, Pakistan and Syria went from net exporters to net importers.

The cost is having a major impact on the balance of payments of food importing countries. In 1980 six non oil-exporting countries in the region, Egypt, Morocco, Syria, Tunisia, Yemen Arab Republic and Yemen People's Democratic Republic paid a total of $2 billion for cereal imports. This accounted for over 50% of their balance of payments deficit. Projections of future cereal imports are alarming—50 million tons of wheat alone by 2000 if current rates of demand are maintained.

Cereals and sheep are the basis of incomes and diets in the ICARDA region. Wheat consumption per person is the highest in the world at 150-200 kg/yr. Wheat provides over half the calories and often half the protein.




Changing shares of total wheat imports by developing country regions, 1961-65 to 1978-80.

The massive importation of cereals is directly related to three factors: more people; more livestock, especially sheep and chickens; and higher incomes enabling people to buy more food. Countries in the region have among the fastest expanding populations in the world. Between 1973-82, of the 10 countries in the world with the highest population growth rates, six were in the ICARDA region; five of the six recorded growth rates over 4%. The major portion of the population is under 25.

What is not well known is that the urgent need for major increases in domestic cereal production comes at a time when large parts of the region's agricultural lands face serious environmental deterioration. The problem has evolved over the last 30-50 years with the introduction of mechanization, more intensive cultivation, an increase in the population and expansion of production to more marginal areas. Particularly in these drier, less favorable areas, the land is severely overtaxed. "Agriculture is a mining activity," says one scientist. Farmers take nutrients from the soil but do not replace them. They are increasingly abandoning the practice of fallowing part of their land and cropping it constantly to meet the demand for food and feed. As they do not apply fertilizer or manure, soil fertility is very poor with deficiencies in key plant nutrients, such as phosphorus and nitrogen. Crop yields are falling. In parts of Syria fallowed lands have dropped from 60 to 30% of cultivated area since 1965. Many farmers are growing more barley instead of wheat because it performs better under poor conditions.

In the transitional areas between high-productivity croplands and the steppe or rangelands where sheep graze, ecological stresses are at a peak. Not only is vegetation being destroyed by overgrazing, but barley growing has spread into locations with less than 200 mm rainfall in which there can be no cropping without the risk of serious soil erosion. In Yemen Arab Republic large tracts of grazing land have turned into semi-arid desert and massive erosion is causing siltation of irrigation systems. At the other end of the ICARDA region, overgrazing of pasture and forest areas in Morocco has led to destruction of vegetative cover and erosion.

Agricultural production is not fully exploited in the wetter areas, justifying the investment governments are presently making. However, if the degradation in the drier zones continues, it will jeopardize the region's agricultural future, reducing the impact of gains achieved in more productive areas.

To pull the region out of this downward spiral of food imports and environmental deterioration, crop and livestock production systems must be made more efficient and profitable. Agricultural researchers are investigating possible solutions and alternatives. Their efforts must be coupled with ongoing financial and moral support from the international community and government commitment to encourage local research and implement results. Without that support and action now, great parts of the ICARDA region will become tomorrow's deserts with cities encircled by barren wasteland and people living from imports and food aid.

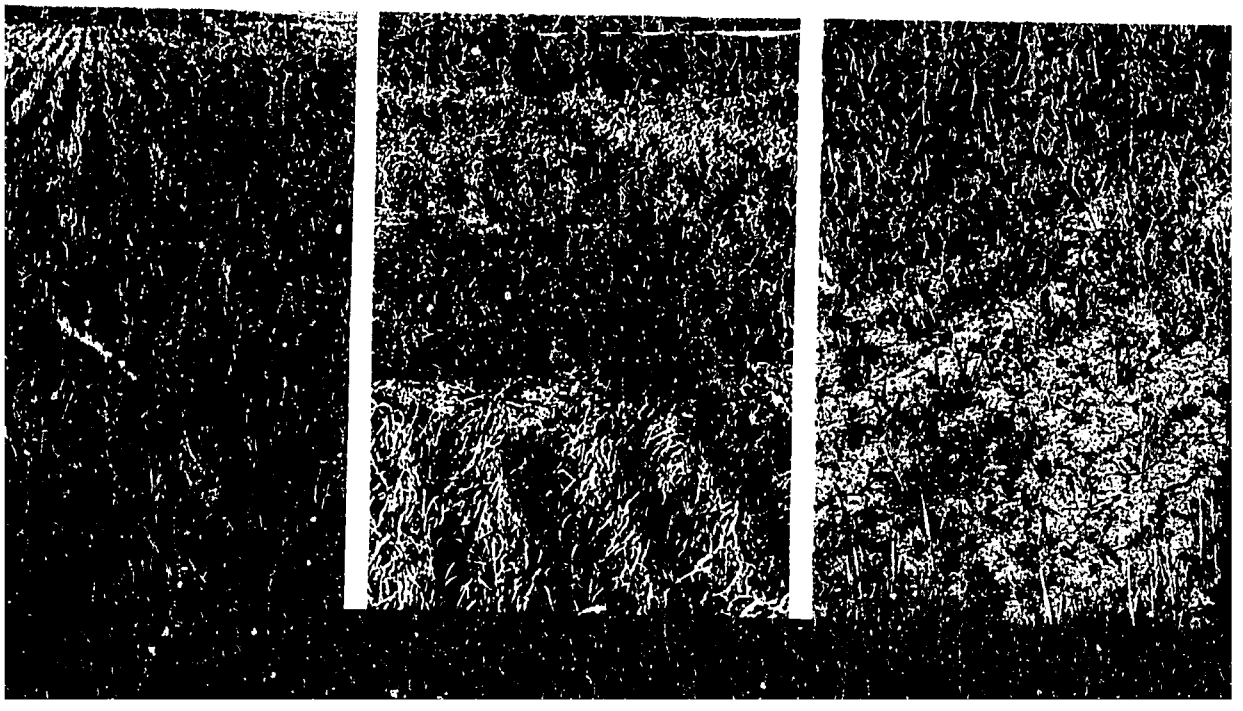
# NATURE'S CHALLENGE

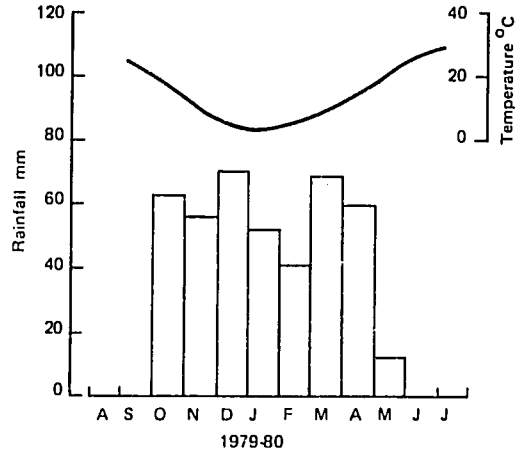
The challenge of agricultural research in the tropics is great, but perhaps not so great as in the ICARDA region. Nowhere in the world are crops as exposed to such weather extremes. During the growing season, usually October/November to May/June, a given cereal crop might be damaged or killed by too little or too much water, frost, scorching heat or high winds. Long stretches of no rain, or short dry spells during critical growing stages, reduce grain yields. Yet too much rainfall causes the plant to lodge and drains nitrogen from the roots' reach. Winter cold spells in the lowlands can damage young plants. If freezing temperatures occur later in the spring, especially during pollination, no seeds are formed. Yet excessive heat in the spring stunts plants. Hot desert winds marking the arrival of summer often blow when the crop is flowering or during grain filling, causing sterility or shrunken kernels. Closer to harvest time strong winds shatter mature grain heads.

In areas above 1000 meters the temperature variations of the lowlands are exaggerated, both in range and rapidity. Winter temperatures frequently go far below 0°C but then rise above freezing during the day. Spring is short followed by a summer of extreme heat. Solar radiation is more intense than in lowland areas and winds more violent.

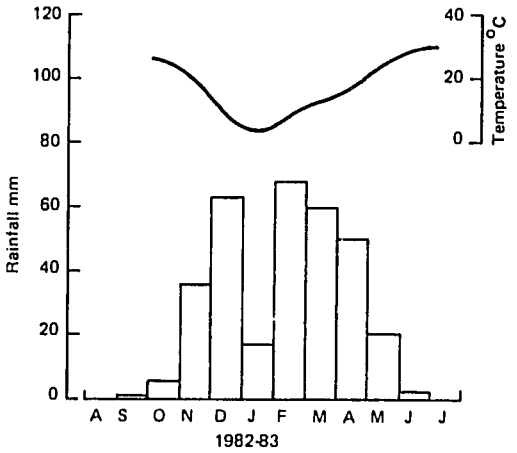
Yet nature's greatest challenge to farmers and scientists is not the tremendous range of stresses but their unpredictability. «In the seven years I have worked at ICARDA,» says ICARDA's senior barley breeder, «not one seaon has been similar to any other.» Predicting the season is a little like playing Russian roulette. All scientists can bet on are probabilities based on long-term weather data. Even this can be risky, though. Rainfall was above the long-term average during the 1984/85 season in Syria, but it did not rain during a critical period of the plant's development. The result was stunted crops and depressed yields.

**Nature's challenge: from left to right, the impact of drought, cold temperatures and saline soils on young and maturing wheat and barley crops.**

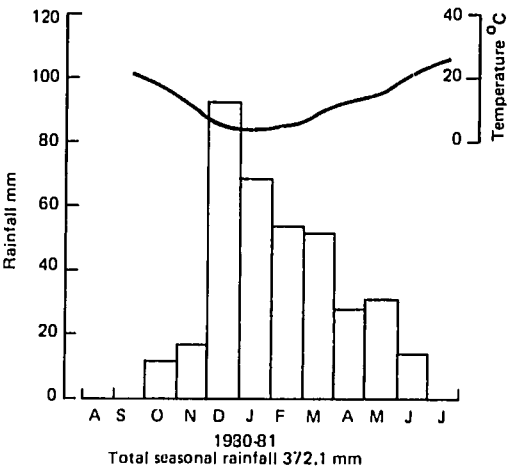




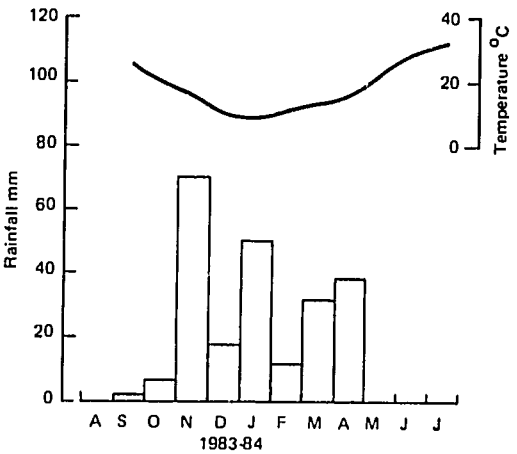

Total seasonal rainfall 425.9 mm



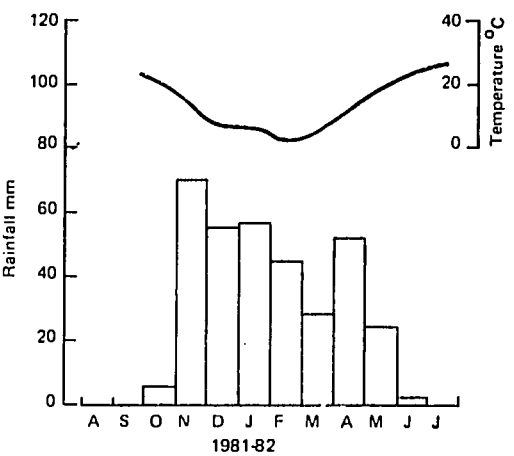

Total seasonal rainfall 324.4 mm



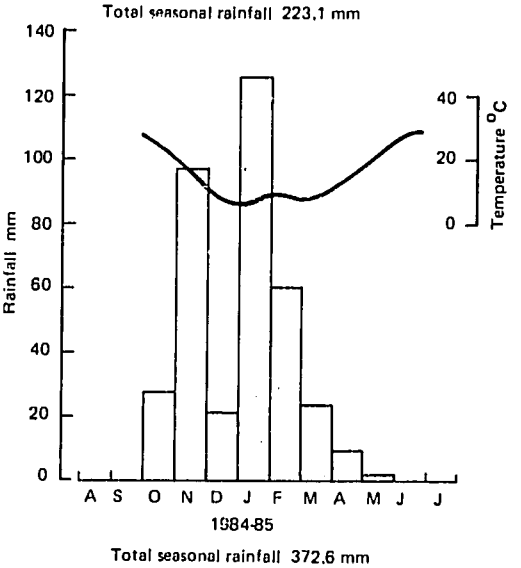

Total seasonal rainfall 372.1 mm




Total seasonal rainfall 223.1 mm




Total seasonal rainfall 337.6 mm




Total seasonal rainfall 372.6 mm

Seasonal Fluctuations in Mean Rainfall and Temperature at Tel Hadya Station

As these stresses are so variable, both in intensity and timing from year to year, evaluating the tolerance of plants to specific stresses and screening for useful germplasm is extremely difficult. Inevitably in such environments progress will be slower.

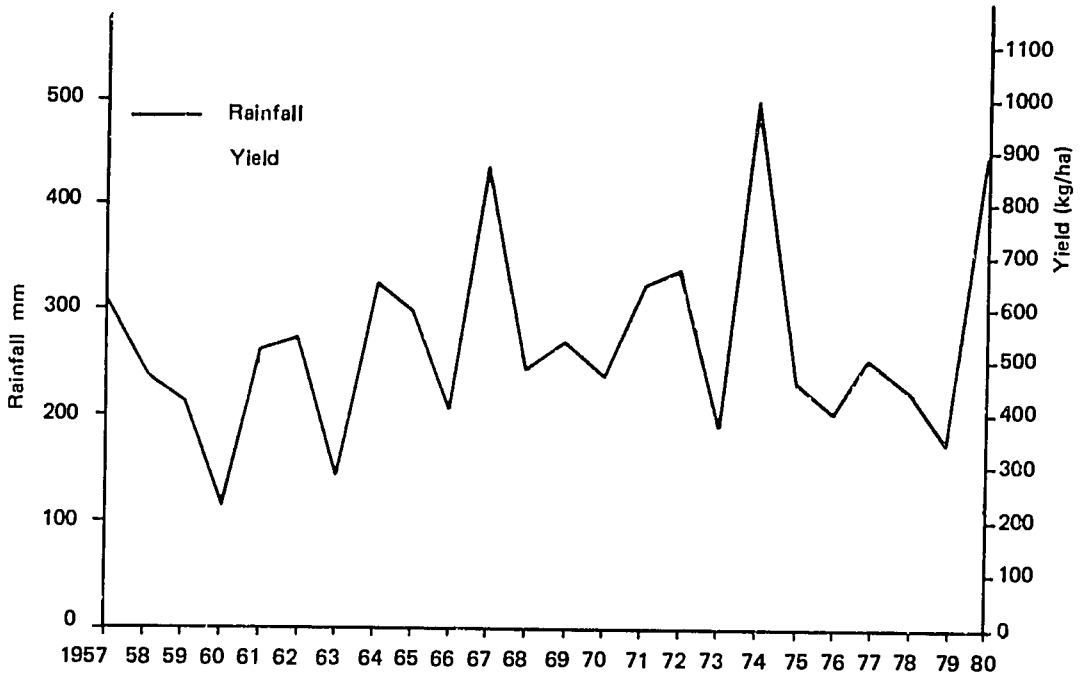
Compounding the water and temperature stresses are soil problems and a host of diseases, insects and native weeds. Salt can be carried into low lying areas via runoff from the mountains or from irrigation schemes and remains in the soil as there is not enough rain water to leach the salt below the root zone. The development of salt tolerant varieties could improve yields in salt affected areas.

