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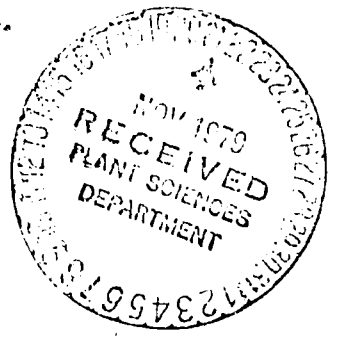

PRELIMINARY PROGRESS REPORT

MARCH 1977 - OCTOBER 1979

UNIVERSITY OF ARIZONA

USAID, SANA'A

PROJECT 030

20 October 1979

Prepared by

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OVERVIEW

In 1974 the U.S. Government at the request of the Yemen Arab Republic undertook the development of a National Sorghum/Millet Improvement Program for the Yemen. This interim report briefly outlines activities and accomplishments under the Program during the period March 1977 - October 1979, the period during which the University of Arizona has been associated with the effort.

Dr. Robert Voigt served as Chief of Party and Plant Breeder in Yemen from March 1977 until March 1979. He has since returned to Yemen twice serving in an acting capacity. We anticipate Dr. Voigt's continued association with the Project as a periodic visitor and Plant Breeding consultant. This should provide for continuity over a long period under Dr. Voigt's guidance. Dr. Donald Stewart served as Agronomist in Yemen from May 1977 until December 1978. He was responsible for pest control matters, weed collection, consultation on plant disease and the execution of outreach studies in 1978. A final report covering Dr. Stewart's activities is available. Dr. R. P. Upchurch has served as Technical Director of the Project and has visited Yemen several times. Campus back-up has been provided by various professors according to need. Detailed research reports are

being prepared on the 1977 and 1978 field results. In the meantime, this interim report is being issued.

The University of Arizona has devoted considerable time since October 1978 to replacing Dr. Voigt and Dr. Stewart. A series of unfortunate events has prevented replacement. Hopefully, agreement is now possible to allow two highly qualified experts to take up residence in Yemen. In the meantime the USAID Mission and the University of Arizona have taken special steps to maintain the momentum of the work.

The principle observations regarding the results of the project are as follows:

1. Cultivar Evaluation. Since 1974 numerous cultivar (varieties and hybrids) used outside of Yemen have been tested for performance. Dr. Voigt added about 650 such entries to the tests in 1977. In spite of the excessive variability at Bir El Gohm a reasonable conclusion is that sorghum cultivars developed outside of Yemen have not yet provided superior cultivars for use in Yemen. Our conclusion is that testing of additional cultivars from outside Yemen should be given additional attention when better field research areas are available. In the meantime substantial emphasis has been given to a bonafide sorghum breeding program which holds the greatest chance for success in Yemen.

2. Hybrid Sorghum Development. While hybrids developed elsewhere have not shown promise for use in Yemen the long-term prospects for having the ultimate performance of sorghum in Yemen rests upon the development of hybrids in Yemen through a Yemen-based plant breeding program. Since hybrids hold promise for the long-term only current efforts on the hybrid approach have been minimized. Research on hybrids is being limited to restricted testing of hybrids developed elsewhere and to the generation of pure lines of Yemen adapted genotypes which will eventually serve as a basis for hybrids bred in Yemen. This minimal research on hybrids is necessary to hold open the prospects for the long-term development of hybrids in Yemen. In any case the practical use of hybrids in Yemen in the next ten years is not feasible because of the high level of technology required to maintain good hybrid stocks in the hands of farmers. Beginning ten years from now Yemen agriculture will be ready for sorghum hybrids.

3. Improvement of Research Procedures and Facilities.

Research at Bir El Gohm in 1977 revealed that this site has a number of limitations. University of Arizona personnel had to learn how to grow sorghum in Yemen and under the especially difficult conditions at Bir El Gohm. Constant improvements in testing procedures were made over the past

three growing seasons. While Bir El Gohm is a site with limited usefulness we have learned to work with it and the 1979 field results just before harvest look quite promising. Some of the genotypes now in the field could be contenders for introduction to farmers after two more seasons of purification and improvement. Efforts have been made to make Al Jarubah operational and hopefully test plantings can be made there in 1980. We will go through a learning period in Al Jarubah as we did at Bir El Gohm.

