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Trip Report

Visit to ICRISAT

(International Crops Research Institute

for the Semi-Arid Tropics)

at Hyderabad, India

Date of Visit:

November 22-24, 1979

Contract No.

AID/NE-C-1304 Yemen

By:

Dr. Robert L. Voigt
Department of Plant Sciences
The University of Arizona

Distribution:

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Director, International Agriculture Programs (1)
Head, Department of Plant Sciences (1)
Department Plant Sciences file (4)
Dr. Albert K. Dobrenz
Dr. Victoria Marcarian

In support of:

National Sorghum and Millet
Crop Improvement
Project No: 279-11-110-030

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I. Introduction and Purpose of this Visit to ICRISAT

ICRISAT (International Crops Research Institute for the Semi Arid Tropics) is a world center for research on Sorghum and Millet for adaptation to environments quite similar to the Yemen Arab Republic. This Research Institute also conducts training programs for personnel at all levels of research activities. Information in these two areas is of great importance to full development of the University of Arizona-USAID Sorghum-Millet Project in the Yemen A.R., therefore this visit was made to ICRISAT.

I arrived at ICRISAT headquarters in Hyderabad at about 1200 on Thursday, 22 November 1979. I departed the same offices at about 1200 on Saturday, 24 November, 1979.

I entered into the following activities and private professional discussions with staff personnel. Dr. D. S. Murty was responsible for making local arrangements for my visit. He did an excellent job.

II. Visit Agenda Items

1. Private discussions were held with each of the following staff personnel regarding their professional research activities and responsibilities.

   a. Dr. Lee S. House, Principal Plant Breeder in Charge of Sorghum. Dr. House explained the world-wide establishment of research stations linked with the main ICRISAT headquarters at Hyderabad and the specific research possible at each of these sites due to possessing specific environments associated with the semi-arid tropics. This network of "sub-stations" is just being developed.

The various environments make possible more precise research revolving around elevation, drought (moisture stress), temperature, diseases, insects, and soils, etc.

Dr. House expressed a desire to obtain seed of the Yemen Sorghum collection as soon as it is available. He also wishes to give this collection IS (International Sorghum) numbers.

He advised that Dr. Vartan Guiragossian of CIMMYT at El Bataan may also be able to furnish seed of sorghum types adapted to cool (high elevations) environments as in the Uplands of Yemen. These lines may offer another source of germplasm for selection in Yemen.

b. Dr. D. S. Murty, Sorghum Breeder

Dr. Murty has responsibility for research on grain quality in sorghum. His work involves grain molds and diseases, and food quality of the grain. The Uplands of Yemen are so dry that the grain is generally quite free of molds and diseases. However since most of the grain in Yemen is consumed by the people, its nutritional value and quality is very important. Attention needs to be made as to the food quality of selections made in Yemen. So far it is not clear how this should be done.

It is relatively easy to analyze grain for standard constituents however I have noted that the Yemeni have a high taste preference for their own locally selected sorghums. Whether this preference is real or imagined may be difficult to determine and also difficult to overcome.

c. Mr. Bhola Nath Verma, Sorghum Breeder

Mr. Verma has responsibility for development of sorghum populations for different environments and purposes and incorporating different germplasm sources into populations.

Some 900 lines have previously been incorporated into populations. Several imported populations are being discontinued for being unadapted and having no potential. Populations he has brought to ICRISAT from the U.S. and other places have been agronomically quite unadapted and have had to be reselected and rebuilt at an expense of several years time. Populations are now being built from the beginning using locally adapted genotypes.

d. Dr. B. V. S. Reddy, Sorghum Breeder

Dr. Reddy has responsibility for the study and development of drought resistance in sorghum. He had been selecting for drought resistance at two stages -- in the seedling stage and at the end of the growth cycle. He has currently discontinued the work on drought selection in the seedling stage. From his limited work he did not feel that the seedling drought tolerance was very well related to mature plant drought tolerance.

His seedling drought selection system consisted of planting different genotypes in well-watered flats in a shade house (or greenhouse) and allowing them to dry. When nearly completely dry they would be re-watered once. Survival and recovery scores would be taken before and after rewatering.

The "end of growth cycle" drought selection process consists of drying up the plant in the field in the reproductive phase.

A special planting date must be used to try to insure lack of rain during this period of plant growth. ICRISAT has occasional rains so dry conditions in the fields have been variable and unpredictable. He is using a pedigree system of selecting and testing what appears to be drought tolerant plants. He has not been carrying on this research long enough to be very sure of his results. He plants an "irrigated" (non-stressed) counterpart plot to try to measure the relative performance of the stressed selections.

The weather at Sana'a appears to be drier for a longer period of the growing cycle than at the main ICRISAT site. I feel we can do at least an equal and probably better job of stressing sorghum at Sana'a than the current ICRISAT program. I feel it is important to stress a sorghum or millet plant early in its life to harden it. This ability to harden plus other characters associated with drought tolerance are then selected for altogether in one genotype.

(Note: I have been using this same system in Arizona for about 10 years, or longer than ICRISAT, and have obtained measurable positive results. Arizona has a longer dry season so my selection procedures have been carried out from right after the seedling stage throughout most all of the life growth cycle of the plant. I feel the plant needs to be "hardened" at an earlier age than near maturity. This ability to harden plus other characters involved can be selected for. Arizona currently has a very superior

field laboratory situation due to long, hot dry periods of weather).

e. Dr. M. J. V. Rao, Sorghum Breeder

Dr. Rao has been working about 5 months on striga resistance in sorghum. He has taken over the program of Dr. K. V. Ramaiah who had been active in research on striga for about 5 years. Dr. Ramaiah is now at one of ICRISATS new research locations in Africa but is not working on striga.

The current status of striga research is well summarized in an Attachment (1) to this report given me by Dr. Rao.

It was interesting that ICRISAT is having considerable difficulty in establishing striga sick plots. They have been rather unsuccessful in spreading striga to where they want it.

f. Dr. F. C. Gupta, Millet Breeder

The staff working on Millet consists of 7 professional breeders (2 principal scientists and 5 scientists) and each has about 5 or 6 graduate students.