The wetter years, favorable for better harvests, are also the years disease epidemics are most likely to occur. Major cereal leaf diseases are: scald, powdery mildew, the rusts, septoria leaf blotch *(Septoria tritici)*, tan spot, bacterial leaf streak, net blotch and Barley Yellow Dwarf Virus. Major grain diseases are common bunt and smut.

Insect pests come in the form of Hessian fly, wheat stem sawfly, sunn bug and aphids. The aphid species are especially important in Sudan and Egypt, accounting for 25-30% of grain yield losses. Investigations to develop suitable biological controls have so far been unsuccessful. Other insect predators are not an effective control. Their populations build up too slowly to check the multiplication of aphids. This is due to a disruption of the ecosystem through the heavy use of insecticides on other crops, like cotton. With increasing use of insecticides and the destruction of aphid predators, aphid infestation is on the rise in many countries.

Developing and identifying better cultivars and farming practices under the various stresses is a formidable task. While time consuming and complex, it is not beyond the grasp of scientists. The major complicating factor is the human one. Scientists may develop a variety that tolerates drought, cold and major diseases, but if it does not bake up into a tasty bread or the straw does not appeal to his sheep, the variety will not be planted by farmers. Nor will a new cereal variety have much chance of success if the farmer lacks the knowledge or means to grow the variety at a satisfactory level of management. For example, a very productive short-statured wheat variety may not compete well with weeds and will perform badly if the farmer does not weed his field manually or apply herbicide.

**Relationship between Rainfall and Wheat Yields in Jordan**
**1957-80**




*Source: Factors Affecting Wheat Production in Jordan. Ministry of Agriculture, Jordan, University of Jordan and ICARDA.*

# CEREAL FARMING IN THE ICARDA REGION

Bread wheat, durum wheat and barley cover a total of 42 million hectares in the ICARDA region, 70% of the land where annual food crops are grown. Bread wheat alone occupies 23 million hectares. Where each cereal is grown depends largely on the supply of moisture. Bread wheat is found in the wettest areas (350-600 mm annual rainfall) and under irrigated conditions. It is estimated, though, that almost half the bread wheat is grown in areas with less than 400 mm rain. Durum wheat is planted in drier environments than bread wheat (300-450 mm). In Algeria, Jordan, Morocco, Syria and Tunisia two of every three hectares planted to wheat are durum. At the driest end of the rainfall spectrum (200-350 mm) barley is the dominant crop. Almost 40% of the 11 million hectares of barley receive less than 300 mm rain. Farmers lose one or two out of five crops to drought. These farmers tend to be the poorest in the region with the lowest incomes and few or no options when crop failures hit.

Throughout the ICARDA region most governments have developed supportive agricultural policies for the irrigated and wetter growing areas where wheat is the most important crop. They encourage farmers to adopt fertilizers, herbicides and improved varieties. Inputs, generally state-operated, are channeled to these more productive regions. In the drier, predominantly barley growing areas, soils are nutrient deficient and overworked. Farmers are not using fertilizer. Thus, as wheat yields and production edge up, barley productivity has not improved. In the Middle East barley imports have jumped from 0.4 million metric tons in 1972 to 5.5 million metric tons in 1982, an average increase of 31% a year. This is faster than the recent annual growth rate in wheat imports. Where most bread wheats now grown are improved varieties, and more productive durums are rapidly being introduced and adopted, most barley farmers still use locally adapted landraces.

It could be said there are as many farming systems as farmers. However, ICARDA's social scientists have identified two major

**Status of ICARDA Cereal Crops in West Asia and North Africa 1983**

| Crop | Area/hectares (million) | % /world | Production/tons (million) | % /world | Range of average yields/kg |
|---|---|---|---|---|---|
| Bread wheat | 23.3 | 10.5 | 37.1 | 8.0 | 700-1800 |
| Durum wheat | 8.5 | 45.0 | 10.7 | 35.0 | 600-1200 |
| Barley | 11.0 | 17.0 | 11.8 | 7.0 | 400-1000 |

*Source: Rachis*

**Today's drylands tomorrow's deserts? Overcropping and overgrazing is causing serious soil erosion in the drier areas of the region, turning large tracts of land into unproductive wasteland.**

types of farming systems in the lowland areas. One is based primarily on wheat in rotation with legumes and/or summer crops like sesame or watermelon, and prevails in areas with more than 350 mm annual rainfall. The second dominates in regions with less than 350 mm rain and revolves around barley and sheep production. ICARDA's Farming Systems Program has conducted several surveys in Jordan, Syria and Tunisia to get a better understanding of these systems and farmers' problem. Two case studies from Syria illustrate the kinds of farmers with whom ICARDA scientists are working and trying to help. Highland farming systems have not been as well investigated. However, beginning 1985/86 ICARDA will be involved in a major agricultural research project supported by USAID, aimed at improving the productivity of Pakistan's highland regions. Studies of the farming systems there will be an important component and are expected to be of relevance to other highland areas in North Africa and West Asia.

Abu Khalid (foreground) with his family threshing the chickpea crop.

## Farmer 1

*Abu Khalid farms 15 hectares of cereals, chickpeas, fruit and nut trees and summer crops. His soils are shallow and stony on rolling countryside. Each season he gets about 400 mm rainfall. Bread wheat is his principal crop, covering five hectares. He uses the variety Mexipak, an improved bread wheat of CIMMYT origin, which he buys in the state-run village cooperative. Abu Khalid practices a two-year rotation. His wheat crop, grown October to June, is followed by a nine-month fallow period and then a summer crop from April to July the next year.*

*Although Abu Khalid uses tractor-drawn attachments to prepare his land, and hires a combine to collect the harvest, he still broadcasts his seeds by hand. For many years he has been applying fertilizer, also purchased in the village. In his fields he ranks fertilizer, cultivation and weed control as the three most important factors affecting yields.*

*In good years he harvests 20 bags of grain per hectare each weighing 120 kg. In bad years he might only net two or three bags. This year he hopes for eight bags – an average year. Abu Khalid sells 25% of his harvest. His family uses the rest. The wheat straw is gathered for feed stock and he grazes his eight sheep on the stubble left in the harvested field. Asked which qualities he wants in a new bread wheat variety, he replied it should be high yielding.*

**Farmer 2**

*Abu Mustafa is 48 years old with two years formal schooling but 30 years farming experience. He lives with his wife and eight children on a 25-hectare farm in northern Syria, in an area receiving 250 mm rainfall. He has five hectares of land on good deep soil where he grows barley every season. His remaining 20 hectares are on poor shallow soils. About half he plants with barley each season and half he fallows. He also grows a small plot of wheat for home use. The barley is grown exclusively to feed his 45 sheep. They are his insurance policy in bad years, in addition to providing meat, milk, wool and cash.*

*Abu Mustafa rents a tractor and equipment to cultivate his land and sows the local landrace, Arabi Aswad. He maintains his own barley seed stock, picked at random from his fields. He does not use fertilizer. He understands its value but access is difficult and his farming environment is too uncertain for him to risk the purchase of costly inputs. In good years he hires a combine to harvest the crop on his deep soils, at the cost of 7-18% of the yield. The percentage is highest in bad years.*

*During the recent 1984/85 season Abu Mustafa's crops were badly affected by the cold. Since they were too stunted for combine harvesting he grazed his sheep on some fields and harvested the rest manually —backbreaking work with 10 people working eight hours to harvest one hectare. A combine takes one hour and one person.*

**Abu Mustafa grazing his sheep on barley stubble.**

**Harvesting barley by hand.**

## INTERNATIONAL AND NATIONAL RESEARCHERS TEAM UP

The objective of the Cereal Improvement Program is to provide national cereal scientists with the tools they need to improve cereal production in their countries, while enhancing their skill and ability to use those tools effectively. Thus active and close cooperation with national research organizations is the very foundation on which the Cereal Program is built, ensuring its relevance and impact. ICARDA and national scientists jointly identify problems and priorities and draw up a shared agenda for research and training.

However, as the needs of the region are great and the Cereal Program's budget limited, the Program is increasingly playing an important catalytic role. It martials organizations around the world to supplement its own activities and to focus additional resources on cereal research and extension in the region. Ongoing collaboration and interaction with this global network of cereal researchers as well as with the region's scientists and policymakers shape the Program's priorities and strategies.

**Partners in cereal improvement: while ICARDA's first priority is to work with scientists and programs in the region, such as the Agricultural Research Institute, Sariab, Quetta, Pakistan (right), it also supports many countries outside North Africa and West Asia. Left, a team of Chinese scientists visit ICARDA on-farm cereal trials.**

## National Programs

The development of national agricultural research in North Africa and West Asia has been uneven. In many countries it has not been given the policy importance it deserves. Even where it has, low salaries, lack of equipment and trained people, and bureaucratic procedures are still common problems. In simple graphic terms, this means, for example, that in Morocco there are not enough vehicles for scientists to monitor off-station trials. In Sudan there are only two full time wheat breeders. And presently in the whole of the ICARDA region, there are only three PhDs and eight MSes working full time on barley, the region's second most important crop. This is less than the breeding team of a small American university. Yet, seen in perspective, this represents tremendous progress over the last eight years. When ICARDA came on the scene only three countries had a scientist working on barley improvement at all. Now all the countries in the ICARDA region have a full-fledged barley program and all have had staff trained at ICARDA. In the next five years there will be 5-10 new PhD barley breeders. Now, though, there is a serious shortage of agronomists and pathologists.

Still, there is a clear trend towards sustained improvement in the research capacity of individual countries, especially in wheat. Given the overwhelming demand for wheat, national programs have invested first in irrigated and assured rainfall areas rather than in the more extensive dry areas. Cereal production in North Africa and West Asia has increased by almost 3% a year over the last 10-15 years. Much of this increase is attributable to an expansion in area. In Syria irrigated wheat rose from 5% to 12% of the total cultivated area between 1967-1976. ICARDA is making a major contribution by getting national policy-makers and research organizations to recognize and invest in the needs and potential of the rainfed areas.

Because national cereal programs are at different stages of development, the Cereal Program must be flexible and provide research and training support for a range of capabilities. For example, it sends breeding materials to the more established cereal programs while furnishing younger programs with more finished products.

## Evolving Relations

Cooperation between the Cereal Improvement Program and the national programs in the region has evolved quickly over the last eight years, from indirect contacts through the international nurseries to individual country projects and more recently to regional networks. As of 1985 the Cereal Program had signed cooperative agreements with 12 countries. This reflects the establishment of ICARDA's reputation in the region and a growing interest on the part of national programs to intensify efforts in dryland agriculture.

Not a minor factor contributing to the rapid development of productive and collegial relations with national programs has been the role of the Cereal Program's staff itself. Half of the scientists are from the region. While educated in Europe and the U.S., followed by extensive international experience, they know the culture and languages of the region. They are familiar with the agriculture and agricultural research problems, and are sensitive to discrepancies in facilities between ICARDA and some national programs. Most importantly, however, their relations with national colleagues are based on mutual respect and a desire to listen and help.

In most cases the Cereal Program is approached by national government and research officials seeking strengthened contacts. In other cases ICARDA staff traveling in the region identify projects where additional assistance is required for the Program's materials to have an impact or where there is clear potential for collaboration.

The increase in the number of bilateral country agreements is encouraging as there is evidence that materials distributed through ICARDA's nurseries are used most effectively by countries with whom the Program has close relations. Most individual country agreements are general understandings of cooperation involving more intense and regular contact between ICARDA and national staff. This includes greater interaction in research plots, the preparation of special nurseries, consultancies and more training. Limited funds for vehicles and equipment may also be provided. ICARDA has had the longest working relations with Cyprus, Jordan, Lebanon, Morocco, Syria, Pakistan and Tunisia.

As a consequence of the Program's support, these countries in particular are gradually changing from recipients of technology and training to full partners in the research process, supporting the Cereal Program and colleagues in other countries. For example, Cyprus is helping the Program identify early maturing cereals. Sebou, a durum wheat variety identified as promising by Cypriot scientists, is doing very well in farmers field verification trials in Syria and in other countries. In a joint project with ICARDA, Jordan is evaluating durum wheat landraces to identify potential sources of genes for stress tolerance. This will benefit many other countries.

Besides strengthening relations with individual countries the Program is developing small networks based on subregions, agroclimatic zones and widely shared research problems. These networks allocate more leadership and responsibility to na-

tional programs and foster closer collaboration among the region's research programs. They also serve to help ICARDA refine its research targets. The five countries of North Africa comprise one subregion, for example. The Arabian Peninsula is another, and high elevation areas yet another.

The Program's pathologists are currently in the early stages of organizing networks to identify the race and virulence of rust pathogens and septoria leaf blotch, major cereal diseases. Rather than installing costly facilities at ICARDA or drawing on laboratories in developed countries, the pathologists have identified institutions in Pakistan, Portugal and Egypt that have the capacity to identify rust races and measure their virulence. Through this project they will enhance the status of their operations and also share their expertise with colleagues in the region. ICARDA will analyze the data on its computer and distribute the results to national programs. Suitable germplasm can then be included in the regional crossing blocks.

## Evolving Relations With Advanced Research Institutions

As the shift of general breeding work to the national level gathers momentum, ICARDA will increasingly concentrate on more pressing research roadblocks. Chief among these is the problem of stress tolerance, particularly to drought, cold, heat and salinity. While developed countries, principally France, Australia, Italy and the U.S., have done some research on cereal production in dry environments similar to the ICARDA region, there are many unanswered questions. Some questions were not even asked until ICARDA posed them. Since the Cereal Program does not presently have the facilities or resources to delve into these basic problems, it is turning to universities and research organizations in developed countries for support. A list of collaborative projects is included in the second part of this book. In most cases these research institutions contribute the research at their expense or are supported by national development programs. This represents a major contribution to the Program and the region.

# THE ICARDA CEREAL IMPROVEMENT PROGRAM: STRATEGIES AND SERVICES

The following section describes the major activities of the Cereal Improvement Program: Genetic Resources; Crop Improvement; International Nurseries; Training; Quality Testing; Workshops and Conferences; and Information.

## GENETIC RESOURCES

Together with ICARDA's Genetic Resources Unit, the Cereal Program collects, evaluates, documents and preserves valuable wheat and barley germplasm for rainfed areas. Characterized samples are sent to scientists around the world on request. Institutions in Canada, U.S., Jordan and Italy, and the IBPGR are also supporting collection and evaluation activities at ICARDA. Landraces, or old crop strains, and wild relatives are of special interest as a useful reservoir of genes for important characters such as drought tolerance, wide adaptability and resistance to diseases.

Seed samples are saved in a genebank. Some accessions are stored in a long-term account for safekeeping up to 25 years. Others are kept in an active germplasm account to be drawn on by cereal scientists in other countries and by ICARDA's own breeders. In 1985 5000 different barley samples were evaluated and cataloged.

**Accessions in ICARDA's Cereal Genebank 1984**

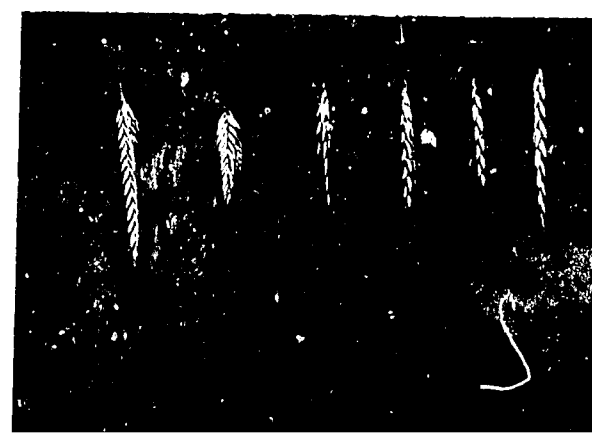
| | |
|---|---|
| Barley | 15,145 |
| Durum Wheat | 16,412 |
| Bread Wheat | 1,656 |

Each entry included 25 records describing the plant's habitat, physical traits and response under certain stresses.