4. Preferred Plant Breeding Approach. The current breeding approach involves the assembly of many genotypes in Yemen and the selection of improved individual sorghum seed heads with subsequent testing and retention of the best types. We now have promising selections at Bir El Gohm for upland conditions. These selections will be converted into varieties for release and serve as the basis for a crossing program for variety production and serve, long term, as the basis for hybrid production. The progress in the Uplands is most encouraging and holds promise for yield enhancement in the area. As far as we know this is the only active sorghum breeding program in Yemen.

5. Yemen Sorghum Collection. Working cooperatively with the UNDP approximately 4500 sorghum specimens have been collected from throughout Yemen. These sorghum types have been selected by Yemeni farmers over hundreds of years and represent

valuable types for specific plant features. The collection is now being increased in the USA and samples will be returned to Yemen and serve as a valuable component in the plant breeding program.

6. Training. The Program involves an effort to train Yemenis at various levels. The USAID Mission has been supporting the sending of about 75 Yemenis each year to begin BS level training outside of Yemen. Hopefully some of these will be assigned to the Sorghum/Millet Program as counterparts upon return to Yemen. In the absence of a full complement of counterparts the Program has concentrated on training support personnel and has made significant progress in this regard.

7. Projected Activities. Breeding for improved sorghum types for the Uplands should continue using a new field research site as soon as possible. In the meantime Bir El Gohm should be used again in 1980 if no other upland site is available. Outputs from this breeding effort should generate entries to be tested in outreach tests and in tests to be run by other donors. Coordination with other donors should be continued as in the past and intensified. There seems to be little duplication in the past work and this should be the case in the future. A report on cooperative studies in 1978 has been issued. Special efforts should be mounted in the Tihama especially to get the Al Jarubah station operational for millet/sorghum work in 1980. In 1980 a Yemen millet

collection should be generated for use in the breeding program. During 1980 efforts should be made to initiate sorghum/millet work in additional areas such as weed control and planting methods.

In order to accomplish the above projected activities two full-time professionals will be required in Yemen.

CONTENTS

I. Introduction.

The overall objective statement for this project is to "Assist the Yemen Arab Republic Government to Develop a National Sorghum/Millet Improvement Program for Yemen." A viable improvement or breeding program is made up of (1) a complete staff of technically trained personnel, (2) sufficient resources of land, laboratories, equipment and supplies for them to do their job, and (3) germplasm sources of potentially superior genotypes with which to work and modify. A shortage or deficiency in any one of these three major resources will prevent or hinder attainment of the desired final result.

This project has tried to move forward in its first two years in all three of these areas and has also initiated as much work as resources permitted in other supporting activity areas.

The following report briefly describes the major areas of activities of importance for the period March 1977 - October 1979. This is the period of time in which the University of Arizona has had responsibility under the Sorghum/Millet Improvement Program.

This report touches upon essentially all of the University of Arizona activities under the Project. Reference is made to some but not all of the activities carried out by the USAID Mission.

II. 1977 Field Research Activities in Sana'a: (Bir Al Gohm)

A project technical person (Plant Breeder) was in-country by mid-March 1977 about one month before planting time at Sana'a to begin work on this contract. 1977 was a year of study and evaluation of the situation in order to develop a workable program. It was necessary to study the strengths (and weaknesses) of the research station, of the land, of the local research procedures and of the technically trained support personnel already available. An important initial activity was to evaluate the germplasm already on hand as well as that having been imported into the country.

In the one month prior to planting the 1977 tests it was necessary to tabulate and summarize the 1976 data on hand sufficiently to plan for 1977, make research plans, put up seed, and prepare the research station land.

The 1977 field tests were a repeat of many of the 1976 tests (and genotypes) because 1976 had been such a poor year and few conclusions could be drawn from the data for keeping or discarding certain genotypes. The University of Arizona imported and entered about 650 sorghum lines in the 1977 tests. Lists of all 1976 tests and of all 1977 tests are attached. Many genotypes of an equal level that were grown in separate tests in 1976 were combined in 1977 so that meaningful comparisons could be made. The field plot layout, field plot procedures, etc., used in 1977 were the same as used previous

years. A cultivator shovel was used to make a small furrow 2 to 4 inches deep for the plot row. A large amount of seed was sowed by hand on the dry soil in this furrow and mixed in the soil with hand picks. "Hand made" small irrigation ditches were dug every 7 m across the cultivator marks to give plots with an effective length of 6 m. Irrigation water was flooded down the shallow furrows. The soil became extremely hard as soon as the water soaked in and the surface dried within 24 to 48 hours after irrigation. Most of the seedlings would take 10 to 14 days to emerge so several repeat irrigations had to be made on a frequent basis. The unlevel soil surface prevented uniform irrigation so some parts of the field remained too hard and too dry to allow any plant emergence. Many gaps in plots and uneven plot plant populations resulted. The plots were hand weeded but weed growth exceeded hand weeding activities and subjected many plots to severe weed competition.