The millet improvement program consists of (1) population improvement and (2) production of hybrids (variety crosses) and synthetics.

Populations are being built from lines showing (1) grain yield stability, (2) resistance to diseases and (3) nutritional quality. Populations are not released to the farmer but are used as a germplasm source for selection.

Five to eight superior selected lines from populations or other sources are combined to make up an experimental variety. These

experimental varieties will be tested in a national (India) program. Seven experimental varieties are currently at different stages of testing in this program. None have been released yet to the farmers.

Hybrids and other crosses are being made between African and Indian lines to obtain larger parental genotype differences and thus hopefully obtain superior hybrids.

g. Dr. K. Anand Kumar, Millet Breeder

Dr. Kumar has responsibility for supervising the international evaluation of millet varieties, hybrids and composite varieties. These tests are at other ICRISAT locations as well as with other cooperators. We have received seed for these evaluations in Yemen but have not had the resources to plant and grow the tests. Sanaa is not in a millet-producing environment.

Dr. Kumar recommends that interested cooperators grow and observe a number of composited varieties. Then request seed of individual lines composing this composite for further testing and selection.

An Indian hybrid, BJ 104, has an extremely wide adaptation.

2. Meeting with Training Administrator

a. Dr. Dallas L. Oswalt, Principal Training Officer

The training opportunities for interested personnel are available for new Ph.D's (post doctorates) down to new technician apprentices and range from two years down to one or two weeks.

These opportunities are more adequately described in Attachment 2 to this report.

Basically a usable knowledge of the English language is required of all trainees. Full dormitory and cafeteria facilities are available on site for students.

3. Tour of the Research Station

I was given a brief tour of the field facilities. It was late in the season and most all sorghums and millets had been harvested. The entire farm site consists of 1394 hectares. There are two basic soil types, typical of India, on the farm. These are referred to as Alfisols (red soils) and Vertisols (black soils).

There are irrigated and non-irrigated portions of the farm. There is a swampy area where rice is grown.

The farm field labor force numbers over 2,500 of which there are about equal numbers of males and females.

4. Seminar on "Sorghum Research in The Yemen Arab Republic"

I gave a seminar on the above topic to the sorghum and millet research staff on 23 Nov. 1979. The group in attendance consisted of plant breeders, plant physiologists, plant pathologists and entomologists.

Most were of Indian citizenship. There were 3 or 4 western country individuals.

RECV'D: 23 NOV. 1974

ATTACHMENT 1.

ICRISAT STRIGA RESISTANCE BREEDING PROGRAM

DR. M. J. V. RAO
ICRISAT, HYDERABAD, INDIA

Striga is a holoparasitic phanerogam that can parasitize many crop and non-crop hosts, and is recognized as an economically significant yield reducer of sorghum, sometimes to the extent of total loss of the sorghum crop. ICRISAT, thus, has Striga on its priority list in the sorghum improvement program.

Objectives:

(i) To understand the Striga resistance mechanisms in sorghums.

(ii) To identify Striga resistant source material.

(iii) To transfer the Striga resistance to the agronomically elite background.

Work done so far:

(i) Three mechanisms have been identified which possibly confer resistance to sorghum against Striga infestation. They are: (a) Low-stimulant production, (b) Mechanical barriers to the development and establishment of Striga haustorium, and (c) Antibiosis mechanism, due to a physiological imbalance between the host and parasite after haustorial connection is established.

(ii) A double-pot technique has been developed and nearly 14,092 germplasm lines have been screened for low stimulant production in the lab and 730 lines are found to be low strigol producers.

(iii) Inheritance of low strigol production character has been worked out. It is controlled by a single recessive gene designated st_1.

(iv) Few mechanical barriers for the development of haustoria have been identified. They are - a highly thickened endodermis in the roots, endodermal inner tangential wall thickening, development of pericycle layers and formation of silica crystals.

International Testing and Identification of Resistance Sources:

International testing of the possible sources of *Striga* resistance is going on for the past few years in the form of an International *Striga* Resistance Nursery (ISRN). Several *Striga* resistance sources are identified in international testing at different agroecological zones. However, except SRN-4841, none of the other sources is resistant at most locations.

Breeding Programs:

A sick-plot is being developed at Patancheru and this has facilitated field screening of the breeding material very much.

Both pedigree and composite approaches are given emphasis:

(i) Pedigree approach:

(a) Strengthening of resistance *per se* by intercrossing different resistant cultivars.

(b) Transferring resistance into *elite* agronomic background.

(c) Simultaneously incorporating resistance to other traits such as shoot-fly etc.

(ii) Composite approach:

A composite has been developed involving parents with different resistance mechanisms and those which are resistant to *S. asiatica* and *S. hermonthica*. Several crosses were made onto the genetic male-steriles ms_3 and ms_7; and one backcross to the few best resistant cultivars was effected.

Problems encountered:

1) Erratic response of *Striga* resistant lines to *Striga* from different agro-ecological zones.

2) The difficulties in getting uniform stand of *Striga* in *Striga* sick fields.

ATTACHMENT - 2

International Symposium

on

Development and Transfer of Technology

for Rainfed Agriculture and the SAT Farmer

Training at ICRISAT

by

D. L. Oswalt and A. S. Murthy
Principal Training Officer, and Senior Training Officer

August 1979

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS
ICRISAT Patancheru P.O., Andhra Pradesh 502 324, India

Training at ICRISAT

D. L. Oswalt and A. S. Murthy

Abstract

International internships, research fellowships, research scholarships, in-service training programs, and apprenticeships provide opportunities for skill and concept development and practical experience at ICRISAT Center, linking national, regional and international research and development programs with ICRISAT's scientific expertise and research facilities. Designed to accommodate participants with diverse backgrounds, the programs enable each person to follow an individualized study program most relevant to his ability and his sponsor's need. Training ranges in duration from a few weeks to two years; a follow-up program communicates research findings to former trainees and maintains contact with their progress.