## CROP IMPROVEMENT: OVERVIEW

The Cereal Improvement Program is developing germplasm and cultivation techniques that improve the reliability of yields in bad years while increasing them substantially in favorable years. In practice this requires improving the resilience of crops to combinations of drought, cold,

**ICARDA's Genetic Resources Unit houses the world collection of barley germplasm, as well as samples of local wheat varieties. Below are examples of different types of barley.**



heat, saline soils and insect and disease pressure. This goal is tackled by a team of specialists in agronomy, breeding, cereal quality, entomology, pathology, physiology, weed control and the social sciences from both the Cereal and Farming Systems Programs.

Since the environments in the ICARDA region are so diverse, with weather and disease patterns changing radically from year to year, germplasm has to be tested in many locations to ensure adequate exposure to the full range of stresses. For example, barley farmers in the drier areas of the region need varieties that can withstand cold temperatures, intense heat and lack of rain, as any or all of these conditions could occur and cause serious losses. Thus, scientists have to test breeding materials in at least three different locations where each of these stresses is almost certain to occur, just to identify potential lines for a single type of environment. This multi-location testing and selection approach enables scientists to identify and select superior gene combinations with specific and broad adaptability, high yield potential and stability, good disease and insect resistance and acceptable grain quality.

ICARDA's main experiment station at Tel Hadya in Syria was chosen because it is representative of large areas in the region in terms of soils and climates, and because these very contrasting environments can be observed within a 100 kilometer radius. Annual rainfall ranges from about 500 mm in the northwest to less than 200 mm southeast of the station. Tel Hadya is in the middle with an average seasonal rainfall of 350 mm. Research sites around Tel Hadya are supplemented by locations in many other countries in the region.

## Germplasm Development

Five main steps characterize the Cereal Program's breeding strategy:

*1. Identification of parental material at stress-specific sites;*

*2. Crossing of superior parental lines followed by growing of the resulting segregating populations;*

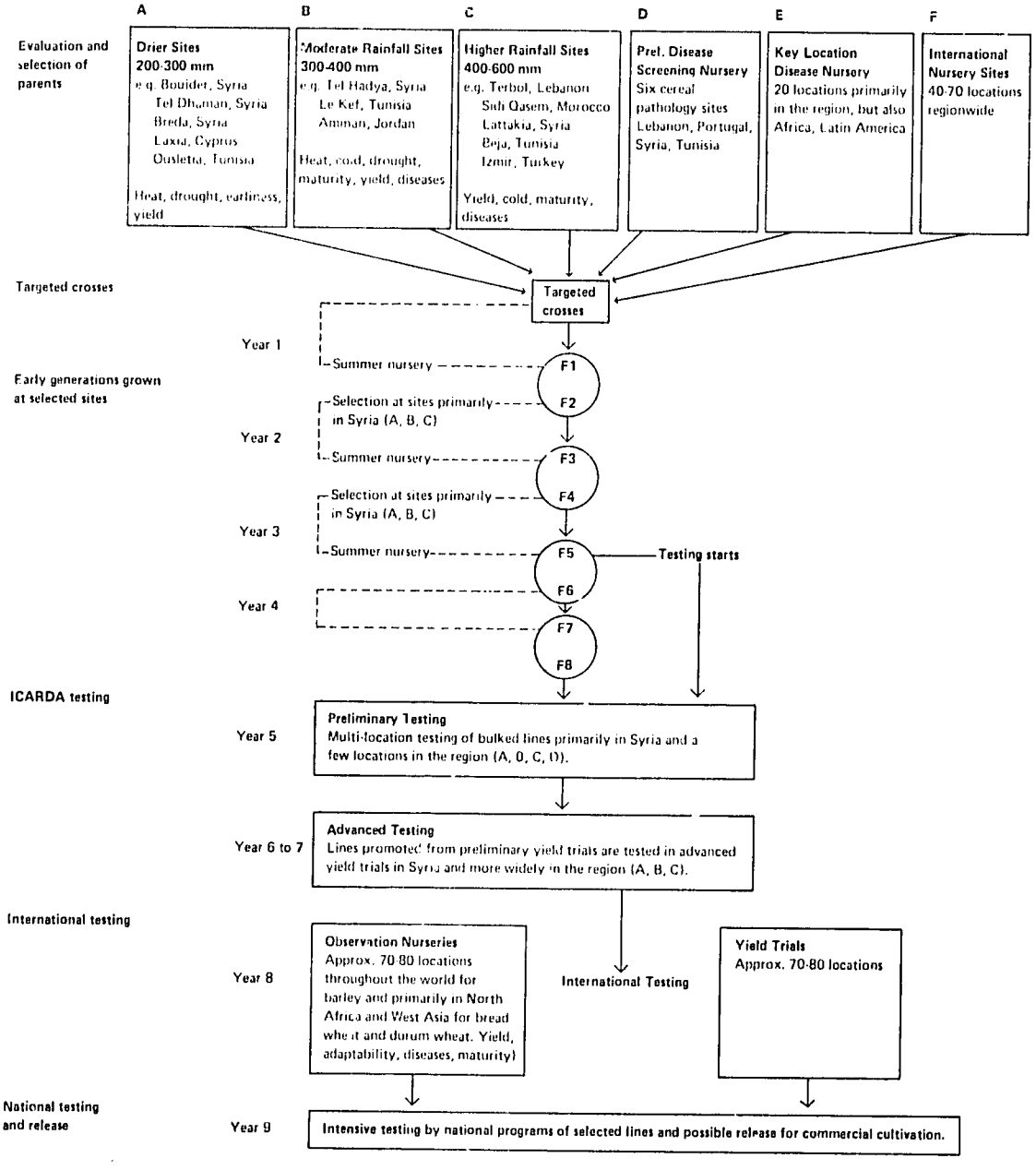
*3. Exposure of early generation populations to stress environments and selection of superior plants;*

*4. ICARDA yield testing of advanced lines (F4-F5) at selected locations prior to distribution to national programs;*

*5. International testing in cooperation with national programs.*

Selected parents for crossing come from ICARDA preliminary and advanced yield trials, national programs, the ICARDA Genetic Resources Unit collection and CIMMYT. The germplasm material is first evaluated for stress responses at sites throughout the region. Plants are tested for drought tolerance, for example, at four locations in Syria, three locations in Morocco and one each in Cyprus, Jordan and Tunisia. High yielding agronomically desirable parents are then crossed with stress tolerant, disease and insect resistant parents and parents with good grain quality. The scale of germplasm development through crossing varies for the cereals according to each crossing program's objectives and ranges from 600 crosses each season in bread wheat (where backstopping at CIMMYT is high) to over 2000 crosses in barley and durum wheat. Scientists identify the most promising segregants from the crosses and advance them along the selection pipeline, exposing them to the range of stresses at each stage.

## GENERAL ICARDA CEREAL BREEDING SCHEME



**Pathologists create artificial disease epidemics on-station to identify and to test the performance of resistant lines.**

The Program's breeding procedures involve a pedigree or modified pedigree system. At Tel Hadya expression of plant characters is satisfactory enough to allow single plant selection in the F2 generation. At other sites replicated selection of the best families (bulk) or individual plants is carried out. Yield evaluation of promising lines starts around the F5 generation and progresses from ICARDA preliminary and advanced yield trials to distribution to national programs through an international nurseries system. In ICARDA preliminary yield trials, genotypes are tested in four environments in Syria for two seasons. The best entries are promoted to advanced trials in eight environments for one to two years in Cyprus, Syria and Tunisia.

Since national programs have varying capabilities and breeding objectives they need germplasm at different stages of development. Programs with trained scientists prefer parental material for their own crosses and early generation (F2) material from which they can select promising genotypes. On the other hand, national programs short on manpower and technical staff prefer a limited but targeted collection of semi-finished and fixed lines adapted to their environments.

## Pathology

Pathologists work closely with the Program's breeders to upgrade germplasm resistance to the major diseases in the region: yellow rust, leaf rust, stem rust, septoria leaf blotch, Barley Yellow Dwarf Virus, common bunt, smuts, scald and powdery mildew. Field screening of ICARDA's breeding material starts in segregating populations.

Populations grown on the main station, Tel Hadya, are inoculated with yellow rust, scald and common bunt up to a level that enables the breeder to discard susceptible plants. Screening for septoria leaf blotch, leaf rust and stem rust is carried out in "hot spots" in Syria where natural infestation is high. Lines entering preliminary and advanced yield trials are subjected to more severe screening by planting the lines in disease nurseries in hot spots in the region, where they are exposed to other diseases and to a wide range of pathogen strains, or in artificially created disease epidemic conditions.

Generally the more advanced the material the more screening sites are used. The Preliminary Disease Screening Nursery, comprised of entries in the preliminary yield trials, is planted in six sites: two in Syria, one in Lebanon, two in Tunisia and one in Portugal. The Key Location Disease Nursery, with entries from advanced yield trials and entries selected for resistance to one specific disease, is planted in 20 or more

sites in Syria and other countries in the region, and even countries outside the region such as Ecuador and Kenya. In this way, the disease resistance of germplasm is assessed before it is sent to national programs and only superior materials are included in the international nurseries.

## Physiology and Agronomy

Work on physiology and agronomy helps scientists match varieties to environments. At ICARDA agronomy research is pursued by both the Cereal Program and the Farming Systems Program in conjunction with national scientists. The primary thrust is to close the growing gap between farmers' yields and those obtained by researchers.

Farming Systems scientists are trying to identify management practices that achieve maximum yields with minimum risk. For example, improving the water use efficiency of cereal crops is central to raising dryland production. Better crop management can make a major impact. Practices which tend to maximize transpiration, i.e. the amount of water passing through the crop, and minimize evaporation from the soil surface are necessary. Simple changes in planting date, density and sowing depth can markedly increase the amount of moisture used by the crop.

While «best bet» practices can be relatively quickly developed, it takes longer to convince farmers to use them. To overcome this problem ICARDA works closely with Syria in particular, but also countries like Jordan, Pakistan and Sudan, in developing systems of on-farm demonstration to verify research findings on farmers' fields and show farmers the value of improved varieties and management practices.

In coming years the Cereal Program will focus increasingly on the area of stress physiology to determine if plants have certain physical characteristics that give them a competitive edge in stressful growing

Smut disease (left) and aphids are but two of the diseases and insects for which breeders are developing genetic resistance in new wheat and barley cultivars.

conditions. For example, research shows that earlier maturing plants have a yield advantage because they ripen before the long dry season.

A wide range of genotypes differing in physical traits and rate of development will be tested for their response to cold and drought in Syria's rainfall gradient. The aim is to identify those traits principally responsible for resilience under stress. Special emphasis is being given to the study of landraces. Thousands of years of selection by both the farmer and nature have resulted in them being well adapted to the environment. The work is jointly conducted with the Program's plant breeders and it is hoped that sound criteria for screening techniques for the major stresses in the ICARDA region will emerge.

## Entomology

In the area of entomology most emphasis is on screening for resistance to wheat stem sawfly, aphids and suni bug. Wheat and barley lines are screened for wheat stem sawfly at Suran, Syria under natural infestation and at Tel Hadya under artificial infestation. Lines are also tested for suni bug resistance under artificially created and natural conditions and their performance is fed back to the breeders.

## Barley

Given ICARDA's global mandate for barley improvement, barley receive. the largest percent of the Cereal Program's budget. Since 1984, following the arrangement between CIMMYT and

**With such favorable traits as height and cold tolerance, the wild barley, *Hordeum spontaneum*, may unlock the door to higher yields under the driest conditions.**

ICARDA for research on barley and durum wheat, ICARDA employs a jointly appointed barley breeder who is integrated in CIMMYT's Wheat Improvement Program in Mexico. The objective of the joint CIMMYT/ICARDA barley program is to develop barley germplasm suited to the environments of Latin America, with special focus on the Andean region, where although the total acreage is very small, barley is essentially used for human consumption. In Latin America the prevailing environment requires short-maturity, cold tolerant spring habit barley. Barley Yellow Dwarf Virus and yellow rust are the most serious diseases.

Encouraging and helping national programs develop practical agronomic improvements is an important component of the joint program. A revised system for more targeted and coordinated distribution of barley materials is being introduced. The exchange of germplasm, information and visits between the Aleppo and Mexico based barley programs is intensifying.

The Aleppo based barley improvement program is increasingly focusing on the problems of farmers in areas with less than 300 mm rainfall. Improving the ability of barley crops to survive drought is thus a major objective. Since barley is primarily an animal feed in low rainfall areas, scientists are trying to raise the overall biological yield of the plant rather than grain yield alone, thereby increasing both amounts of grain and straw that can be fed to livestock.

Except for seed borne pathogens and dry root rot, diseases are not a major problem in dry years, but in the wetter more favorable years diseases inflict high losses. Barley stripe and scald are among the most important diseases regionwide, with smuts, loose smut and covered smut, also widespread and causing crop losses of 10-12%. In North Africa leaf rust, powdery mildew, Barley Yellow Dwarf Virus and net blotch are also major constraints. Yellow rust is a serious problem in high elevation areas with cool springs.

In the early years of barley research at ICARDA the breeder built up and evaluated a large gene pool. Barleys, mostly from southern France, Italy and California, showing high yield and promising qualities were crossed with locally adapted varieties. In all the program has made over 10,000 crosses, 1760 with local cultivars and landraces. However, research in the U.S. and Europe had concentrated on low protein barleys for malting purposes and lodging resistant varieties in which straw quality for animal feed was not important. Barley improvement at ICARDA, with its focus on barley for human and animal consumption had to introduce just the opposite characteristics: high protein content and good straw quality in addition to high productivity and lodging resistance. These objectives have already been successfully achieved.

For the driest areas below 250 mm rainfall, the barley breeding team is also looking to locally adapted landraces and the barley wild relative, *Hordeum spontaneum*, as possible sources of hardiness under extreme heat, cold and drought. Early evaluation of over 1000 wild barleys reveals useful variability and potential for improving plant height and cold tolerance under dry conditions. The increase in plant height is especially important when even local landraces are severely stunted from cold and

| | Purpose | Number of crosses |
|---|---|---|
| 1. | Commercial Varieties x High Yield x Yellow Rust Resistance | 368 |
| 2. | High Yield x Earliness | 115 |
| 3. | Earliness x Multiple Disease Resistance x Earliness | 293 |
| 4. | High yield x *Septoria tritici* Resistance | 394 |
| 5. | Cold Tolerance x Earliness | 85 |
| 6. | Drought Tolerance x Earliness | 353 |
| 7. | Grain Quality x High Yield and Disease Resistance | 56 |
| 8. | Bunt Resistance x High Yield | 105 |
| 9. | Xanthomonas Resistance x High Yield | 23 |
| 10. | Tan Spot Resistance x High Yield | 101 |
| 11. | BYDV Resistance x High Yield | 13 |
| 12. | Aphid Resistance x High Yield | 5 |
| 13. | Suni bug Resistance x High Yield | 23 |
| 14. | Hessian Fly Resistance x High Yield | 51 |
| 15. | Wheat Stem Sawfly Resistance x High Yield | 20 |
| 16. | Landraces x High Yield | 60 |

**Durum wheat crossing program in the 1983/84 season with purpose and number of crosses made.**

drought, making combine harvesting impossible. The Program is also taking a harder look at the usefulness of landraces. Physiologists are trying to unlock the secret of their consistently stable performance under stress.

## Durum Wheat

Durum wheat research and training is the second largest component of the Cereal Improvement Program. Since 1984 it is conducted jointly with CIMMYT. CIMMYT funds the durum breeder, who is totally integrated in the ICARDA Cereal Improvement Program under the direction of the Program Leader. The ICARDA/CIMMYT program focuses on stress tolerance and disease resistance for environments with 300-500 mm rain, while the CIMMYT based program in Mexico concentrates on the problems of irrigated and high rainfall areas.