There was a usual stem borer (insect) outbreak which wasn't very well controlled by the standard procedures in use. Thinning of the thick populations in some plots was delayed according to past practise until the stem borer had taken its toll and ceased activity. By this time the plants were too old to be influenced by changing to a proper population by thinning. Root depths were very shallow causing drought stress in a few days after irrigation.

The results of the 1977 field tests at Bir Al Gohm were highly variable for the reasons mentioned above. A thorough review of the situation led to the following suggestions for improvement:

1. Leveling the research farm so that a uniform depth of irrigation water could be applied.

2. Obtaining and using equipment to make deep furrows. A small pair of furrow openers were borrowed in 1978 and 8 new, large ones obtained from the US for 1979.

3. Pre-irrigating in these deep and level furrows and planting in moisture on the side of the furrow. Hopefully no more irrigation would be necessary to cause emergence thus preventing crusting over.

4. Planting 5 or 6 seed in hills about 25 cm apart (according to Yemeni farmers practice) and thinning to 2 or 3 plants per hill if necessary. (Five or 6 seedlings in one spot help each other through the soil.) No over-population situations should occur with this procedure.

5. Obtaining and using a tractor drawn chisel instrument to chisel to a depth of about 20 inches and break up the hard pan (plow sole) at about 6 inches to allow pre-irrigation water penetration to 18 to 24 inches. This would also allow deeper root penetration and hopefully successful plant growth for longer periods of time without rainfall or supplemental irrigation.

6. Providing deep furrows to run the length (or width) of the field, thereby permitting eventual mechanization, of planting and cultivation.

7. Developing chemical weed control methods.

8. Developing better stem borer control procedures.

A set of adapted A and B lines (a male sterile line with non-restorer line) was identified from materials sent from the US. This male sterile is being developed further and used for research and development of hybrids for use when the Yemen infrastructure can utilize hybrids.

III. 1978 Field Research Activities

A list of the 1978 field tests is attached.

Leveling equipment was not available to level the farm for 1978. We were fortunate in being able to borrow a "light weight" furrow opener from the UNDP at Taiz. Our soil is heavier and requires a heavier (stronger) furrow opener. A chisel arrived from the U.S. in time to chisel to about 18 inches and break up shallower hard pans. We found we had to chisel on narrower spacings than the manufacturer recommended in order to "shatter" our particularly heavy soil. We obtained good pre-irrigation water penetration.

More uniform plant phenotypes were obtained due to greater and more uniform root penetration and to uniform plant spacings and populations from hill plantings. These uniform plant phenotypes made possible greater precision of selection of superior genotypes (for grain or forage).

Plans were made to enlarge the field area available for research plots and to level all of the research station for 1979.

In 1978 improved insect control procedures developed in conjunction with the German Farm were initiated at Bir Al Gohm. This resulted in much improved control of the stem borer. The procedures involved improved sprayers, improved application schedules and the use of an improved insecticide.

Detailed tables of 1978 results will appear in a formal report being prepared. The 1978 field data were more reliable due to less variability within plots and among plots of similar genotypes as compared to 1977.

From the 1978 field results 28 experimental genotypes from 3 sources were indicated to be superior and were advanced to the 1979 Elite Yield Test, 11 experimental genotypes from 3 sources were advanced to the Advanced Yield Test and 200 experimental genotypes from 6 sources were advanced to the Preliminary Yield Test level.

IV. 1979 Field Research Activities in Sana'a

A list of the 1979 field tests is attached. Most research work is oriented toward use of irrigation only to assure emergence or prevent later loss due to extreme drought. These tests include: (1) Four types of tests to evaluate genetic materials for yield of grain and/or forage (see Breeding Approach Section for description.)

(2) An evaluation of short grain types which have potential for future hybrid production.

(3) An evaluation of U.S. type forage hybrids to local conditions (2 tests).

(4) A sorghum x sudangrass hybrid multiple clipping test for forage potential (needs irrigation).