The objective of our training program is to train agriculturalists to work more efficiently in agricultural research, training, and extension programs and thereby increase and stabilize food production in the rainfed semi-arid tropics. By developing practical skills and concepts, the program provides for an increasing number of scientific, technical, and service personnel who can assist in improving the production and utilization of sorghum, pearl millet, pigeonpea, chickpea, and groundnut cultivars and in better exploitation of natural resources in improved farming systems. The training programs link the national, regional, and international research and development programs of the SAT with ICRISAT's scientific expertise, germplasm resources and research facilities which are not readily available elsewhere.

These programs enable scientists who are currently working on problems within ICRISAT's mandate to become familiar with the adapted germplasm and research technology for increased and stabilized food production in the semi-arid regions of the tropics.

Participants in the training programs at ICRISAT are primarily from, or are interested in working in, the semi-arid regions of the world. These regions urgently need persons skilled in research and technology transfer to manage the utilization and conservation of natural resources. Efforts toward increased food production and an improved standard of living in these agricultural regions are often limited by an insufficient number of experienced and qualified persons who can effectively adopt and communicate improved agricultural skills and technology. In addition, improvement in agriculture is often slow as the producer must be assured that accepting new varieties and techniques will not adversely affect his source of food and farm income. Farmers are also slow to accept recommended changes when the scientist is unskilled and insecure.

ICRISAT's training programs are designed to accommodate persons with diverse education and experience. Individual programs are developed in association with scientific and training staff, permitting each student to conduct his own experiments, trials, or demonstrations, using the ICRISAT collection of natural and scientific resources unique to the physical, economic, and social environment of the SAT.

The transfer of technology in the training programs starts when the individual develops his research plans or undertakes practical experience with the research scientists and training supervisors. The staff, equipment, germplasm, natural resources, and physical facilities and the trainee's abilities, attitudes, motivation, and experience combine to form an ideal training-learning situation in which skill and concept development can be practically oriented to laboratory research and food production in the SAT.

Types of Training

Five types of training programs, ranging in duration from one or two weeks to two years, currently serve a wide range of trainee needs.

International Interns, with recent Ph.D. degrees from agricultural universities of donor countries, learn to use a team approach to problem solving, to applied research, and to technology transfer procedures. Interns work with

research scientists on selected on-going problems for one to two years.

Research Fellows, SAT scientists with M.Sc or Ph.D. degrees, work with teams of research scientists on specific problems utilizing recent developments, techniques, and concepts. The length of training, a few weeks or up to two years, depends on the areas of research selected.

Research Scholars, university students conducting their thesis research, do so in a scientific environment in which they acquire practical experiences, concepts, and skills, and learn managerial techniques related to SAT food production and natural resource development. Research scholars are scheduled for 18 to 24 months' training at the research Center in order to collect three to five cycles of data on their selected thesis problem for partial fulfillment of their degree program.

In-service Trainees, participate in three types of training programs of six to nine months, based on field problems involving a full season for the area in which they specialize. In crop improvement, they develop the practical application of plant breeding techniques and the utilization of sources of resistance and tolerance for improved and stabilized yields of the crops in ICRISAT's mandate. In crop production, they learn to utilize production and management procedures for application to local conditions and to reduce adverse influences that limit crop production. In farming systems, they learn to assess the potentialities of natural resources and develop farming systems that will utilize genetic resources, cropping systems, land and water management techniques, machinery, power, markets, and economic and human resources.

Apprentices, who are agricultural engineering and other students, have a work-study opportunity to obtain practical experience in land development, water management, and economics, in the operation, maintenance, and repair of farm machinery, and in other field and laboratory techniques. The students are provided one or two months of work experience with engineers, research scientists, and maintenance personnel.

Organization of Training

An advisory committee representing the ICRISAT research program and the Associate Director for International Cooperation assists the training staff in developing training policies. All applications for training are evaluated by the advisory committee and the appropriate Institute scientist or research guide. To qualify for training at ICRISAT, each candidate must:

- be sponsored by an agency or institution working or intending to work in the semi-arid tropics, or indicate an aptitude and desire to work in SAT agricultural programs.

- present records of his academic training and experience--including capabilities in the English language--which indicate that he will profit from the training.

- indicate a willingness to do practical field work and to study and conduct laboratory and field research in areas compatible with ICRISAT's mandate and the objectives of the sponsoring agency's programs.

Training programs for each category of candidates are organized within the specialized sciences of ICRISAT's five crops, farming systems, and other ICRISAT Center programs. Comprehensive individualized programs, based on precourse evaluations and interviews, are developed to provide practical and theoretical experiences in agricultural research, crop improvement, crop production, agricultural management procedures, extension programs, and training methods.

The duration and content of each training program are adjusted to the number of seasons necessary to obtain adequate data and the desired specialization of the trainee. As an integral part of his training, each trainee develops and conducts laboratory and field experiments or demonstrations within the approved research program of the Institute.

All field and laboratory studies are supervised by research scientists and training staff, with practical training activities forming the core of the research and

managerial experiences. The field and laboratory learning activities occupy more than 60 percent of each individual's training program. Accomplishments are periodically evaluated on the basis of skill performance and theoretical concept development. Final evaluations determine an individual's progress, help establish his personal confidence, and assess his reaction to the training program. Evaluations are also used in following up a trainee's later performance in fields related to the training received at ICRISAT.

Cooperation within ICRISAT

The field, laboratory, and classroom learning experiences are conducted by research scientists, assisted by the training staff. Research scientists participate directly in the training activity as field, laboratory, and classroom instructors, thesis research guides, and supervisors of interns and research fellows. The training staff coordinate the individualization of research projects, the instruction, the evaluation of practical concept comprehension, and the follow-up programs. They insure a balanced and comprehensive learning opportunity for each person.