Durum wheat is grown on approximately 8.5 million hectares in North Africa and West Asia, about 45% of the total world durum area. Within the ICARDA region durum wheat has historically received less research attention than bread wheat. In the past decade a number of countries have increased their research efforts to improve national durum wheat production. While landraces are still popular among farmers, the area sown to improved varieties is increasing, particularly under irrigated and higher rainfall areas. Susceptibility to diseases and poor grain quality restrict greater acceptance by farmers. In general present varieties are somewhat late in maturity and do not have adequate drought and cold tolerance. One of the most critical needs is to increase grain yield without a decrease in grain quality.

The durum project is concentrating on cultivars that are tolerant to the major

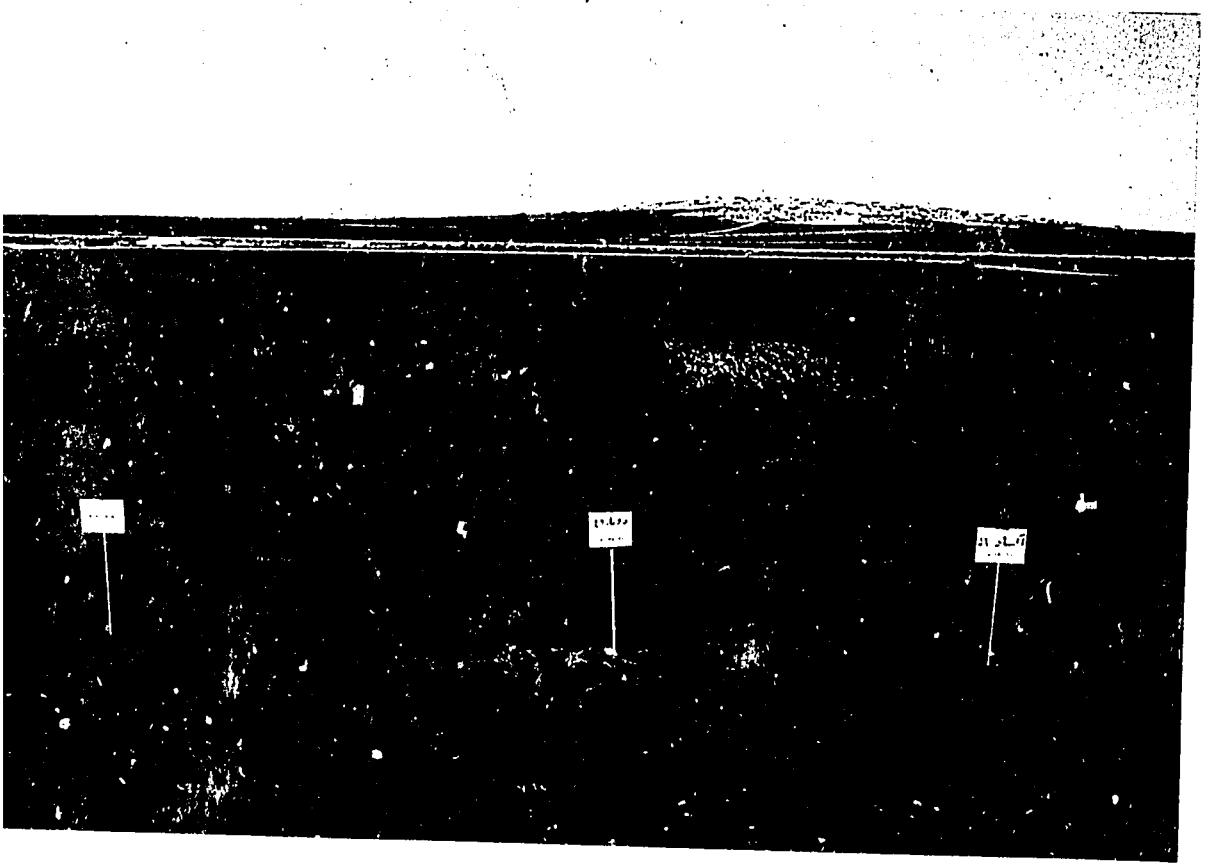
stresses of drought, heat and frost. Developing durums that mature earlier, thereby escaping drought damage and yielding more, is a major breeding objective. All new lines now feature this characteristic. Common durum diseases are yellow rust, leaf rust, septoria leaf blotch, tan spot, dry root rot, Barley Yellow Dwarf Virus and common bunt. Hessian fly, suni bug, wheat stem sawfly and aphids are the main insect problems tackled by the entomologist. Factors such as poor plant stand, late planting, weeds, low soil fertility also often contribute to low yields and are being investigated by agronomists and physiologists.

## Bread Wheat

The Aleppo based bread wheat research program involves a joint ICARDA/CIMMYT breeding effort. The project has special responsibility for developing suitable varieties for the lower rainfall zones. High-yielding cultivars coupled with improved agronomic practices offer hope for large production increases in the region.

In addition to the key stress, drought, materials are selected for tolerance to cold, heat and salt. Improved disease resistance is another important goal, with particular attention being paid to the three rusts—stem rust, yellow rust and leaf

**Wheat and barley varieties that mature earlier tend to yield more grain as they escape the full impact of spring and summer droughts. This patchwork of plots at Tel Hadya includes wheats almost ready to harvest and others at a very green stage.**



Typical highland farmer in Pakistan with his sparse bread wheat crop one or two months before harvest.

rust—septoria leaf blotch, common bunt and BYDV. Insects are a serious problem in many areas; lines are screened for resistance to wheat stem sawfly, Hessian fly, sunn bug and aphids.

As in durum wheat, the bread wheat breeder is developing earlier maturing varieties as a means of avoiding drought. Earliness in crop maturity helps the crop escape the very dry periods, but as such it is not a true genetic mechanism.

The lack of good agronomic practices such as poor land preparation, moisture conservation, weeds, poor crop stands and sowing problems, reduce yields in farmers' fields. The bread wheat program is focusing in particular on understanding the response of new bread wheats to nitrogen applications.

## High Elevation Cereals

Eight of the countries in the region, Afghanistan, Algeria, Iran, Iraq, Morocco, Pakistan, Turkey and Yemen Arab Republic have a substantial land mass over 1000 meters. Except in Turkey insignificant research has been done to improve cereal productivity in these regions. Traditional methods of cultivation and landraces or unimproved local cultivars are common. Yields are low. Winter habit wheat and barley varieties are frequently grown to survive the cold winters.

The Cereal Improvement Program's research on cereals for high altitude areas is an interdisciplinary project encompassing bread wheat, durum wheat and barley. Due to the different climates, technologies

of lower elevation areas do not fit into the highland environment. Studies indicate the need for a special plant type with a longer vegetative phase and shorter reproductive phase with adequate cold, drought and disease tolerance to enhance production.

An important feature of the local varieties is a long vegetative period of growth and the ability to fill grains quickly after anthesis (flowering). Most local lines take about 182 days from planting to heading, but only 27-30 days from heading to maturity. This is an important adaptive mechanism in the plant where winter rains practically cease after April and temperatures rise rapidly. Wheat from other regions of the world, such as U.S. and Europe, do not have that characteristic. They have a similar vegetative period but the grain filling period is so long that grains shrivel because of high temperatures and lack of rain.

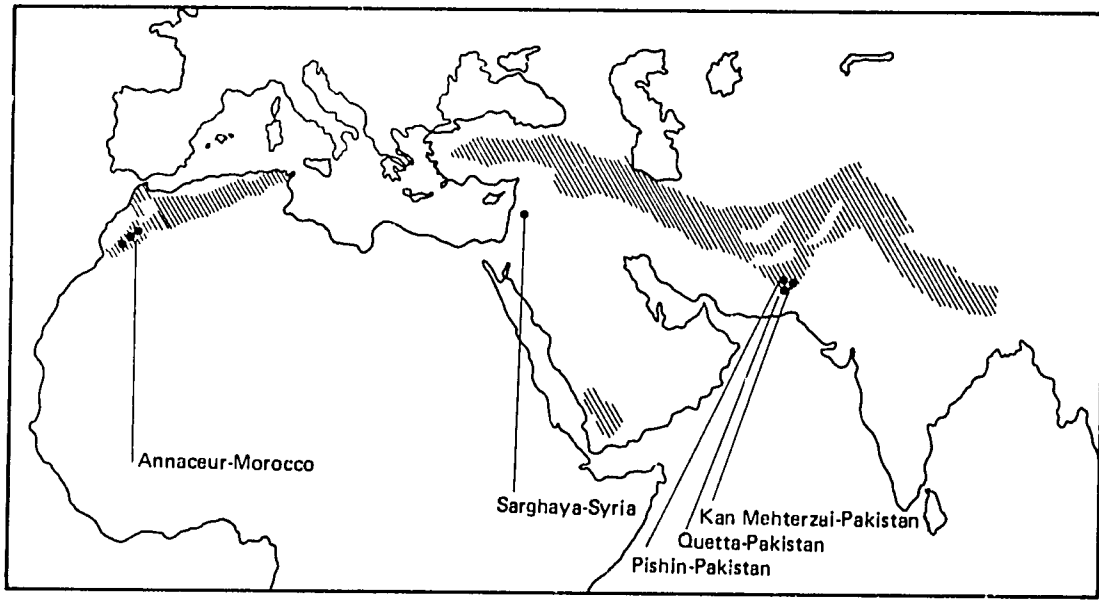
The highlands cereal breeder is collecting locally adapted materials and using them extensively in his crosses to produce a range of materials not available elsewhere. A network of testing and selection sites have been developed including: Quetta, Pishin and Kan Mehterzai in Pakistan; Sarghaya, Syria; Terbol, Lebanon; and Annaceur, Morocco. More sites in Turkey and Iran are planned.

The program has already been able to select promising lines for resistance to yellow rust, common bunt and tan spot, the three principal diseases in highland areas. To incorporate cold tolerance, high protein and drought tolerance into bread wheat and durum wheat, the breeder is using a related wheat species, *T. dicoccoides*, in many crosses. Work is also being carried out on seeding rates, sowing time and fertilizer requirements to accompany the new varieties.

## Triticale

Triticale is a cross between wheat and rye. It is intended to couple the frost and drought tolerance and disease resistance of rye with the yield potential and grain quality of wheat. Work by CIMMYT, ICARDA and other institutes has confirmed the potential of this manmade crop. In North Africa and West Asia it can be used as livestock feed or mixed with wheat for breadmaking.

Despite its advantages, though, triticale has not aroused enough interest yet in the region. In view of the much greater economic importance of wheat and barley the Cereal Program maintains triticale research at a low level. Its primary aim is to develop germplasm suitable for the most difficult environments with sandy, acid soils, erratic rainfall and heavy disease pressure. The Program is thus focusing on problems of drought tolerance, leaf rust, septoria leaf blotch, winter survival and yield performance. Grain yields of triticale lines tested in ICARDA regional nurseries are equal or slightly superior to bread and durum wheat yields, but remain inferior to those of barley in the low rainfall areas (300 mm).




High elevation areas (1000 meters) in the West Asia and North Africa region and the testing sites

NEW WHEAT AND BARLEY VARIETIES FROM ICARDA/NATIONAL PROGRAM PARTNERSHIP

| Crop | Country | Year of Release | Variety | Status | Characteristic | % Yield Increase over National Check |
|---|---|---|---|---|---|---|
| Barley | Cyprus | – | Kantara (Roho) | standard variety in Cyprus, commercial cultivation | early, moderate resistance to powdery mildew, net blotch and scald | – |
| | Tunisia | 1985 | Roho (Roho) | released to growers on small acreage, seed multiplication on 220 hectares 1984/85 | early, moderate resistance to powdery mildew, net blotch and scald | 25% in low rainfall areas |
| | | 1985 | Taj (WI 2198) | | early, moderate resistance to powdery mildew, adapted to low rainfall areas | 25% in low rainfall areas |
| | | 1985 | Faiz (ER/Apam) | | satisfactory resistance to powdery mildew, yellow rust and stem rust | 30% in high rainfall areas |
| | Qatar | – | Gulf (Aut/Aths) | used to be 100% under commercial cultivation | moderate resistance to leaf rust and stem rust | – |
| | | 1983 | Harma | commercial cultivation | resistant to scald and leaf rust, early maturity | – |
| | Morocco | 1984 | Tamellalt (Orge 1703) | seed multiplication | moderate resistance to powdery mildew, moderate resistance to net blotch | 16% in low rainfall areas* |
| | | 1984 | Asni (Orge 1579) | seed multiplication | moderate resistance to powdery mildew and net blotch | 11% in moderate rainfall areas* |
| | | – | Tissa (Orge 1580) | seed multiplication | resistant to powdery mildew, moderate resistance to net blotch | 12% in moderate rainfall areas* |
| Durum wheat | Cyprus | 1977 | Aronas | commercial production | early, high yield potential | 31% over Kyperounda |
| | | 1982 | Mesoaria (Anshinga 'S' x Volunteer) | commercial production | high yield potential, high vitreousness, high and stable protein content | 34% over Kyperounda |
| | | 1984 | Karpasia (Sham 1) | seed production, commercial production | high yield potential and stability, good grain quality | 48% over Kyperounda |
| | Egypt | 1978 | Sohag (Stork 'S') | commercial production | high yield potential, early | – |
| | Morocco | 1984 | Marzak (E12-BD11) | seed multiplication | high yield potential, drought tolerant, tolerant to *Septoria tritici*, leaf rust and root rot | 4% over Cocorit |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Libya | 1984 | Marjawi (Eider) | | high yield, adapted to Benghazi area and good grain quality | – |
| | | 1984 | Baraka (AA'S') | | | – |
| | | 1984 | Zorda (gdovz 469 AA) | seed multiplication and distribution to a few farmers | high yield under full irrigation, adapted to Sebha (desert) climate | – |
| | | 1984 | Fazan (D-25) | | | – |
| | ** Portugal | 1983 | Celta (Sham 1) | | high yield potential, yellow rust resistance, good grain quality | – |
| | Syria | 1984 | Sham 1 | | high yield potential, yellow rust resistance, good grain quality | 8.8% over Gezira (irrigated) |
| Bread wheat | Iran | within last 10 years | Azadi | released for rainfed region of Kermansha | | – |
| | Libya | 1984 | Zellaf | seed multiplication and distribution to a few farmers | high yield under full irrigation, adapted to Sebha (desert) climate | – |
| | | 1984 | Sheba | | | |
| | | 1984 | Germa (CC-Inia/-Tob x ctn 136) | | | – |
| | Morocco | 1984 | Jouda (Kal x Bb) | seed multiplication | high yielding, good grain quality, better disease resistance | – |
| | | 1984 | Merchouche | | | – |
| | Pakistan | 1982 | Zargoon (Cc-Inia/-Tob C:n x Bb/7c) | seed multiplication and distribution, grown in farmers' fields | better adapted, better grain quality, resistance to yellow rust | – |
| | PDR Yemen | 1982/83 | Ahgaf (S311 x Norteno) | seed multiplication and distribution, grown on 500 hectares 1983/84, expected to replace current commercial varieties | more salt tolerant, heat tolerance at seedling stage, increased straw yield, rust resistance, high yielding | up to 40% obtained by the Agricultural Research Institute |
| | Sudan | 1982 | Debeira (HD 2172) | commercial production, expected to replace Mexicani, grown last 10 years | more resistant to stem rust than present improved varieties, better yield and grain quality (for the Gezira and Khashm Elgirba areas) | – 20% |
| | Syria | 1982 | Sham 2 (7C x Tob/Cno)Kal) | seed multiplication and distribution, planted in farmers' fields farmers' fields | good grain quality, disease resistance | about 10% |

** Yield increase is calculated over five sites and varies from 10-45% from one site to another.*

*** Portugal has advised the Cereal Program that since 1980 besides Sham 1, 5 bread wheat, 5 durum wheat and 2 barley cultivars were selected from ICARDA nurseries and released.*

## INTERNATIONAL NURSERIES

One of the major objectives of the Cereal Improvement Program is to provide the region's scientists with superior wheat and barley germplasm for their breeding programs. This is accomplished through a system of international nurseries. Essentially three different types of germplasm are made available through the international nurseries system.