(5) Nursery for crossing and purification of genotypes.

(6) National cooperative tests for Sorghum, Maize and Millet (5 tests).

(7) Tests for head smut control and stem borer control cooperative with the German Farm (2 tests).

At the time of this report near the end of the season, many promising genotypes with both grain and forage potential are apparent in the earlier stages of the selection program for yield of grain and/or forage.

The entire research farm was surveyed by project personnel for leveling. A small tractor mounted blade with a limited leveling capability was borrowed from the British Farm Mechanization Unit at Taiz. Some leveling was accomplished prior to furrowing out for planting the 1979 research tests. Some improved pre-irrigation by furrows was obtained.

The exact 1979 results are not yet available but the 1979 plots show increased uniformity within plots over 1978 due to improved research methods and more knowledge and practice by

project staff. There are greater numbers of diverse genotypes with superior attributes for forage and grain evident in resource materials available for selection. This signifies that there should be greater numbers of experimental genotypes competing for selection and advancement in the breeding program.

V. Breeding Approach

The procedure implemented for evolving improved genotypes for grain and/or forage production involved the use of standard plant breeding procedures. It is necessary to use basic procedures in the beginning years of setting up a national breeding program that could be understood and followed by project personnel in on-the-job training.

Single plants selected from whatever source the first year are put into an unreplicated head to row test in the second year in order to evaluate it on a row basis. Those head rows showing potential will progress through three years of replicated yield testing (years 3, 4 and 5). These stages have been designated as preliminary, advanced and elite tests, respectively. Only those entries showing promise relative to local standards or checks will be retained for further testing from year to year. The number of experimental entries remaining by the end of the testing program will depend on the genetic potential inherent in the original germplasm sources from which the selections were made. We have observed that

much of the superior genetic material utilized in other parts of the world is unadapted to the uplands of Yemen. A sorghum improvement program for Yemen based only on direct introduction of varieties developed elsewhere does not appear feasible based on results of tests in Yemen up to this point.

A very usable procedure for the generation of potentially superior genotypes through a random mating population is being developed. This procedure involves a male sterile facilitated recurrent selection program. It can be immediately adapted to different environments and, if handled properly, produce breeding materials indefinitely.

A major effort to identify or develop hybrids for general use in Yemen is not being exerted at the moment since Yemen currently does not have the infrastructure to produce and use hybrid seed. Limited research efforts are being directed toward the development of adapted genotypes suitable for hybrids. Experimental hybrids are being developed. Limited resources of the project dictate this course of action since the immediate need of Yemen is for improved varieties.

Other experiments in agronomy, entomology, plant pathology, plant physiology, weed control, etc., as related to the sorghum plant are all a part of a sorghum improvement program and have been started to a limited degree. A well-rounded breeding program depends on a complete staff of educated and trained farm support personnel.

VI. On-Farm or Outreach Tests.

Small sorghum tests were planted on farms of willing cooperators in 1978 and 1979. These farms were in selected areas in different directions from Sana'a so that the experimental sorghum entries could be tested under different environments. Four sorghum entries were in each test (three experimental and the farmers' own variety). Four replications were used allowing a Latin Square experimental design for maximum precision.

Fourteen different tests were put out in 1978. Two were destroyed before harvest and six more were harvested by the cooperators just before project personnel were scheduled to harvest the test. Yield results were obtained from six tests. One experimental variety from this project was the top yielder in five of the six tests.

There are 3 tests out on farms in 1979. A shortage of transportation and trained staff early in the season prevented arranging any more locations.

Pest and chemical weed control measures were used where needed on the 1978 tests which made very great and favorable impressions on the cooperators involved.

VII. National Cooperative Tests.

At Bir Al Gohm we have regularly conducted research tests of sorghum, millet and maize superior genotypes from other

research centers to obtain information as to the breadth of adaptation of these items. These particular tests are furnished sufficient irrigation for normal non-stressed growth since many of the donors are testing under conditions of sufficient rainfall or irrigation. There are usually 6 tests involved: a yield test and an observation test for each of sorghum, millet and maize.

We enter our superior sorghum selections in these tests to obtain such information on our own items at all of these locations in Yemen.

These tests are a direct result of coordination among various agencies in Yemen interested in sorghum and millet improvement.