Cooperation with other Institutions

Special assistance is obtained by utilizing the staff and facilities of neighboring institutions. French-speaking West Africans have been given intensive instruction in English language by the Central Institute for English and Foreign Languages and the Osmania University. In addition, special extension methods, lectures, and laboratory exercises have been provided by staff of the Extension Education Institute. Scholars conducting their thesis and practical research at ICRISAT Center have been enrolled for their degree programs or cooperative agreements for training have been established at:

- Andhra Pradesh Agricultural University, Rajendranagar, India

- Himachal Pradesh Agricultural University, Simla, India

- University of Manitoba, Canada

- Iowa State University, Ames, Iowa, USA
- Cornell University, Ithaca, NY, USA
- Agricultural University, Wageningen, The Netherlands
- University of Reading, Reading, UK
- Texas A & M University, Texas, USA
- Asian Institute of Technology, Bangkok, Thailand
- Punjab Agricultural University, Ludhiana, India
- Haryana Agricultural University, Hissar, India
- Jawaharlal Nehru Krishi Viswa Vidhyalaya, Jabalpur, India
- Tamil Nadu Agricultural University, Coimbatore, India
- University of Agricultural Sciences, Bangalore, India

The interaction among scientists of the Institute and university advisory committee members has been extensive and advantageous to both scholars and scientists. Indian universities, institutes, commercial companies, and local farmers have been contacted on educational visits. These visits demonstrate the adaptability of research findings and germplasm to other research programs and farms.

In-service Training Programs

The following objectives and program outlines are used to develop specific training activities for individuals or groups:

Crop Improvement

Objectives

The crop improvement program is to provide opportunities:

- to learn breeding techniques for improving and stabilizing yields.
- to assess and learn to utilize the potential of the germplasm available for use in the SAT.
- to practice and learn breeding techniques and requirements for efficient and effective identification and utilization of resistances to factors which reduce production in the semi-arid tropics.
- to work with crop improvement scientists.
- to develop skills in organizing and managing a successful breeding program.

Program Outline

- identification and utilization of phenotypic characteristics associated with desirable plant types.
- plant breeding methods and their utilization for increased and stabilized yield.
- breeding for improved quality and acceptability.
- breeding for resistance or tolerance to diseases, insects, pests, weeds, and environmental stress (water, temperature, nutrients, competition).
- germplasm--origin, classification, diversity, adaptability, utilization, preservation.
- physiology of the adapted germplasm and factors associated with stages of plant

development and range of adaptability attributing to improved yield.

- establishment, selection and development of breeding nursery, seed production, and testing facilities.

- experimental design, field-book design, record keeping, data analysis, and management of breeding materials, experimental plots, and nurseries.

- environmental requirements for accurate screening and testing.

- agronomic requirements and production procedures for breeding for crop improvement.

- utilization of statistics in crop improvement.

Crop Production

Objectives

The crop production program is to provide opportunities:

- to gain practical skills for increasing crop production in the SAT through an integrated approach to natural and human resources in ever changing environments.

- to assess improved cropping and management procedures and learn how to adapt them to local conditions.

- to learn to identify and reduce adverse influence that limit crop production in rainfed semi-arid tropics.

- to develop an appreciation of the role of and the importance of utilizing social, cultural and economic factors in improving agricultural production.

- to develop the ability to use extension techniques for communicating new and improved technology for increased and stabilized food production.

Program Outline

- climate and other environmental factors influencing crop production in rainfed semi-arid tropics.

- soils and their type, fertility, conservation and utilization in relation to environment and crops.

- soil management for efficient water utilization and seedbed preparation.

- selection of crops and cropping systems for economic production.

- disease, insect, and pest symptoms and their levels of incidence; control methods and economic evaluation of procedures.

- harvesting, drying, storage, and marketing.

- efficient use of animal-powered equipment and other power sources.

- development, establishment, and evaluation of trials, experiments, and demonstrations.

- use of communication media, management methods, and procedures which will result in increased and stabilized crop production by farmers.

Farming Systems

Objectives

The farming systems program is to provide opportunities:

- to develop skills in natural resource utilization research related to catchment-area development for improved land and water management.

- to become proficient in production factors, research methods and techniques related to agronomic practices, cropping systems, soil fertility, soil physics, plant protection, farm power, machinery, economics and management skills to insure increased and stabilized food production for the rainfed semi-arid tropics.

Program Outline

- study of climatic influences, probabilities, and predictions in relation to farming systems in semi-arid tropics.

- soil types, physical characteristics, fertility and management factors in relation to nutrient and water availability and crop systems.

- land development for improved soil and water management,

- cropping patterns, plant and environment interactions, and selection of intercropping systems.

- land preparation, soil management, crop stand establishment, fertility management, weed control, and cultivation.

- plant protection measures (use of insecticides, fungicides, herbicides), economic levels and safety factors.

- use and maintenance of farm power and machinery for economic production.

- harvesting, threshing, storage and marketing.

- economics of farming system, risks, investments, costs and returns.

- experimental design, layout and implementation, data collection, analysis and interpretation.

- management of experimental nurseries and farms.

- development and utilization of extension methods and techniques for adaptation of farming systems which will increase and stabilize food production.

Specialized Areas

Objectives

The specialized programs are to provide opportunities:

- for a skill development or improvement by practical experience working with specific equipment and techniques.

- for training and experience in working with a team approach to problem solving.

- for identifying specific new skills and techniques relative to identified special SAT problems for increased and stabilized food production.

Program Outline

- study and work with selected equipment and procedure.

- work with specialists in soil science, natural resource management, entomology, pathology, microbiology, physiology, breeding, economics, sociology, engineering, agroclimatology, cropping

systems, computer science, communications or other related ICRISAT speciality.

Follow-up

National program scientists, in-country development program staff, and former trainees assist in identifying areas where trainee selection procedures can be improved, where additional training is required, and where additional training programs are needed. Contact is maintained through correspondence and personal visits by ICRISAT staff who are working and travelling in areas where former trainees are employed. Germplasm, reports, newsletters and informational materials are provided to former trainees to keep them informed of new developments. Such follow-up contact is maintained with 174 trainees from 35 countries who participated in over 30 000 mandays of training at ICRISAT from 1974 through 1978.

Future Prospects

The number of trainees at ICRISAT Center is expected to increase by 1980 to an optimum at any one time of 60 to 75 in-service trainees, 10 to 15 research scholars, 10 to 12 research fellows, and 10 to 15 international interns, plus special area trainees (a few days to a few weeks for groups of up to 25 to 30 persons at a time) for intensive training in such areas as pathology, microbiology, entomology, land and water management and cropping systems.