1. **Regional Crossing Blocks:** these are parental genotypes scientists can use in their own crossing programs. Entries in the crossing blocks are grouped by plant traits, such as days to heading and maturity, tolerance to various stresses, single and multiple disease resistance, grain yield and grain quality.

2. **Segregating Populations:** these are F2 populations derived from crosses made at ICARDA. National scientists use them as pools of genetic diversity and select promising genotypes in their local environments.

3. **Preliminary Observation Nurseries and Regional Yield Trials:** these nurseries include a more ready made or finished product in the form of ICARDA's most promising wheat and barley lines. The best entries from the Preliminary Observation Nurseries are promoted to the Regional Yield Trials for more rigorous testing. Scientists select outstanding lines as candidates for in-country testing and possible release as varieties or for use in the national crossing program.

The Cereal Program's international nurseries system includes 19 different nurseries encompassing over 3000 different genotypes. In 1984/85 over 700 sets were distributed to 87 national program sites in 46 countries. About two thirds went to

### ICARDA BASE INTERNATIONAL NURSERIES

| Name | | Number of entries |
|---|---|---|
| **Regional Crossing Blocks** | | |
| Barley | | 175 |
| Durum | | 150 |
| Bread Wheat | | 150 |
| **Regional Segregating Populations** | | |
| Barley | - Low Rainfall | 150 |
| | - Moderate Rainfall | 150 |
| | - Cold Tolerance | 150 |
| Durum | | 150 |
| Bread Wheat | | 150 |
| **Observation Nurseries** | | |
| Barley | - Low Rainfall | 100 |
| | - Moderate Rainfall | 100 |
| | - Cold Tolerance | 100 |
| Durum | - Low Rainfall | 100 |
| | - Moderate Rainfall | 100 |
| Bread wheat | - Low Rainfall | 100 |
| | - Moderate Rainfall | 100 |
| **Regional Yield Trials** | | |
| Barley | - Low Rainfall | 24 |
| | - Moderate Rainfall | 24 |
| | - Cold Tolerance | 24 |
| Durum | - Low Rainfall | 24 |
| | - Moderate Rainfall | 24 |
| Bread Wheat | | 24 |
| **High Altitude** | | |
| **Segregating Populations** | | |
| Durum | | 150 |
| Bread Wheat | | 150 |
| **Observation Nurseries** | | |
| Durum | | 125 |
| Bread Wheat | | 125 |
| **Yield Trials** | | |
| Durum | | 24 |
| Bread Wheat | | 24 |
| **Cereal Quality Nursery** | | 42 |
| Bread Wheat | | |
| Durum | | |
| Barley | | |
| Triticale | | |

countries in the ICARDA region. Countries of southern Europe, such as Portugal, Spain and Greece were the next largest recipients.

Data feedback between ICARDA and the national scientists is a critical part of the international nurseries system. Cooperating scientists record about 100,000 observations in their returned field books. CRISP, CERINT and SPSSx software packages available on the ICARDA computer are used to store and analyze this data. Results of the analyses are sent back to national programs in preliminary and final international nursery reports. Scientists use these reports to identify lines that performed best in grain yield and many other important characters over a range of locations or in specific environments. They can then make more targeted breeding decisions.

Disease response data compiled in the Key Location Disease Nurseries also helps them identify lines in each nursery with the best disease resistance. Since pathogens and insects appear at different locations with different levels of intensity from year to year, scientists benefit from reviewing the results obtained by their colleagues in the region.

## COUNTRIES REQUESTING ICARDA INTERNATIONAL NURSERIES

| Countries in the ICARDA Region | Turkey | Kenya |
|---|---|---|
| Abu Dhabi | AR Yemen | Korea |
| Afghanistan | PDR Yemen | Madagascar |
| Algeria | | Mexico |
| Cyprus | **Other Countries** | Netherlands |
| Egypt | Argentina | Nepal |
| Ethiopia | Australia | Nigeria |
| Iran | Bangladesh | Peru |
| Iraq | Bulgaria | Philippines |
| Jordan | Canada | Portugal |
| Lebanon | Chile | Somalia |
| Libya | China | Spain |
| Morocco | Colombia | Sri Lanka |
| Oman | Ecuador | Sweden |
| Pakistan | Ethiopia | Switzerland |
| Qatar | Finland | Tanzania |
| Saudi Arabia | France | Thailand |
| Sudan | FR Germany | UK |
| Syria | Greece | USA |
| Tunisia | India | USSR |
| | Italy | Zambia |

Preparing international nursery sets. In 1984/85 700 sets with 8000 genotypes were requested by 46 countries.

## TRAINING

Training national cereal scientists is a major activity of the Cereal Improvement Program. The objective is to improve their technical and practical knowledge so that they can use ICARDA's technologies more effectively and progressively take over basic crop improvement work from ICARDA. Types of training activities include residential courses, short specialized courses, individual training and in-country training courses. In recent years the number of scientists and technicians trained annually by the Cereal Program has increased substantially.

Each year the Program offers one 3-4 month residential course for 10-20 trainees. Participants are trained in field and laboratory research techniques with some classroom lectures, covering such topics as hybridization, disease scoring, agronomy, on-farm trials, selection, harvesting and grain quality.

Short specialized courses and individual training tailored to the immediate needs of national programs are receiving greater attention. The «in-country» courses are especially popular and the Program is getting a growing number of requests to organize these in the region.

Individual scientists come to ICARDA for one week to several months to work with Program scientists on specific topics relevant to the research they are doing in their national institutions. Degree training is also offered, with students conducting thesis work at ICARDA. Links with Aleppo University and other universities in the region are also being strengthened.

Laboratory and field training are basic features of the Cereal Program's training courses.

The Cereal Program also supports national training activities. Besides supplying educational materials and some training to the national staff in designing and implementing courses, Cereal Program scientists participate as guest lecturers.

Identifying the training needs of countries in the region is an ongoing task shared by all the Program's scientists. Regular contacts with national colleagues through visits, correspondence, conferences and workshops are the main sources of information. Through its training activities the Cereal Program develops more awareness of the practical needs of national programs.

As a result of ICARDA's training efforts, over 300 cereal researchers have upgraded their skills and are actively applying them in cereal research projects in their countries. A number of them hold key leadership positions in national programs. In Syria and Pakistan the heads of the national cereal improvement programs are graduates of the Cereal Program's residential training course.

Another important spinoff of ICARDA's training is the contact among trainees from all over the region. Reinforced over the years through scientific exchanges and regional workshops, this has led to a dynamic enthusiastic network of cereal researchers.

**SCIENTISTS TRAINED BY THE CEREAL IMPROVEMENT PROGRAM 1978-1985**

**Country of Origin**

| | |
|---|---|
| Afghanistan | 3 |
| Algeria | 5 |
| Bangladesh | 5 |
| Cyprus | 7 |
| Djibouti | 1 |
| Egypt | 8 |
| Ethiopia | 5 |
| Greece | 2 |
| India | 6 |
| Iran | 8 |
| Iraq | 13 |
| Jordan | 19 |
| Lebanon | 4 |
| Libya | 6 |
| Morocco | 14 |
| Oman | 3 |
| Pakistan | 7 |
| People's Republic of China | 1 |
| Qatar | 1 |
| Saudi Arabia | 3 |
| Somalia | 3 |
| Spain | 2 |
| Sudan | 9 |
| Syria | 54 |
| Tanzania | 1 |
| Tunisia | 19 |
| Yemen Arab Republic | 11 |
| Yemen People's Democratic Republic | 8 |
| Total | 228 |

**Others**

| | |
|---|---|
| Federal Republic of Germany | 1 |
| The Netherlands | 1 |

**In-country Courses**

| | | |
|---|---|---|
| Morocco | 1982 | 20 participants |
| Morocco | 1984 | 24 participants |
| Pakistan | 1985 | 21 participants |

**Cereals-Related Training Courses Conducted Jointly by ICARDA and the Syrian Ministry of Agriculture and Agrarian Reform**

| | | |
|---|---|---|
| 1984 | Maintenance and use of harvesting machines | 8 trainees |
| 1984 | Experimental designs and field plot techniques | 19 trainees |
| 1983 | Mechanical harvesting of field crops | 7 trainees |
| 1983 | Mechanical planting of field crops | 6 trainees |
| 1983 | Cereals, food legumes and forage improvement | 17 trainees |
| 1982 | Cereals, food legumes and forage improvement | 16 trainees |

## CEREAL QUALITY

The Cereal Improvement Program strives not only to increase the amount of cereal based food available, but also to maintain and gradually improve the quality of processed foods. Meeting consumer demands while avoiding heavy waste during industrial, commercial and domestic food processing are major objectives.

A cereal quality laboratory, capable of routine physical and chemical analyses and dough testing, was first installed at ICARDA in 1980/81. A separate area on the station contains flour mills, a purifier for semolina milling and commercial-type baking equipment, including a traditional stone built oven for two-layer flat bread baking. In 1983/84 the cereal quality laboratory ran a total of 34,000 tests for bread wheat, durum wheat, barley and triticale. (See table).

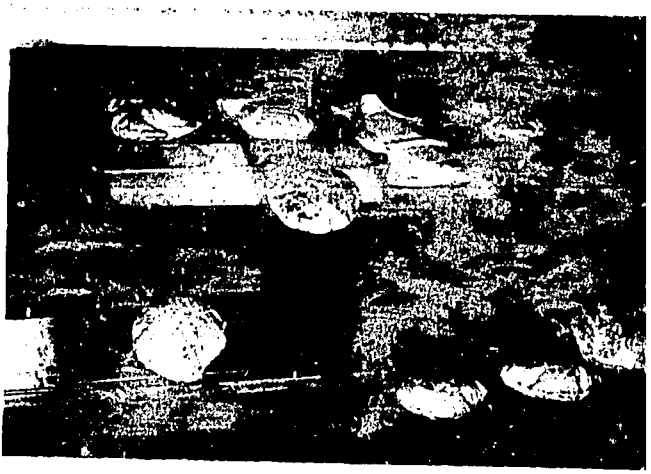
To complement the laboratory testing, the Cereal Improvement Program initiated the cereal quality nursery (CQN) in 1980, primarily to evaluate the stability of quality characteristics in advanced lines. The CQN contains 12 bread wheat, 12 durum wheat, 10 barley and 6 triticale genotypes. In each crop two cultivars are grown as a permanent control. The breeders are encouraged to introduce two advanced lines every year which are then exposed to heavy environmental pressure to measure their quality. The other lines remain in the CQN for three years. This format provides breeders flexibility while generating enough information on genotypes to allow statistical analysis. The CQN is presently grown in 12 locations and conditions in the region, including one irrigated and one low fertility location.

**Ensuring consumer acceptance— ICARDA's cereal quality lab has a traditional furnace-type oven to simulate the conditions of local bakers. The lab also tests for industrial quality.**

ICARDA's cereal laboratory is not only an integral part of the Program, but it is recognized regionally as a comprehensive and reliable center for quality testing. Its staff are contacted regularly for technical advice and research support.

National agricultural research programs in Cyprus, Jordan, Libya, Pakistan, Syria and Tunisia have sent materials to the cereal laboratory for testing. The laboratory carried out 1316 tests for these countries in 1983/84. Nine countries have been visited in the region to establish relations and collect information about the cereals industry.

The laboratory also plays a major teaching role. All cereal trainees passing through ICARDA cereal courses come to the laboratory for training in grain quality testing. An operations manual for all the tests carried out by the laboratory is almost complete and has already been given to several national agencies on request in its preliminary form.



QUALITY TESTS FOR BARLEY AND WHEAT

| Crop | Test | Lines Tested | Quality Factor |
|---|---|---|---|
| Barley | Thousand kernel weight | F3 + | energy level |
| | Kernel size distribution | F4 + | processing in feed mills, fermentation |
| | Diastatic power | F4 + | energy level |
| | Protein content | All | energy level |
| | Lysine content | All | energy level |
| | Test weight (1 liter volume) | F4 + | processing in feed mills |
| Bread wheat and Triticale | Hardness | F3 + | water absorption, gas production, flour yield |
| | Wheat meal fermentation time | F3 + | dough strength |
| | Protein | All | dough strength, water absorption |
| | Test weight (1 liter volume) | F4 + | processing in mills |
| | Mixograph | selected lines | dough strength |
| | Flour milling | selected lines | flour yield |
| | Farinograph | selected lines | dough strength |
| | Baking two-layer flat bread | elite lines | baking quality |
| Durum wheat | Protein | All | dough strength |
| | Test weight (1 liter volume) | F4 + | processing in mills |
| | Thousand kernel weight | F3 + | processing in mills |
| | Mixograph | selected lines | dough strength |
| | Flour milling | selected lines | flour yield |
| | Farinograph | selected lines | dough strength |
| | Baking two-layer flat bread | elite lines | baking quality |
| | SDS sedimentation | F3 + | dough strength |
| | Vitreousness (kernel glassiness) | F3 + | semolina yield, burghul quality |
| | Yellow pigment | F4 + | semolina yield, burghul quality |
| | Semolina milling | elite lines | semolina yield |
| | Spaghetti making | elite lines | pasta quality |

POPULAR CEREAL BASED FOODS IN THE ICARDA REGION

| FOOD | GRAIN |
|---|---|
| *Two-layer Flat Breads* (khobz, baladi) | bread and durum wheat |
| *Single-layer Flat Breads* (tannour, saaj) | bread and durum wheat |
| *Burghul, Couscous* (Mature grains are boiled, dried, milled and steamed with meat and vegetables.) | durum wheat, some bread wheat |
| *Pasta* | durum wheat |
| *Frekeh* (Green wheat is charred, ground into coarse chunks, then steamed or boiled.) | durum wheat |

## WORKSHOPS AND CONFERENCES

The Cereal Program plays an active role in organizing workshops and conferences of special relevance to the region. These meetings remain a major vehicle for international and national researchers to meet and discuss their work. They contribute to the growth of a regional network of cereal scientists and help minimize duplication of effort among and even within countries. The presentations and discussions are recorded in published proceedings distributed wordwide.

The Program has developed a rather novel approach to workshops, called the Traveling Cereal Workshop, intended to foster closer links among scientists. This involves scientists from a particular subregion, such as North Africa or the Middle East, meeting and spending a week in one or two neighboring countries. They visit research plots, discuss local problems and share experiences. Three traveling workshops were held in 1984 and 1985, two in North Africa and one in the Middle East for scientists from Jordan, Cyprus, Turkey, Syria, Egypt and Sudan.

The Cereal Program regularly invites senior research scientists and administrators from national programs to its annual internal program planning and review meeting, at which the work plan and priorities are set for the coming year. Twenty-two national program representatives were invited to participate in the Cereal Program's 1985 planning session.

**Cereal Program Sponsored and Cosponsored Workshops/Conferences**

Fourth Regional Winter Cereal Workshop-Barley. April 1977. Amman, Jordan. (ICARDA and Montana State University).

Diseases of Small Grains-Their Incidence and Control in the ICARDA Region. December 1978. London, U.K.

Fifth Cereals Workshop- The Gap between Present Farm Yield and the Potential. May 1979. Algiers, Algeria. (ICARDA with CIMMYT and the Algerian Ministry of Agriculture and Agrarian Reform).

Seed Production Symposium. March 1981. Aleppo, Syria. (ICARDA and the Government of the Netherlands).

Barley Diseases and Associated Breeding Methodology Workshop. April 1981. Rabat, Morocco. (ICARDA in association with Montana State University and CIMMYT).