VIII. Cooperation With Other Donor Agencies.

Meetings with other donor agricultural research professionals have been held quarterly at the Ministry of Agriculture for exchange of research plans, information and problems. An annual tour of all research facilities is taken by this group to observe the research underway by other agencies. This is usually a 3 or 4 day trip. Much valuable information is exchanged, activities are coordinated and duplication minimized.

Three small threshing machines have been loaned to the UNDP at Taiz to facilitate their research and extension capabilities in sorghum and wheat. Their wheat research activities have been able to be more than doubled through use of these

machines. About 30,000 sorghum selfing bags were also furnished to the UNDP at Taiz along with 25 to 30,000 seed envelopes. They had attempted to buy these special items in-country, but such items have not been available.

IX. Training of Support Personnel.

No research program can succeed without a number of technically trained staff support personnel. There are thousands of hours of careful and somewhat skilled work involved in correctly processing seed for planting, planting, care of growing plants, collection of numerous data throughout the season, harvest, threshing grain, processing of forage, tabulation of thousands of items of data, and processing and storage of seeds.

We have trained 4 locally hired personnel in these 2 years. These people had the approximate equivalent of a high school education and thus were able to be trained and do the work. It takes a full year to go one full cycle through the work so a minimum of one year is necessary for minimum on-the-job training. All 4 currently work full-time on the project and are all needed.

Three IVS personnel with BS degrees also assisted full-time in conducting the above research activities.

X. Al Jarubah Experiment Station Site

The contract for this project calls for the eventual development of a total of three research stations. One at

Sana'a (Uplands), another at Al Jarubah (Tihama), and a third at an intermediate elevation or environment, for which the exact site is yet to be selected.

The site at Al Jarubah was selected and decided upon in 1977. Work on development of the site began in 1978. The remoteness and inaccessibility of the site has made development work there very costly in time and money. Personnel and resources involved in the development of the site in 1978 and 1979 had to be pulled from on-going activities at Sana'a thus reducing the pace of activities at Sana'a.

A road was graded out from the highway to the site but has since been washed out by rains.

The well has had 6 inch pipe, a pump and a motor installed. It is operational with an output capacity of about 4.5 liters per second. Two more wells are planned in order to produce the needed volume of irrigation water for about 25 ha of research land.

Land for about 5 to 10 ha has been surveyed and attempts made to do some leveling with inadequate equipment. Most of this area is planned for horticultural crops. The output of the existing well is about enough to care for the current horticultural activities. Any millet or sorghum research plantings of any size will depend on the development of at least one of the two new wells that are planned.

XI. Short Term Professionals

As technical problems arose during project activities that were outside the expertise of the two professionals' in-country, outside professional consultants in these specific problem areas were brought in to advise on solving the problem. To date short-term professionals have advised in the following areas:

Soils: A soils man was called in to determine characteristics of the soils in our research site at Sana'a and advise on better agronomic field methods.

Irrigation: Water management and reorganization of the research farm was a big problem. Two professionals were called in to help revamp the irrigation and other relative agronomic field procedures.

Weed Control: A certain type of weed has been an overwhelming problem during most of each year of field operation at Sana'a. A professional weed control man was called in to study and advise on this problem. He also studied other weed problems or potential weed problems around Sana'a.

Entomology: An entomologist was called in to study the general insect population in the areas of our research operations throughout Yemen. He made as extensive a collection as could be made during the short time of his visit and the particular time of the year of his visit. This collection was

taken to the US for accurate identification and classification.

Seed Storage: Losses each year between field harvest and actual consumption of sorghum grain in Yemen are very large. Reduction of these losses would be the same as a very large increase in average sorghum yields across the country. A seed storage expert came in and surveyed seed storage methods and facilities in various sections of Yemen.

Individual reports were submitted by each of the above professional consultants.

XII. Yemen Sorghum Collection

The Yemen economy and society is in a fast state of change. The agricultural sector is no different than all of the other sectors in that interaction with the rest of the world is resulting in large changes in the role of sorghum and millet in Yemen.

Sorghum and millet have been traditional human food crops in Yemen for thousands of years because of their capability of assurance of some production most of the time on agricultural lands marginal for water or rainfall resources. There are large areas of Yemen where these water restrictions will remain for the future, so sorghum and/or millet are still the best hopes for these areas. Recent development of many less marginal areas has resulted in production of new crops of

greater use and economic return than sorghum. This pattern has occurred in the past in many countries and is an expected happening. There are thousands of different environments in Yemen and thousands of different special sorghum genotypes have evolved over the centuries for maximum adaptation to these local environments. These particular special sorghum genotypes are forever lost to mankind the moment these local farmers switch from sorghum to some other crop. It is an important step in a breeding program to improve or change a crop in an area, to save a sample of the native genotype being replaced.