A major restriction to the number of applicants will be the inability of national research programs, development-program sponsors, and Institute staff to identify persons qualified in English and agricultural science from areas where the predominant languages are French, Portuguese, Arabic, and Spanish. The number of potential trainees with satisfactory education, research, and agricultural training and experience in most SAT regions is relatively low, a condition expected to continue until the number of science graduates increases. The third limiting factor will be the number of persons which the research and training staff can accept for instruction in the laboratory, classroom, library, and seminar facilities of ICRISAT Center.

To meet the needs of the regions within our mandate, the in-service training program anticipates accepting approximately 66 percent of its nominees from African SAT regions where trained scientists are few. The remainder will be accepted from other regions. Approximately equal numbers of research scholars and research fellows will be considered from the African regions and from southern Asia; the remaining one-third will come from other regions of the world.

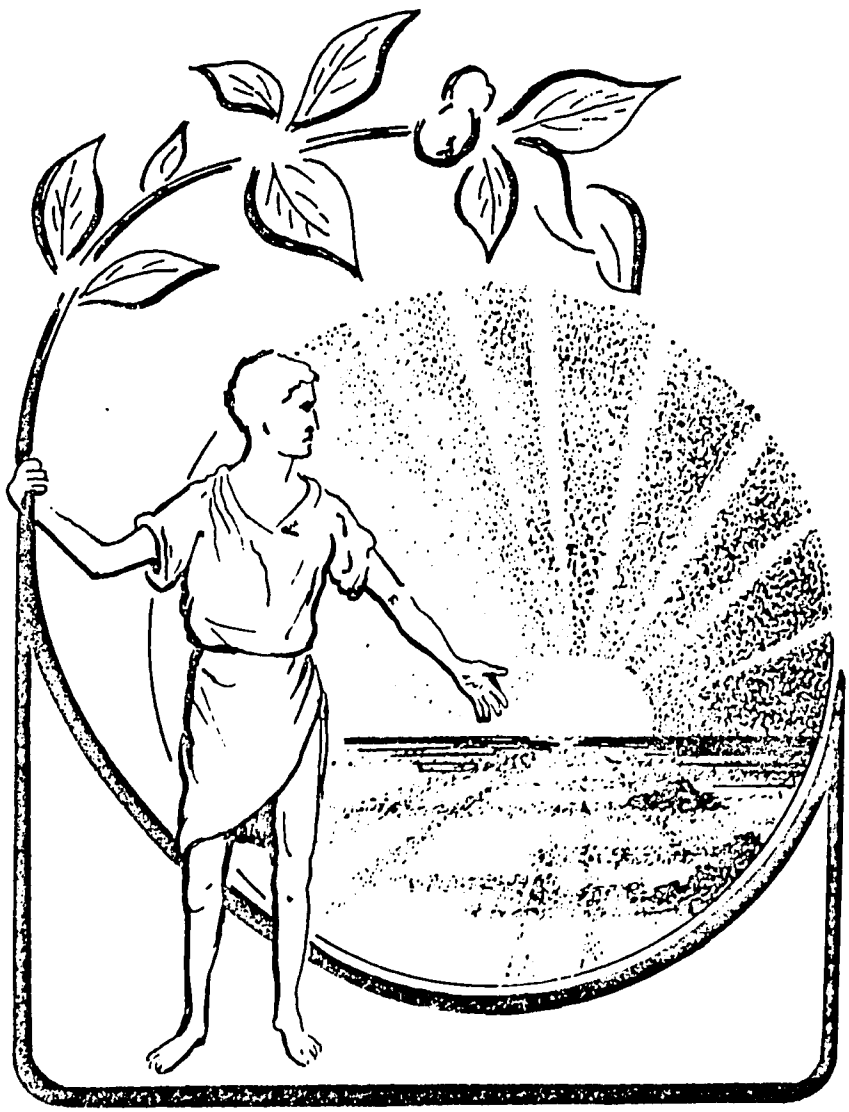
Instruction at ICRISAT will continue to be mainly in English. Intensive English language training courses will be conducted at Hyderabad or encouraged in the home country to facilitate the use of a common set of instructional materials and provide a wider source of literature to the trainees. The development of audio-tutorial teaching units in English and other languages can be used at ICRISAT to broaden the opportunity for those not fluent in English. Development of training programs in other language-group areas of the world will be explored as the number of potential trainees in a region increases or as regions obtain training facilities. However, the generally small number and widely scattered agricultural science graduates working in the semi-arid regions reduces the feasibility of establishing training centers in specific language-speaking regions for the 6-month type of individualized practical training programs. In addition, training in one's home environment reduces the value achieved through experience gained in a new environment with a different range of natural resources and research facilities.

The number of requests for pigeonpea, chickpea, groundnut and farming systems training programs will significantly increase as the national and regional programs expand their research and development activities with these crops and in farming systems. One of the major responsibilities placed on researchers at all levels is management of research farms and training personnel. Thus research farm management and training methods will continue to be emphasized in all our programs.

Persons who complete training and work in research and development programs of the semi-arid tropics are isolated and lack contact with other agricultural

scientists. Hence, ICRISAT will--as part of the follow-up program--communicate current research findings and new germplasm developments to former trainees so that they can continue their professional improvement.

A Preliminary Description Of The Germplasm Collection Of Sorghum Varieties From The Yemen Arab Republic



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PLANT SCIENCES DEPARTMENT
JANUARY 1, 1979

COLLEGE OF AGRICULTURE
UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

Robert L. Voigt and Mohamed A. El-Lakany

Attachment Five

ACKNOWLEDGEMENT

The following Agencies cooperated in generating this seed collection:

1. Department of Plant Sciences
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   Tucson, Arizona
   U.S.A.

2. United Nations Development Program, FAO
   Taiz, Yemen Arab Republic

3. United States Agency for International Development
   Sana'a, Yemen Arab Republic

4. Yemen Arab Republic Ministry of Agriculture
   Sana'a, Yemen Arab Republic

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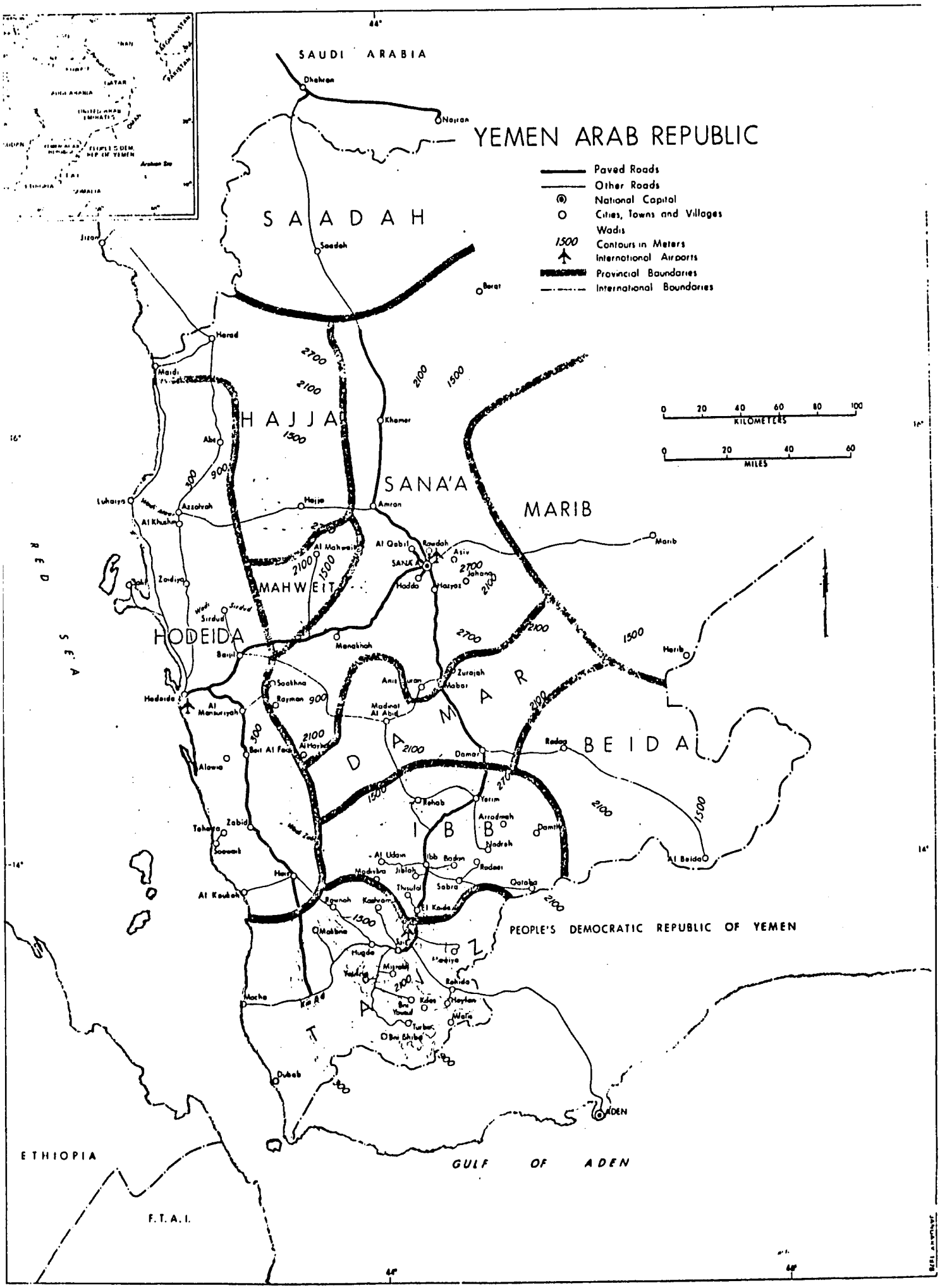
YEMEN ARAB REPUBLIC
Paved Roads
Other Roads
National Capital
Cities, Towns and Villages
Wadis
1500 Contours in Meters
International Airports
Provincial Boundaries
International Boundaries
KILOMETERS
MILES
SAUDI ARABIA
SAADAH
HAJJA
SANA'A
MARIB
MAHWEIT
HODEIDA
DAMAR
BEIDA
IBB
TAIZ
RED SEA
PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN
GULF OF ADEN
ETHIOPIA
F.T.A.I.
Dhahran
Najran
Saadah
Berat
Jizan
Harad
Maidi
Khamer
Abs
Luhaiya
Azzolyah
Al Khushm
Hajja
Amran
Al Mahweit
Al Qabil
Rawdah
Asiv
Jahana
Hadda
Hazyaz
Marib
Zaidiya
Sirdud
Manakhah
Baijil
Zurajah
Mabar
Hodeida
Al Mansuriyah
Soakhna
Rayman
Madinat Al Abid
Al Hayha
Beit Al Faqi
Alawia
Damar
Radaa
Harib
Rehab
Yerim
Arradmah
Nadreh
Damth
Al Beida
Zabid
Tahaita
Soowaik
Al Udain
Ibb
Badan
Radaei
Jiblah
Sabra
Qataba
Al Koukah
Rawnah
Kashram
El Kaida
Makbna
Hugda
Mizrahi
Rahida
Kdas
Haylan
Mafia
Turba
Bni Bhiba
Mocha
Dubab
ADEN
2700
2100
1500
900
300

A Brief Description of the Germplasm Collection of Local Cultivated Grain Sorghum Varieties in the Yemen Arab Republic

Robert L. Voigt and M. A. El Lakany[1]

INTRODUCTION

Modern fast communication and easy transportation has resulted in great movement of people and of crop seeds in and out of what was heretofore relatively inaccessible areas of the world. Special genotypes that have evolved over long periods of time for maximum local adaptation in these areas are often rapidly lost as so called improved genotypes are introduced in an effort to improve agricultural production in these areas. It is important that agricultural improvement within lesser developed areas and countries of the world by the more advanced nations include a collection of all genetic variability naturally existing before replacement with standard improved genotypes. These genetically diverse local genotypes may possess many genetic alleles and combinations not present in other parts of the world. This new and different germplasm should be maintained for future use by plant breeders the world over for possible development of more highly improved or adapted cultivars.