Cereal Improvement Traveling Workshop: North Africa. April/May 1984. Morocco and Spain. (ICARDA and CIMMYT).

Cereal Improvement Traveling Workshop: North Africa. April 1985. Morocco. (ICARDA and CIMMYT).

Cereal Improvement Traveling Workshop: Middle East. May 1985. Jordan and Syria. (ICARDA and CIMMYT).

Improving Wheat and Barley in Moisture Limited Areas. October 1985. Capri, Italy. (ICARDA and CNR, Italy).

Middle East Traveling Workshop — Senior scientists from Lebanon, Jordan, Egypt and Sudan confer with each other (above) during a recent traveling cereal workshop. Below, Jordan University's Dean of Agriculture explains the university's research to ICARDA and national colleagues. The 1985 Middle East Traveling Workshop was cosponsored by CIMMYT and ICARDA. Fifteen scientists from nine countries, including several countries outside the region, such as Chile, Ecuador and Spain, participated. During the week-long workshop scientists got a comprehensive view of cereal research in Jordan and Syria, visiting on-farm trials and university and national research stations. Some of the comments from the summing up session at ICARDA included: "This workshop has been very valuable. It is the first time I have been able to see agriculture in Syria and Jordan."

"What I didn't like is that we didn't have enough time to discuss the needs of each site and environment and how they could be solved."

"Perhaps one day should be spent in the ICARDA library. Some of us don't have access to the range of publications in our information centers."

One of the many positive results of the workshop was that Jordan and ICARDA strengthened their association even further. In the next season Jordan's Deir Alla station will be used by ICARDA to screen materials for drought tolerance without the complication of cold. Egypt, Ethiopia and Sudan will benefit from these kinds of barley lines.

## INFORMATION

The Cereal Improvement Program believes strongly in the exchange of information among the world's college of cereals researchers. In the region it is encouraging national scientists to share interesting research findings in *Rachis*. *Rachis* is a journal on barley and wheat published twice a year by ICARDA in English and Arabic. It contains review articles on research and production, short communications and news of recent publications and forthcoming events. *Rachis* provides a forum for ICARDA and national staff to discuss research results that are perhaps of more immediate relevance to the region and might not be published in a major international journal. To reach the larger community of scientists, however, the Program's scientists do publish regularly in scholarly journals as well. In 1984 four staff had five articles accepted by such journals as *Crop Science* and *Theoretical and Applied Genetics*.

The Cereal Program has also produced a field guide for wheat diseases in the region, and is in the process of preparing more training manuals to accompany its courses. One training manual on *Techniques of Seed Production* has already been used by students.

Beginning 1985/86 ICARDA becomes the headquarters for a major USAID-funded project called the Rainfed Agricultural Information Network (RAIN). This network will support the flow of agricultural research information, including information on cereals, between research agencies and institutions extending services to farmers in North Africa and West Asia.

# COUNTRY AND PROJECT PROFILES

# COUNTRY PROFILES

The strength of ICARDA's Cereal Improvement Program is its close interaction with national programs. The following profiles highlight projects developed by the Cereal Program together with individual national research programs to tackle specific needs at the country level. Underlying these special efforts is a common base of cooperation between the Cereal Program and its partners in the region. Besides training and the extensive network of germplasm exchange and testing, there are many other important but less well known ways in which the Program is helping strengthen national research. Each year, for example, the Program brings many senior national scientists to ICARDA. They meet the cereal staff, learn about their activities, and discuss their own research needs and areas of possible collaboration. Likewise Cereal Program scientists spend amost half of their time on the road working with national colleagues in their fields and laboratories and discussing broader issues of crop improvement and priorities with research administrators. The Cereal Program is often approached to review national program activities and suggest changes to accelerate the pace of research results. They are also frequently asked to lecture to national research staff and university students and to help supervise masters degree candidates in their thesis work.

Not only does the Cereal Program underwrite the participation of national scientists in the workshops and conferences ICARDA organizes, but it also funds their attendance at international conferences and professional meetings throughout the world and pays for their visits to other national programs in the region.

**Professor Jaradat (left) from the University of Yarmouk, Jordan, and Professor Jana (right) from the University of Saskatchewan, Canada, are working together with ICARDA on the collection and evaluation of durum wheat landraces.**

In some programs the lack of modest equipment, like a pickup truck or plot thresher, and supplies like envelopes, crossing bags, labels and simple spare parts can severely hamstring the efforts of national scientists. Where appropriate, the Cereal Program supplies critically needed equipment, sometimes making the difference between a struggling and dynamic research program.

Finally, the national programs are full partners in developing the Cereal Program's own workplan. Each year they are invited to attend the Program's fall planning session where they can express satisfaction or dissatisfaction with their joint work and comment on the Program's activities and priorities.

## CYPRUS

### PARTNER ORGANIZATION

Agricultural Research Institute (ARI)

### NATURE OF COOPERATION

**Research**—Since its establishment ICARDA's Cereal Improvement Program has had close ties with the Cypriot national program. Since 1981 Cyprus has been helping ICARDA develop and evaluate short maturity barley and wheat. ICARDA sends promising lines to Cyprus where winters are mild and the growing season relatively short. Cypriot scientists evaluate material and identify the best entries. Some of the selections made by cereal researchers in Cyprus are doing very well in other countries, such as Syria, Tunisia and Greece, where early maturity is also needed in certain areas. An example is the durum wheat Sebou.

The Agricultural Research Institute also sends ICARDA seeds to be advanced one generation in ICARDA's summer nurseries. This cuts the breeding time substantially. ICARDA also receives selected material generated in Cyprus. ARI's head of Agronomy and Breeding spent one year with ICARDA as a senior visiting scientist. Scientists from the two institutions visit each other regularly.

**Training/Workshops**—Seven Cypriot scientists have been at ICARDA for training since 1978, mostly to attend specialized short courses. ICARDA has sponsored Cypriot scientists at international conferences, workshops and in visits to other countries in the region.

### AGREEMENT

An agreement was signed in 1981 for four years; this was extended in 1984 until 1987.

### FUNDING

ICARDA (core budget): a nominal amount for equipment, supplies, travel and the additional costs of screening ICARDA nurseries.

### PROGRESS TO DATE

The Cypriot Agricultural Research Institute has recently identified one barley and two durum wheat varieties from ICARDA nurseries. The barley has been named Kantara (Roho), and the durum varieties are called Mesoaria and Karpasia, which is Sham I in Syria. Large quantities of seed are being supplied to farmers.

## EGYPT

### PARTNER ORGANIZATION

Agricultural Research Center(ARC)

### NATURE OF COOPERATION

ICARDA has had very close cooperation with the Egyptian national program from the start. From 1975-77 ICARDA wheat and barley nurseries were grown, selected and distributed from Egypt. A number of Egyptian scientists were sponsored by ICARDA at international conferences and seminars and Egyptian research officials regularly make valuable contributions to ICARDA workshops and annual program planning sessions. The Cereal Program also cooperates in special projects, such as screening for salt tolerance in wheat and barley, and grain quality testing. More recently two new projects have been developed.

Together with ICARDA, Egypt's Agricultural Research Center at Giza is taking responsibility for the mass rearing and screening of aphids. Two aphid species are known to inflict grain losses of 25-30% in Egypt. With financial and technical support from ICARDA, a modest laboratory has just been completed in Giza, which will be able to mass rear three or four aphid species and screen plants at a seedling stage. The laboratory will have the capacity to test 200-500 wheat and barley lines each week. Over 5000 bread wheat, barley and durum wheat lines were delivered in 1985 to launch the project; these have already been screened. Laboratory testing will be supplemented by field screening at two sites in Egypt, where natural infestation is very high. The laboratory will also screen faba beans for aphid resistance. In the future this screening facility could be made available to other national programs in the region.

ICARDA and Egypt also have a small project that enables Egyptian scientists to test barleys in four sites along the northeast coast of the country.

### AGREEMENT

An agreement was signed between Egypt and ICARDA in 1984.

### FUNDING

ICARDA Nile Valley (IFAD)/ICARDA (core budget)

## ETHIOPIA

### PARTNER ORGANIZATION

Institute for Agricultural Research

### NATURE OF COOPERATION

The Cereal Program regularly distributes international nurseries of barley, durum wheat and bread wheat to Ethiopian scientists. Several researchers have been trained at ICARDA in barley and durum wheat improvement, pathology and agronomy. Senior Ethiopian scientists have visited the Cereal Program to become acquainted with it and to select disease and stress tolerant lines. ICARDA staff have also visited Ethiopia and participated in a seminar organized by Ethiopians to discuss their strategy for crop improvement.

Barley is one of Ethiopia's major food crops, grown on more than one million hectares in the highlands under stressful conditions. Yields vary from 400 kg/ha to 2000 kg/ha. Under the agreement signed between ICARDA and Ethiopia in 1984, the Cereal Program will provide particular support to the country's barley research activities. ICARDA will assist the barley program with consultancies, germplasm, literature and short-term training as well as individual and graduate training abroad. ICARDA will also bring Ethiopian scientists to Tel Hadya and help them organize workshops and conferences of specific relevance to their problems. Further areas of mutual cooperation will be identified during periodic consultations.

The Cereal Program also maintains close relations with Ethiopia's Plant Genetic Resources Center in Addis Ababa.

### AGREEMENT

An agreement between the Government of Ethiopia and ICARDA was signed in 1984.

### FUNDING

ICARDA (core budget)

## ISLAMIC REPUBLIC OF IRAN

### PARTNER ORGANIZATION

Agricultural and Natural Resources Research Organization, Ministry of Agriculture

### NATURE OF COOPERATION

**Research**—In 1985 ICARDA and Iran initiated a modest project for cooperation in cereals research. This stems from a general agreement signed in 1984 between ICARDA and the Islamic Republic of Iran for research and training support. Under this agreement ICARDA is helping Iran improve its research capabilities in dryland farming through the exchange of germplasm as well as scientific information and literature. Iranian scientists are coming to ICARDA for training and are invited to participate in workshops and conferences organized by the Cereal Program.

At Iran's request in 1985 one of the Program's scientists spent time in Iran reviewing varietal improvement and agronomy research throughout the country, but especially in the Tabriz area.

**Training/Workshops**—In 1984/85 four Iranians were trained in the Cereal Program's residential course, and three Iranian scientists received individual training. In addition, 30 researchers came from Iran to ICARDA to visit the Cereal Program.

### AGREEMENT

ICARDA and the Islamic Republic of Iran signed a general agreement of cooperation in 1984. A workplan is jointly prepared each year.

### FUNDING

Iran

## JORDAN (Project 1)

### PARTNER ORGANIZATION

University of Jordan, Faculty of Agriculture
Ministry of Agriculture, Department of Research and Extension

### NATURE OF COOPERATION

Research—The Jordan Cooperative Cereal Improvement Project
Since 1978 ICARDA has been working with the University of Jordan and the Ministry of Agriculture to strengthen the testing and development of new wheat and barley varieties and agronomic practices in Jordan. This has involved identifying better performing varieties and crop management practices and demonstrating these to farmers in farmers' fields.

Training/Workshops—Training to enhance the technical levels of both the University's Faculty of Agriculture and the Ministry's Department of Research and Extension was an important component of the project. The project also included surveys of cereal producing areas to determine the status of existing farming systems, practices and constraints to ensure that any new practices would be within the means of farmers. Since the beginning of the project 15 Jordanian scientists have come to ICARDA for specialized training as well as to participate in the residential course.

One of the first conferences the Cereal Program cosponsored, the Fourth Regional Winter Cereal Workshop, was hosted by Jordan.

### AGREEMENT

The Government of Jordan, together with the University of Jordan, signed an agreement with ICARDA in 1978.

### FUNDING

Ford Foundation 1978-1983/USAID 1984- / The Government of The Netherlands financed the socio-economic studies conducted by the project.

### PROGRESS TO DATE

Based on five years of experiment station research and on-farm trials, Jordanian and ICARDA scientists believe that the current average durum wheat yield of 700 kg/ha can be increased by 30% to 900-1000 kg/ha. If farmers achieve this Jordan could cut wheat imports by about 50,000 tons a year. In 1981/82 ICARDA and Jordanian colleagues came up with a "best bet" package of recommendations for durum wheat and barley production for four different rainfall zones of Jordan, ranging from 250-400 mm. These packages include recommendations on variety, seed rate, nitrogen phosphate, sowing date and weed control. Farmers are being shown what kinds of yield increases they can expect if they use all or just some of the elements of the "best bet" package. A publication describing the project and its results is available from ICARDA: *A Report on the Jordan Cooperative Cereal Improvement Project*. The project will continue with USAID funding.

**Graduate Students Financed by the Cereal Program through the ICARDA/Jordan Cooperative Project**

| Name | Topic | Year Graduating |
|---|---|---|
| Majed Zu'bi | Influence of sowing depth on the establishment and growth of durum wheat | February 1984 |
| Ghaleb Shalaldeh | Inheritance of several morpho-physiological characters, grain yield and yield components in 10 durum wheat crosses | May 1984 |
| Moh'd Ajlouni | Inheritance of certain agronomic characters in durum wheat crosses | February 1986 (tentative) |
| Ali Gharaibeh | Effect of crop rotation and other management practices on wheat yield. | February 1986 (tentative) |
| Jamal Abu el-Enein | Inheritance of certain agronomic traits in durum × dicoccoides crosses | February 1987 (tentative) |

## JORDAN (Project 2)

### PARTNER ORGANIZATION

University of Yarmouk

### NATURE OF COOPERATION

ICARDA and the University of Yarmouk are working together on a project entitled "Evaluation of Durum Wheat Landraces from Jordan". The objective of this project is to evaluate and characterize systematically barley and durum wheat materials collected in Jordan and to store the information in an easily retrievable form for use in crop improvement. Explorations were undertaken in Jordan in 1983 to sample the genetic variability of barley and durum wheat and their wild relatives. Seed was increased the following season and will now be evaluated in Syria, Jordan and Canada under varying environmental conditions. The University of Saskatchewan in Canada is studying the isozyme patterns in the evaluation for stress tolerance, particularly drought tolerance. Under this project several graduate students from the University of Yarmouk will spend a semester at ICARDA for training.

### AGREEMENT

A general agreement of cooperation was signed between the Government of Jordan and ICARDA in 1984.

### FUNDING

ICARDA (core budget)

## LEBANON

### PARTNER ORGANIZATION

Agricultural Research Institute, Tel Amara (ARI)

### NATURE OF COOPERATION

Research—Despite political turmoil in the country strong cooperation exists between ICARDA and the Lebanese national program as well as with the American University of Beirut and Jesuit University. ICARDA's Cereal Program makes extensive use of ICARDA's Terbol station in the Beka'a Valley as a high rainfall (550 mm), low temperature site with heavier disease pressure. Crossing blocks, segregating populations, yield trials and disease screening nurseries for barley, wheat and triticale are planted at Terbol. The most promising lines are multiplied and given to Lebanese scientists.

The Cereal Program cooperates closely with scientists from ARI, Tel Amara in varietal improvement and seed production. The exchange of visits between ICARDA and Tel Amara is frequent.

Training/Workshops—Four Lebanese scientists have participated in training programs at ICARDA, and four or five MSc students came to ICARDA from the American University of Beirut for 2-4 months thesis research.

### AGREEMENT

ICARDA and Lebanon signed a formal agreement of understanding when ICARDA was established.

### FUNDING

ICARDA (core budget)

# MOROCCO

## PARTNER ORGANIZATION

Institut National de la Recherche Agronomique (INRA)
Institut National Agronomique et Veterinaire (INAV)

## NATURE OF COOPERATION

Research—Each year the INRA cereal program receives ICARDA segregating populations and advanced homogeneous barley, wheat and triticale lines for use in national yield trials and their hybridization program. They also select heavily from early generation materials. Besides providing this diverse genetic base through its nurseries, ICARDA provides special, targeted germplasm for high elevations, septoria leaf blotch, tan spot and Hessian fly. In 1983 a team of ICARDA scientists and consultants were invited by Morocco to review its cereal improvement, varietal release and seed multiplication procedures. ICARDA scientists travel regularly with Moroccan colleagues to different research sites in the country to evaluate results and discuss research methodologies. Likewise Moroccan scientists visit Tel Hadya to keep abreast of new developments in ICARDA's Cereal Program.

Training/Workshops—In 1981 INRA and INAV hosted a major international barley diseases workshop with support from ICARDA, CIMMYT and Montana State University. More recently in 1984 and 1985 two regional «Traveling Workshops» were held in Morocco for cereals researchers in North Africa and the Iberian peninsula. Scientists from Portugal, Spain, Tunisia and Morocco traveled around Morocco visiting research stations evaluating the performance of new lines and sharing experiences and approaches to common problems.

Since 1978 12 researchers from INRA have been brought to ICARDA for training in cereal methodology, seed production, pathology and germplasm. Forty-four scientists attended locally organized courses on experimental design and cereal research and production.

Morocco has embarked on an ambitious training program of its cereal research staff. Its three senior wheat and barley breeders are presently in the U.S. working on advanced degrees. The Cereal Research Coordinator will also be leaving in the fall of 1985 for a PhD at the University of Oklahoma. ICARDA has been asked by Morocco to give more support in terms of scientists and facilities, particularly during this transitional phase of staff training. Support to new scientists recruited into the program, most of whom have no field experience, is a first priority.

## AGREEMENT

Morocco and ICARDA have been strengthening cooperative links since 1980, and a formal agreement of general cooperation was signed in 1984 intensifying ICARDA's support.

## FUNDING

ICARDA (core budget)

## PROGRESS TO DATE

For the first time in 10 years Morocco recommended the multiplication and distribution of new wheat and barley varieties. Some of these were identified through ICARDA nurseries. The barley varieties have been released under the names Asni, Tamellalt and Tissa. The durum wheats are Marzak and ACSAD 65 or Stork, and the bread wheats are Jouda and Merchouche. Four more durums and triticale lines are under seed increase and final evaluation for distribution in 1985.

Another indication of Morocco's strong commitment to rapid progress in cereal production is the Minister of Agriculture's decision to jump five promising barley lines straight from international nursery testing to seed multiplication and large scale testing on farmers' fields in 1985/86. These varieties are Harmal, Faiz (early Russian/Apam), Rihane 'S', Assala 'S' and Matnan.

**Moroccan barley and bread wheat scientists evaluating new wheat germplasm for diseases.**

## PAKISTAN

### PARTNER ORGANIZATION

Pakistan Agricultural Research Council (PARC)
Arid Zone Research Institute (AZRI)
Agricultural Research Institute, Sariab, Quetta (ARI)
Management of Agricultural Research and Technology Project

### NATURE OF COOPERATION

Research—Beginning 1985/86 ICARDA becomes executing contractor for a major Government of Pakistan project, funded in part by USAID. The project calls for four full time scientists: an agronomist, agricultural economist, rangeland scientist and extension specialist. ICARDA itself funds the fifth position of team leader/agronomist. This project is an expansion and outgrowth of a pilot project between ICARDA and Pakistan, started in 1981 in Baluchistan. The project was based in the Arid Zone Research Institute in Quetta and the provincial Agricultural Research Institute in Sariab. Its objective was to evaluate genotypes and production practices in the highland environment of Baluchistan. The work was funded through a small ICARDA core contribution, covering the provision of germplasm, a vehicle, plot thresher and some training. In 1983 FAO also became a partner in the project. ICARDA scientists visited the project periodically but the national organization furnished the scientific staff, land, laboratory and field facilities to conduct the trials and most of the operating costs.

The expanded project will be based at AZRI in Quetta. The outposted team will be supported substantially by headquarters staff, in particular a senior cereal breeder who devotes his full time to development of cereals for high elevations, especially for Baluchistan.

### AGREEMENT

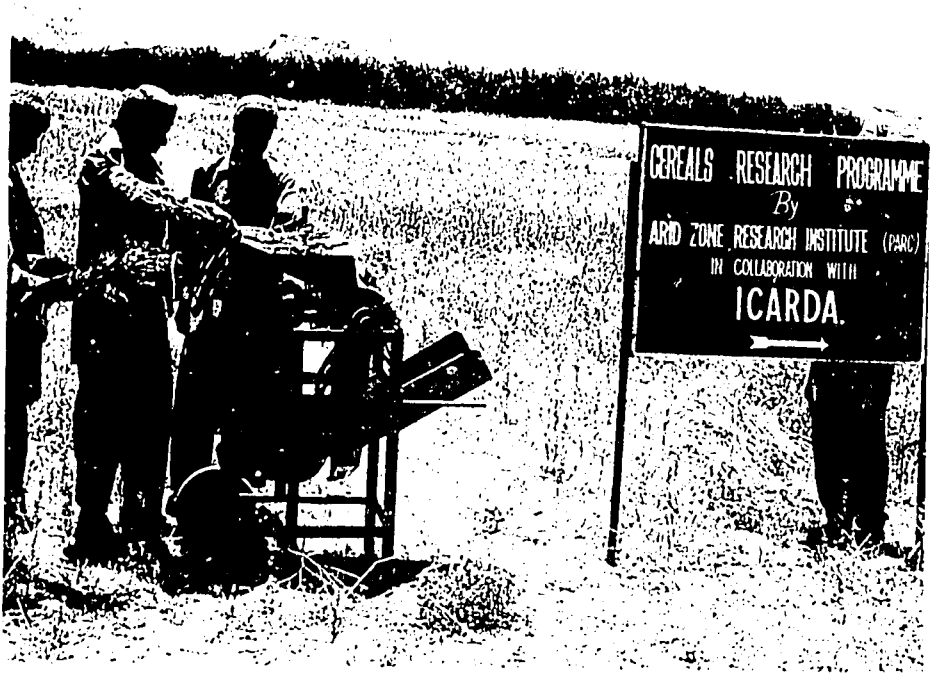
The contract agreement was negotiated between USAID and ICARDA April 1985 for the contract to begin on-site August 1985. The duration of the project is for four years.

### FUNDING

ICARDA (core budget)/USAID/ Government of Pakistan

### PROGRESS TO DATE

The results emanating from the pilot project have provided useful information on the major production constraints in the highland environments of Pakistan. Two diseases, yellow rust and common bunt are responsible for large crop losses. The first can only be controlled by genetic resistance. The second can be controlled with seed dressings. ARI has identified and named two well adapted rust resistant bread wheat varieties, Zargoon and Zamindar. Trials showed significantly higher yields could be obtained using these varieties under irrigated and rainfed conditions. However, farmers do not have access to these varieties or practices because seed is not available and there is no effective program of extension demonstration. To help overcome this barrier, FAO joined ICARDA and PARC in a project of on-farm demonstrations of the new varieties and improved production methods.




**Selecting and threshing new germplasm received from ICARDA by Pakistan's Arid Zone Research Institute.**

«*You must be delighted on the successful negotiations of the USAID/PARC and ICARDA project on strengthening AZRI, and perhaps it came about partly due to our collaboration in improving cereal production through research since 1981.*

*Though our cooperation was small and restricted to training, supply of germplasm and some essential equipment and exchange visits, it came at a very crucial time. Through this cooperative arrangement our research objectives started taking shape and got well focused.*

*The achievements in the form of identification of promising wheat lines and development of a package of production practices on the use of seed rate, seed dressing and fertilizer have been significant. These findings are now being demonstrated to the farmers under the PARC/ICARDA/FAO project.*»

*Zafar Uddin*
*Director, Arid Zone Research Institute*
*Quetta, Pakistan*

## SUDAN (Project 1)

### PARTNER ORGANIZATION

Agricultural Research Corporation (ARC)

### NATURE OF COOPERATION

Presently Sudan imports about 60% of its annual wheat requirements. However, experiments show that with improved wheat varieties now available and better management farmers could more than double their yields from 0.8 tons/ha to 1.5 tons/ha. Practically all wheat production in Sudan is under irrigated conditions. Sudan urgently needs to increase its food production to face the pressing food shortage affecting its 3-4 million inhabitants.

To improve wheat production ICARDA and Sudan are undertaking a major new project modeled somewhat along the same lines as ICARDA's Nile Valley Project for faba beans in Egypt and Sudan. ICARDA and Sudanese scientists and extension workers will come up with a recommended package of technologies to be used in farmers' fields. This will be kept simple and easy to apply. Socio-economists will be involved from the start to help design and evaluate the project. The package will first be verified in farmers' fields and then demonstrated to farmers on a larger scale. Varieties, seed rate, date of planting, seedbed preparation, fertilizers, irrigation, insect and weed control will be considered. CIMMYT's support will also be enlisted.

This pilot project will be coordinated by an ICARDA-appointed cereal agronomist and last two years initially. Although Sudan will be the main beneficiary of the project, it is intended that a number of other countries with similar agroclimatic conditions and constraints, like Somalia, Yemen Arab Republic and Yemen People's Democratic Republic will also benefit.

### AGREEMENT

The Government of Sudan is in agreement with the project proposal, and it is expected to begin with the 1985/86 cropping season

### FUNDING

OPEC Fund special project financing

## SUDAN (Project 2)

### PARTNER ORGANIZATION

Agricultural Research Corporation (ARC)

### NATURE OF COOPERATION

«Aphid Research»—Two aphid species are serious insect pests in Sudan, causing wheat losses of 50-100%. No biological or cultural controls have been successfully developed yet. The only method of control now used is spraying at least twice with insecticide. While chemical control is presently satisfactory, there is the potential of environmental hazards and insects developing resistance. Breeding genetic resistance into new wheat cultivars is the most promising approach for effective long-term control. Sudan is field screening annually more than 300 breeding lines from ICARDA, CIMMYT, Egypt and its own program in three locations under conditions of high natural aphid infestation. The project began with the 1984/85 season.

«On-Farm Verification Wheat Trials»— Farmers' wheat yields in Sudan are low because they do not use improved varieties or suitable agronomic practices. There is a need for a system of on-farm trials to demonstrate their usefulness. In 1984 ICARDA's Cereal Program initiated a small project with the Sudan Agricultural Research Corporation that will allow researchers to verify the performance of improved cultivars and accompanying agronomic practices on farmers' fields at six different locations in Sudan. The ARC scientists are executing the trials with Cereal Program staff acting as technical supervisors.

### FUNDING

ICARDA (core budget)/CIMMYT

## SYRIA

### PARTNER ORGANIZATION

Agricultural Research Center (ARC), Ministry of Agriculture and Agrarian Reform
University of Aleppo, Faculty of Agriculture

### NATURE OF COOPERATION

**Research**—ICARDA has a special relationship with Syria, its principal host country. Although joint research started in 1977, it was formalized as a special project in 1981. Each season scientists in the Cereal Improvement Program provide Syrian colleagues with crossing blocks, segregating populations, advanced yield trials and disease nurseries of wheat and barley. Selections are made together for high yield, adaptability, disease and insect resistance and desirable agronomic traits. Using ICARDA and local germplasm, ARC staff make crosses to combine superior qualities. To test potential cultivars, a major system of on-farm verification trials has been developed by ICARDA and ARC, in which promising lines are tested on large plots in farmers' fields. In 1984/85 over 30 such variety trials were conducted. In addition, 15 agronomy trials were also carried out on farmers' fields to determine appropriate fertilizer combinations for different cereal crops under different agroecological conditions. Agronomic trials show significant yield increases from applications of nitrogen and phosphorus Since 1983 ACSAD is working with Syria and the Cereal Program on farmer verification trials.

The Cereal Program's pathology team also work closely with Syrian scientists on research and training. They evaluate the disease response of materials used in farmers field verification trials in the field and in disease nurseries. They also screen ARC's promising lines in the Program's regular disease nurseries. Annual monitoring of the status of cereal diseases in Syria is another aspect of ICARDA's support.

**Training/Workshops**—So far, ICARDA has trained more Syrian scientists than any other nationality (over 100). This has resulted in Syrian scientists taking more responsibility in the joint cereal work. Precision of experiments has increased. In 1984/85 half of the farmers field verification trials were carried out independently by Syrian scientists.

### AGREEMENT

Syria and ICARDA signed a general agreement of cooperation in research and training in 1981.

### FUNDING

ICARDA (core budget)

### PROGRESS TO DATE

As a consequence of close collaboration with ICARDA's Cereal Program, Syrian scientists identified two wheat varieties in ICARDA's nurseries as superior in Syrian growing condi-

tions. These are being multiplied and distributed widely. Both are originally CIMMYT crosses and selected by ICARDA. Sham 1, the durum wheat is intended for moderate rainfall areas. It combines high yield potential with resistance to yellow rust. The bread wheat, Sham 2, does best in irrigated and high rainfall areas. Not only is it higher yielding than Mexipak, the local check, but it also has better baking quality and higher protein content and excellent cold tolerance. More promising lines have been identified and collaborative work is going on in several areas concerning cereal improvement.

**Cereal Program staff and Syrian scientists use farmers' fields to demonstrate the value of improved cultivars and practices in the Syrian farmers field verification trials.**


## TUNISIA

### PARTNER ORGANIZATION

Institut National de la Recherche Agronomique de Tunisie (INRAT)
Institut National Agronomique de Tunisie (INAT)

### NATURE OF COOPERATION

**Research**—At the request of the Tunisian government ICARDA posted a barley breeder/pathologist to Tunis in 1980 to help set up a national barley improvement program. By the end of 1983 the new barley program had developed so successfully that a Tunisian was appointed to head the program and ICARDA's scientist was asked to divert his support to pathology problems. Diseases are considered to be one of the major production constraints in the country. Thus, he is presently focusing on yellow rust, septoria leaf blotch and tan spot for wheat and scald, net blotch, powdery mildew and leaf rust for barley.

ICARDA has developed a special relationship with the Tunisian cereal program. Each year the work of the previous year is reviewed and a work plan for the next season is developed. Scientists from Tunisia and ICARDA jointly hold these coordination meetings. Tunisian scientists visit ICARDA's base program to familiarize themselves with the research methodologies and germplasm, particularly for rainfed areas. ICARDA has provided critically needed plot machinery and research equipment and is presently assisting one Tunisian scientist in getting his PhD degree.

Close working relations also exist with INAT scientists in developing facilities for disease screening, and in landrace collection and evaluation.

Tunisia is, of course, a major recipient of breeding materials from ICARDA. ICARDA is benefiting in turn by using sites in Tunisia to test and select germplasm before it is distributed to national programs on a wide scale.

**Training/Workshops**—In all 19 Tunisian scientists have been trained at ICARDA: nine in residential courses; six in short specialized courses; and four in individually developed programs. Areas of training cover seed treatment and nursery preparation, cereal planting and quality and seed production. The Program's scientists are frequently asked to lecture at Tunisian institutions and help supervise students working on their MSc degree theses.

### AGREEMENT

ICARDA and the Government of Tunisia signed a formal agreement in 1980 establishing ICARDA's presence in the country and detailing the terms of cooperation.

### FUNDING

ICARDA (core budget)

### PROGRESS TO DATE

As a result of the collaboration between Tunisia and ICARDA three new barley varieties were named and cataloged as official cultivars in 1985. These are Faiz (early Russian/Apam), Taj (WI 2198) and Roho (Roho). These lines were introduced through ICARDA's nurseries and identified by ICARDA's resident breeder and national colleagues as suited to the Tunisian environment. Faiz is high yielding and has good straw digestibility. It is best suited for areas with more than 350 mm/yr rain. Roho and Taj are more drought tolerant and disease resistant than the local varieties. They mature one to two weeks earlier and this helps them escape drought. These new cultivars give yield increases of no less than 20% without improved management and more than 25% with improved management. The Tunisian Office des Cereales reports increases of 50% over the local checks for Faiz in locations of 325 mm/yr rainfall and 42% for Taj and Roho in 200 mm areas.