The Yemen Arab Republic is a country that had primarily for political reasons delayed open communication with other countries of the world. Also it has a high degree of geographical compartmentation and isolation within itself. Modern transportation has not even yet conquered many of the isolated inhabited areas of Yemen because of the severe mountainous terrain. Many Yemeni when asked how far it is back to their village may reply something like "one-half day by Toyota plus one day by donkey or walking." In the past it has naturally been most efficient for these

(1) Plant Breeder and Professor of Plant Sciences, University of Arizona and Chief-of-Party of Sorghum/Millet Improvement Program, University of Arizona USAID Contract, USAID, Sana'a, Yemen Arab Republic

Lecturer, Sorghum, Maize and Millet Breeder/Agronomist, Field Crop Division, United Nations Development Program, Food and Agriculture Organization of the United Nations. Central Agricultural Research and Training Station, Ministry of Agriculture, Taiz, Yemen Arab Republic

isolated areas to produce their own food locally. Long-range transportation of bulk products has been and still is difficult. Hence agricultural crop seeds tended to stay locally year after year. Great differences in environment from elevation and weather changes up and down mountainsides and valleys dictated differences in germplasm for maximum adaptation within very short distances "as the crow flies." Within many isolated areas great fluctuations in the timing and amount of rainfall from year to year result in early plantings or late plantings along with good or poor subsoil moisture supplies. Many of these local farmers have selected seed stocks with late or early maturity to compensate for fluctuating planting dates. Some farmers feel they also have special seed for seasons with either high moisture (ample rainfall or irrigation) or low rainfall conditions. The severe mountainous terrain and small isolated agricultural areas also produce rather effective genetic isolation. Most farmers are very proud of their own varieties and feel they are superior to others.

Yemen is now assimilating modern world technology at an amazing pace. These changes are starting to reach back into these formerly quite isolated areas. Evolutionary changes in the economic structure of the country as it interacts with the world is greatly affecting the Yemen farmer. The Yemen farmer is no different than other farmers the world over in that he will exert his efforts toward what promises to make him the most money or the best living. In some areas he has quit growing the traditional sorghum in preference to some other crop so this diverse sorghum germplasm is in some cases being permanently lost even though it has not necessarily been replaced by some improved sorghum genotypes.

PROCEDURE

The field collections of the Yemen Sorghum Collection were made during the 1975, 1977, and 1978 growing seasons. One-thousand-six-hundred-ten items were collected in 1975. This portion of the collection is described in a report by Dr. M. A. El Lakany[1]. The major portion of this collection was obtained during the 1977 growing season. This portion of the collection has serial numbers 1611 to 4540. Additional miscellaneous items were added to the collection during the 1978 growing season bringing the total of 4590.

The general field collection procedure was for the field collection team in a four-wheel drive vehicle to proceed up the Toyota (jeep) trail up each wadi or drainage way collecting one typical head every two kilometers. Terraced fields are located one directly above the other up all wadis to collect runoff rainfall. Some sort of vehicle trail generally goes up most of these wadis.

The field chosen at random from which to make the collection usually contained a population of a given race or sub-race reasonably uniform in plant and spikelet types, as a result of the selection pressure practiced

by the Yemeni farmer through many generations. However, natural selection in the various areas differing in micro-climatic conditions resulted in considerable variation among sorghum types grown in different areas but with great similarity within any specific area. A one-head sample was collected to represent each such growing type, but if any generally prevalent abnormality was noticed within the field a second sample was collected.

At the location and time of the collection the name of the local village and usually the name of the governate or area were recorded on the consecutively numbered collection bag. There were not and still are no accurate maps with all villages located and named with any standardized English spelling. English versions of village names are simply phonetic spellings of the Arabic sounds. There are sounds in the Arabic language that are not present in the English language. Each Westerner will likely use a slightly different series of letters to sound and spell out the names as he hears them. Consequently there is likely to be no way for anyone to refer to a map of the country and be able to readily locate the site of many of the individual collections. Major cities or areas may be located but not many of the smaller ones.

Estimates of the elevation were made from a contour map, however, there is some doubt as to the exact accuracy of these elevations. However, they may be considered to be good approximations.

In early 1979 the senior author visited with a member of a British survey and mapping team who in cooperation with the Yemen Government have been working for nearly three years to produce some accurate maps of the Yemen Arab Republic. A corrected version of an eight-piece set with a scale of 1:250,000 has just been released. They are in the early stages of producing a more detailed set on a scale of 1:500,000, which may run to several hundred for the country.

Approximately 90% of the major sorghum growing areas of the country has been collected. The area west-northwest of Sana'a which is approximately the area designated as the Governate of Hajja has not been collected. The eastern section of the Yemen Arab Republic extending out into the desert and bordering Saudi Arabia grows predominantly millet, barley and wheat with little or no sorghum. Few collections were made from these governates.

After collection each entry was characterized for certain phenotypic characters as follows(2)(3):

1. Whole head weight

2. Threshed grain weight

3. Peduncle shape

   G = recurved (gooseneck)
   E = erect

4. Panicle type

L = loose
SL = semi loose
SC = semi compact
C = compact

5. Grain color

L = light
D = dark
R = red
W = white
Y = yellow
Br = brown
P = pink
C = clear

6. Glume color:

L = light
D = dark
B = black
R = red
Y = yellow
W = white
G = green
Br = brown

7. Glume pubescence:

FH	= fully-hairy	80 - 100%
SH	= semi-hairy	50%
PH	= partly-hairy	30%
N	= none hairy	0%

8. Glume to seed ratio:

20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%

9. Race:

B = Bicolor
G = Guinea
C = Caudatum
K = Kafir
D = Durra
GB = Guinea Bicolor
CB = Caudatum Bicolor
KB = Kafir Bicolor
DB = Durra Bicolor
GC = Guinea Caudatum

GK = Guinea Kafir
GD = Guinea Durra
KC = Kafir Caudatum
DC = Durra Caudatum
KD = Kafir Durra

OBSERVATIONS AND DISCUSSION

The phenotype of a typical high elevation sorghum seemed to be a recurved (gooseneck) peduncle with a compact head contrasted with a low elevation sorghum with straight or erect peduncle with a small loose or semi-loose head.