## TURKEY

### PARTNER ORGANIZATION

Ministry of Agriculture, Forestry and Rural Affairs

### NATURE OF COOPERATION

**Research**—ICARDA and Turkey have recently agreed to strengthen their collaboration. Under this agreement ICARDA will provide two sets of various barley, durum wheat and bread wheat nurseries to the Central Anatolian Regional Agricultural Research Institute each year. In addition, Turkey has requested special nurseries for wheat stem sawfly, cold tolerance, salt tolerance, common bunt and cereal grain quality. For the 1984/85 season ICARDA sent Turkish scientists 2500 kg of seed of the durum wheat Sham 1 and 200 kg of the bread wheat Sham 2 to be used on on-farm trials in the south and southeast of Turkey. Turkey and ICARDA also exchange advanced breeding materials to test in Syria and in several wheat and barley growing areas of Turkey. Regularized visits between ICARDA and Turkish scientists to evaluate germplasm and discuss research progress are already proceeding. ICARDA scientists visited Turkish experiment stations in 1985 to evaluate the materials planted. A meeting in Ankara reviewed results and developed the joint 1985/86 work program. Turkish scientists are invited to the Cereal Program's annual program planning session.

**Training/Workshops**—Turkey has requested and received training for one barley scientist and one durum scientist in the Cereal Program's residential course. ICARDA is also providing specialized training in pathology, grain quality, breeding, agronomy and other areas on request. Turkey has provided ICARDA with a list of all its national coordinators to receive publications and information from ICARDA.

### AGREEMENT

A longer term cooperative agreement is being considered between the Government of Turkey and ICARDA.

### FUNDING

ICARDA (core budget)/Turkey

### PROGRESS TO DATE

At the Ankara planning session for the 1985/86 season Turkish officials reported on the excellent performance of several lines provided by ICARDA in the southeast and south of Turkey. The bread wheat Sham 2 performed so well in the southeast region it will be included in large scale demonstrations on farmers' fields as a substitute for the existing commercial cultivar, Malabadi. In the Cukurova region of Turkey the durum wheat Omrabia outyielded the check durum in all six locations with an average yield of 5.3 tons/ha. 'FLK'S'-HORK'S' was the best bread wheat line outyielding the three check varieties.

As part of the 1985/86 work plan the Cereal Program has agreed to conduct an in-country training course on Breeding Methods for Moisture Stress Environments in Turkey.

## YEMEN ARAB REPUBLIC

### PARTNER ORGANIZATION

Ministry of Agriculture and Fisheries, Agricultural Research Authority

### NATURE OF COOPERATION

In Yemen Arab Republic sorghum, wheat and maize are the most important cereals based on area and production. Ninety percent of the wheat is rainfed. The Cereal Program has been cooperating informally with Yemen, providing wheat and barley germplasm and training. Senior scientists from the Program visited Yemen to help develop the wheat improvement work and evaluate materials being tested. In fact, considerable research has been done by national scientists together with expatriate scientists in the last 3-4 years. Research efforts have produced useful data and information on varietal improvement as well as a package of production practices for each crop in various agroecological zones.

Presently there is a serious shortage of scientists. Only one Yemeni scientist is working on wheat an barley. He is a graduate of the Cereal Program's residential course and will shortly leave to pursue an advanced degree. The Program is exploring the possibility of in-country training in collaboration with other international agencies to train additional Yemeni scientists.

## AFGHANISTAN

ICARDA has been providing germplasm and training since the beginning of its operations. Afghanistan continues to make extensive use of the Cereal Program's international nurseries. On request materials are sent to four research stations in Afghanistan. Field books are returned to the Cereal Program for analysis with the results from other countries. Afghani scientists have identified several lines that perform well in their rainfed environments.

Afghanistan made a major contribution to ICARDA by making its wheat and barley landraces available to the center.

## ALGERIA

Although in the past relations with Algeria have not been as close as with its North African neighbors, Cereal Program scientists were recently invited to Algeria to discuss enhanced cooperation and definite plans are being developed for the 1985/86 season.

Together with CIMMYT and ICARDA, the Algerian Ministry of Agriculture and Agrarian Reform sponsored the Fifth Cereals Workshop in Algiers in 1979.

## IRAQ

A limited exchange of germplasm, scientific visits and training comprise the links between Iraq and the Cereal Program to date. An ICARDA team recently visited Iraq to explore possibilities for joint projects.

## LIBYA

As the consequence of an active exchange of germplasm and senior scientists, Libya is introducing three bread wheat and four durum wheat varieties selected from ICARDA nurseries. ICARDA has also been requested to accelerate contacts with the Libyan national program.

## QATAR, ABU DHABI, OMAN, YEMEN PEOPLE'S DEMOCRATIC REPUBLIC

Although local production is smaller than other countries in the region, even these countries are looking increasingly to ICARDA to provide technologies to raise local yields of wheat and barley.

Qatar is presently multiplying seed of two barleys and 100% adoption is expected. In Yemen People's Democratic Republic, the National Committee for Varietal Release is replacing two older bread wheat varieties with one from ICARDA called Ahgaf. Ahgaf tolerates heat at a seedling stage and is thus suitable for early planting. This helps it avoid succumbing to drought later in the spring. It also appears to be more tolerant to soil and water salinity and is free of rust. During 1983/84 Ahgaf was grown on 500 hectares. The current cultivars, Kalyansona and Sonalika, are of CIMMYT origin, first adapted and released in India. They are becoming susceptible to rust. Moreover, the newer varieties are being selected for higher plant height than the semi-dwarfs to obtain more straw for livestock feed.

Oman also is identifying promising cultivars through the ICARDA international nurseries and Abu Dhabi has requested 50 kg of wheat samples adapted to its short-season, mild-winter growing conditions.

## SAUDI ARABIA

Relations between ICARDA cereal scientists and Saudi Arabian researchers actually predate ICARDA, having existed already under ALAD. Good cooperation continues, with the Saudi national program drawing extensively on ICARDA's wheat and barley nurseries for its crop improvement work. On request the Cereal Program has supplied special materials for saline and drought affected areas. Saudi scientists participate actively in regional conferences and workshops organized by ICARDA and a number of former Cereal Program trainees hold senior research positions, such as the head of the national wheat and barley research program.

## OTHER BARLEY GROWING COUNTRIES

In keeping with its global mandate for barley improvement, the Cereal Improvement Program sends its germplasm to almost all the barley growing countries in the world, including the USSR, U.S., China, India, Ecuador and other developed and developing countries. A small number of trainees from Bangladesh, China, India and Nepal have been trained.

Developing lines and cultivars specifically suited to the environments of the countries in the Andean region is a primary objective of ICARDA's barley breeder posted to CIMMYT, Mexico. In the Andes barley is planted in the spring and vulnerable to cold. BYDV and yellow rust are the most damaging diseases. Scientists from Latin America are being trained by the CIMMYT/ICARDA Program in Mexico. ICARDA's barley breeders in Aleppo have visited Andean countries and breeders from Ecuador and Chile reciprocated with visits to Tel Hadya.

As resources permit, ICARDA will expand its activities with barley growing countries outside the region. There is an increasing demand from developed country institutions for ICARDA germplasm with specific traits, such as disease and insect resistance and salt tolerance.

## REGIONAL ORGANIZATIONS

*Arab Center for Studies on Arid Zones and Dry Lands (ACSAD), Damascus, Syria*

ICARDA and ACSAD signed an agreement of cooperation in 1982. Since then both institutes have embarked on a number of joint research and training projects. In addition to a major role in the on-farm cereal trials in Syria, ACSAD also exchanges germplasm with ICARDA. The Cereal Program provides ACSAD on request any materials sent out in its international nurseries for testing in ACSAD's network. Similarly ACSAD is invited to enter any of its promising lines in ICARDA's nurseries for widespread regional testing. ACSAD officials make a valuable contribution to the Cereal Program's annual fall planning session.

More generally, ICARDA and ACSAD are working together on food legume improvement in Algeria and Iraq, fertilizer studies, germplasm collection and training, aspects of environmental zoning and mechanization of lentil harvesting.

*Arab Organization for Agricultural Development (AOAD), Khartoum, Sudan.*

Cooperation with AOAD is being strengthened. AOAD has provided generous support to ICARDA's training program.

## COOPERATIVE PROJECTS WITH ADVANCED RESEARCH INSTITUTIONS

| PROJECT | COOPERATING AGENCY | FUNDING |
|---|---|---|
| CEREAL QUALITY EVALUATION | | |
| The Canadian Grain Commission makes a vital contribution to ICARDA through the services of their senior cereal chemist who comes to ICARDA several months each year to advise on laboratory planning and oversees grain quality testing activities. | Canadian Grain Commission,Canada | CIDA and ICARDA |
| CEREAL ROOT DISEASE | | |
| This project is designed to study probable causes of the reduction in yield when cereals are continuously grown. The project will study the incidence and significance of cereal root diseases in northern Syria and their control by crop rotation, especially through including a legume pasture phase. | University of Bonn, Federal Republic of Germany | GTZ |
| COLLABORATIVE RESEARCH AND TRAINING PROGRAM FOR BARLEY DISEASES AND ASSOCIATED BREEDING METHODOLOGIES | | |
| This joint project is being launched (1986-1990) to organize a network of national, university and international research programs aimed at developing high yielding barley cultivars with broad based resistance to the major diseases. This will include: studying and collecting gene resistance sources; establishing nurseries and planting them in "hot spots"; and developing centers for barley diseases in national programs so they can take regional responsibility for virulence surveys. Short-term and graduate degree training is also a major component. | Montana State University, USA | USAID |

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|---|---|---|
| **COLLECTION AND EVALUATION OF BARLEY, DURUM WHEAT AND THEIR WILD RELATIVES** | | |
| In addition to collecting samples of barley and durum wheat and their wild relatives from throughout the Fertile Cresent, their primary center of diversity, ICARDA and the University of Saskatchewan are assessing them systematically under short-day Mediterranean and long-day temperate conditions. Lines with tolerance to biotic and physical stresses will be identified and used in germplasm enchancement. In the sampling process sites of high genetic variability and low genetic erosion will be of special interest. In 1983/84 136 locations throughout the Middle East were sampled. | University of Saskatchewan, Canada | CIDA and NSERC |
| **EVALUATION AND DOCUMENTATION OF DURUM WHEAT GERMPLASM** | | |
| Begining 1986, this project will focus on the evaluation and documentation of landraces of durum wheat. | Institute of Germplasm, Bari and University of Viterbo, Italy | CNR |
| **EVALUATION AND CATALOGING OF BARLEY GERMPLASM** | | |
| With support from the International Board for Plant Genetic Resources, the ICARDA Genetic Resources Unit and the Cereal Program were able to evaluate and catalog 8000 barley entries in the ICARDA genebank. This project was completed in 1984. | IBPGR, Italy | IBPGR and ICARDA |
| **PERFORMANCE AND INTERACTION OF WHEAT AND RYE GENOMES IN TRITICALE** | | |
| This research topic was the subject of a PhD thesis submitted in 1984. The candidate, supervised by an ICARDA cereal scientist, was investigating the genetics of triticale. While triticale is higher in protein and lysine and better adapted to drought and salt than | Institut für Pflanzenbau und Pflanzenzuchtung, Göttingen University, Federal Republic of Germany | GTZ |

wheat, the interaction between the wheat and rye chromosomes often results in sterility and poor grain yield.

PHENLOGY AND PRODUCTIVITY MODELING IN WHEAT

This work has been done in the Farming Systems Program. SIMTAG—Simulation of *Triticum aestivum* Genotypes—is a computer program developed to help ICARDA scientists predict how wheat yields are affected by climatic factors. SIMTAG was mounted on the ICARDA computer in 1984 and now is an integral part of its climatic zoning work.

University of New England, Australia

UNDP

PHOTOTHERMAL RELATIONS IN BARLEY

This project is entering its second three-year phase. Its objective is to provide precise information on the effects of temperature and day length on the development and growth of barley. The study will help scientists better understand how different genotypes of barley adapt to different environments. Current work is focused on the effect of day length and temperature on the time of flowering of six diverse barley varieties.

University of Reading, UK

ODA

RESPONSES OF BARLEY AND DURUM WHEAT TO WATER SUPPLY AND THE DEVELOPMENT OF A METABOLIC INDEX

The aim of this project is to develop more rapid and accurate screening techniques for drought tolerance in barley and wheat. Physiological and biochemical responses of the plant to drought are studied. In particular the use of a metabolic index of stress based on relative concentrations of certain chemicals in the plant is being assessed.

Birbeck College, University of London, UK

ODA

| | | |
|---|---|---|
| ROOT STUDIES ON BARLEY | | |
| On the basis of field work in Aleppo and detailed controlled experiments in Reading, the project is finding that locations, management and variety affect the root growth and distribution of root systems of barley plants. 1985/86 is the last season of the first phase of this project; an extension is being planned. The work is being done by the Farming Systems Program with the cereal breeders providing some of the lines being evaluated. | University of Reading, UK | ODA |
| SALT TOLERANCE IN WHEAT AND BARLEY | | |
| With GTZ support a PhD student worked in the Cereal Program to field screen barley and wheat germplasm for tolerance to salinity. The work was supervised by a senior cereal scientist and her lab work is being done in FR Germany. She also collected landraces of barley in Syria and Jordan. | Institut für Pflanzenzuchtung, University of Munich at Freising | GTZ |
| SCREENING ADVANCED ICARDA WHEAT AND BARLEY GERMPLASM FOR BYDV | | |
| ICARDA is receiving support from the laboratories of Agriculture Canada in evaluating ICARDA materials for Barley Yellow Dwarf Virus (BYDV). Before 1985 ICARDA did not have the strains, inoculum or facilities to do this in Aleppo. The project is in its fourth year. The data on BYDV resistance is valuable in recommending parental materials to national programs through the regional crossing blocks. | Agriculture Canada, Lavalle University, Canada | IDRC |
| YIELD PHYSIOLOGY OF DURUM | | |
| This project, initiated in 1984, analyzed the interaction between the plant's response to day length and its vernalization requirement. It concluded that photoperiod insen- | Institut für Pflanzenzuchtung, Saatgut Forschung und Population-Genetik, | Vater und Sohn Eiselen Stiftung |

| | | |
|---|---|---|
| sitivity and a higher vernalization requirement increased the number of flowering primordia, thus leading to higher grain yield ultimately. | University of Hohenheim, Federal Republic of Germany | |
| RACHIS | | |
| In 1983 IDRC approved a three-year grant to support the cost of an Arabic translator at ICARDA to translate the cereal newsletter *Rachis*. Other ICARDA documents will also be translated, in order to increase the number and quality of Arabic publications produced by ICARDA. | IDRC, Canada | IDRC |

## CEREAL IMPROVEMENT PROGRAM SCIENTISTS

| | | |
|---|---|---|
| J.P. Srivastava | Program Leader | India |
| E. Acevedo | Physiologist | Chile |
| A. El-Ahmed | Barley Breeder/Pathologist* | Syria |
| S. Ceccarelli | Barley Breeder | Italy |
| G.O. Ferrara | Bread Wheat Breeder** | Mexico |
| H. Ketata | Training Officer & Durum Breeder | Tunisia |
| J. Van Leur | Cereal Pathologist | Netherlands |
| M. Malik | Research Associate (Triticale) | India |
| O. Mamluk | Cereal Pathologist | Syria |
| M.S. Mekni | Barley Breeder | Tunisia |
| D. Mulitze | International Nurseries Scientist | Canada |
| M. Nachit | Durum Wheat Breeder** | FR Germany/Morocco |
| I. Naji | Research Associate (Agronomist) | Syria |
| M. Tahir | Cereal Breder/High Elevation | Pakistan |
| S.K. Yau | Barley Breeder | Hong Kong |
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*Based in Tunisia*

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