There are likely many collection items that are so similar in general phenotype as to be considered duplicates. These will have to be determined later during an increase or grow out. However since there is a high degree of genetic isolation to all areas of collection and the local growers so jealously guard and increase their own seed each year there are very likely some real genetic differences among some collection items that appear similar in gross phenotype. The many different growth environments of from cold or hot weather, high or low moisture, short or long growing season, early or late planting dates, many different soils, and all of the different diseases and insects associated with the various climatic conditions have likely caused the evolution of a multitude of genotypes.

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Following is a numerical listing of this collection of 4590 items with brief descriptive data of each item.

Variation in Characteristics of the Local Yemeni Germplasm Collection

Sample No.	Location	Elevation (M)	Grain Color	Head Form	Head Type	Weight head/gr.	Grain Weight	Glume Color	Gl/S Ratio	Glume Hairy
01	Bir Basa	1300	LR	E	SL	50	42	B	30%	PH
02	Mattar Kadim	1350	LR	E	SL	25	22	B	30%	PH
03	Bir Basa	1300	W	E	L	50	40	B	30%	PH
04	Mattar Kadim	1350	LR	E	L	10	7	DB	30%	PH
05	Haidran	1150	LR	E	L	28	23	DB	30%	PH
06	Haidran	1150	LR	E	SL	18	14	B	30%	PH
07	Haidran	1150	LR	E	SL	28	23	LB	30%	SH
08	Haidran	1150	W	E	L	19	14	LB	30%	PH
09	Bir Basa	1300	LR	E	SL	26	20	LB	30%	SH
10	Turba	2000	R	E	L	65	54	B	80%	SH
11	Turba	2000	Y	E	L	38	22	LR	80%	PH
12	Al Nagd	1600	LR	E	L	25	21	LB	30%	PH
13	Al Nagd	1600	DW	E	L	54	42	B	30%	PH
14	Hedran	1150	R	E	L	6	4	B	50%	PH
15	Hedran	1150	LR	E	L	18	14	DB	50%	PH
16	Bir Basa	1300	LR	E	L	16	10	DB	50%	N
17	Bir Basa	1300	W	E	L	12	9	LB	30%	PH
18	Bir Basa	1300	LR	E	L	30	24	B	30%	PH
19	Al Mattar	1350	LR	E	L	40	32	DB	30%	PH
20	Bir Basa	1300	LR	E	L	45	37	B	30%	PH
21	Al Mattar	1350	W	E	L	50	30	B	30%	PH
22	Aagaga	1300	W	E	L	46	37	B	30%	SH
23	Aagaga	1300	LR	E	L	22	19	LB	30%	PH
24	Haidran	1150	W	E	L	20	15	B	30%	PH
25	Haidran	1150	Br	E	L	45	37	R	80%	PH
26	Haidran	1150	Br	G	C	55	40	R	60%	PH
27	Haidran .	1150	Br	G	C	40	27	R	60%	PH
28	Al Ru Beiee	1150	LR	E	L	16	11	B	30%	SH
29	Al Ru Beiee	1150	W	E	L	56	45	B	30%	PH
30	Al Ru Beiee	1150	LR	E	L	42	35	B	30%	SH

Sample No.	Location	Elevation (M)	Grain Color	Head Form	Head Type	Weight head/gr.	Grain Weight	Glume Color	Gl/S Ratio	Glume Hairy	Race
31	Al Ru Beiee	1150	R	E	L	18	13	LB	30%	FH	
32	Al Ru Beiee	1150	LR	E	L	28	20	LB	30%	SH	
33	Al Ru Beiee	1150	LR	E	L	18	12	B	30%	SH	
34	Haidran	1150	LY	E	L	52	42	LR+Y	70%	PH	
35	Haidran	1150	R	E	L	56	42	DB	40%	SH	
36	Al Ru Beiee	1150	W	E	L	14	8	B	40%	SH	
37	Al Ru Beiee	1150	LR	E	L	30	23	B	30%	FH	
38	Al Ru Beiee	1150	LY	E	L	52	47	LY+R	80%	SH	
39	Al Ru Beiee	1150	Y	E	L	34	20	LR+Y	90%	SH	
40	Aagaga	1300	DW+R	E	L	50	39	DB	30%	PH	
41	Heidran	1150	Y	E	L	17	11	B	80%	SH	
42	Al Ru Beiee	1150	LR	E	SL	40	32	LB	30%	SH	
43	Al Ru Beiee	1150	DW(LR)	E	SL	23	18	DB	40%	PH	
44	Al Remada'a	1100	LR	E	L	30	23	B	30%	FH	
45	Al Remada'a	1100	LR	E	L	26	20	B	30%	FH	
46	Al Remada'a	1100	LR+Y	E	SL	20	15	LR	30%	FH	
47	Al Huseisi	1050	LR	E	SL	28	21	DB	20%	SH	
48	Al Huseisi	1050	W	E	SL	32	25	B	20%	SH	
49	Al Huseisi	1050	LR	E	SL	54	45	B	20%	SH	
50	Wadi Gaher	1050	LR	E	L	7	5	B	20%	SH	
51	Wadi Gaher	1050	R	E	L	5	2	B	20%	SH	
52	Wadi Gaher	1050	DW	E	SL	10	5	B	30%	FH	
53	Hagda	1000	B	E	SL	44	31	B	50%	FH	
54	Al Rubaiyi	1150	LR	E	L	30	24	B	20%	PH	
55	Al Aduf	1150	LR	E	L	30	23	B	30%	FH	
56	Al Aduf	1150	W	E	L	10	8	B	20%	PH	
57	Al Heibee	1100	B	E	SL	42	34	R	50%	SH	
58	Al Heibee	1000	LR	E	SL	20	15	B	20%	SH	
59	Al Ragamah	1000	LR	E	L	24	18	DB	20%	PH	
60	Al Ru Beigi	1150	LR	E	L	50	35	B	20%	SH	

Due to the limited number of copies available of the complete set of data in this voluminous report and the difficulty in producing more, only the cover and first nine pages are presented here. All of the text material are presented plus the first 2 pages of the data which are representative of the remaining 151 pages.

Those readers with a professional use for these data are welcome to request individual copies from the senior author.

Dr. Robert L. Voigt
Department of Plant Sciences
Building #36
University of Arizona
Tucson, Arizona 85721