The UNDP at Taiz had made a small beginning but had no resources to continue and complete a sorghum collection of Yemen. The USAID project furnished all travel resources, part of the personnel and salaries and all equipment necessary to complete a collection of Yemen except for one governate. There are approximately 4,500 entries currently in this collection. This collection is now in the U.S. being processed by this project for entry into the World Sorghum Collection. Such entries are described, increased and stored for use of scientists the world over, including Yemen. Information about entries in this Yemen Sorghum Collection generated from evaluations and studies by hundreds of scientists around the world will be invaluable to sorghum research programs in Yemen.

XIII. Farmer Survey Relative to Sorghum and Millet.

A comprehensive questionnaire was developed and presented to about 1,000 Yemen farmers in 1979. This questionnaire asked about types of sorghums and millets grown, acreages, methods of farm management regarding these crops and sale and utilization of the product.

This survey was run under contract with personnel of the University of Sana'a. The data are being prepared for computer analysis by the University of Arizona.

It is anticipated that the results of this questionnaire can be used to help project the future of sorghum and millet in Yemen. Such educated projections are very helpful in giving guidance to a breeding program. Research work in a breeding program must be initiated some 5 to 10 years ahead of the actual final product being in the hands of thepublic user.

XIV. Herbarium.

A collection has been started of all native forbes in the Yemen uplands. Many of these plants are competitive with cultivated crops under field conditions. Proper identification of these "weeds" is necessary to utilize the scientific information available on their control.

Herbarium equipment and supplies have been purchased and are on hand. Most of the approximately 150 specimens have been identified and labeled with the assistance of appropriate

professionals from Sana'a University and the German Farm.

XV. Arizona Support.

The University of Arizona, with its complete professional staff, has given valuable support in furnishing information concerning solution of particular problems.

The University of Arizona has done all of the work in locating, purchasing, and shipping supplies and equipment to support this project that were not available in Yemen.

Classification and seed increase of the approximately 4,500 items in the Yemen Sorghum Collection are being arranged and carried out by the University of Arizona.

One particular item in the Yemen Sorghum Collection was claimed by the donor to be resistant to "Striga" which is an extremely serious parasitic plant on sorghum wherever striga is found in the world. The University of Arizona is arranging for seed increase and evaluation for this characteristic.

XVI. Summary of Progress.

1. An invaluable resource has been developed in the technical training of 4 project staff personnel. These individuals have from 1 to 3 years training and experience each.

2. One experimental sorghum variety showed superiority in 1978 to local varieties in most of the on-farm tests and also rather broad adaptation capabilities among on-farm tests.

3. Approximately forty experimental sorghum genotypes showed superiority to local checks for both grain and forage in 1978 experimental yield trials. They are being evaluated for both grain and forage potential.

4. There are dozens of experimental selections in early phases of the breeding program in 1979 that appear to have potential for superiority in both grain and forage according to usual evaluations.

5. The Yemen Sorghum Collection is on its way to being a very valuable contribution to the future of Yemen sorghum research and to the world.

6. Equipment, supplies and laboratory facilities have been developed for sustaining a research capability.

7. A few potentially superior genotypes have been identified that can be utilized as a source of superior experimental selections and as a base for a "male-sterile facilitated recurrent selection population."

8. A male sterile line with its fertile non-restorer has been developed that appears to have a good phenotype for Yemen. Experimental hybrids are being produced for testing.

9. The Sana'a Experiment Farm has been developed and improved procedures adopted, making possible more accurate research plot results.

10. Initial steps have been taken to make Al Jarubah operational as a research station.

XVII. Projected Activities.

1. Research work in the Uplands is proposed to continue primarily on sorghum. Sorghum grows best in the Uplands relative to millet which is very poorly adapted to the Uplands. This sorghum research will revolve primarily around the objective of striving for drought tolerance for sorghums on marginal lands lacking sufficient moisture to economically grow any other crop. Plant scientists describe "drought tolerance" as one of the most difficult plant characters to detect, describe and manipulate. This indicates that very difficult and probably time-consuming research lies ahead but if successful will be extremely rewarding.

2. Research work is to be initiated in the Tihama and will evolve primarily around millet which is better adapted and with more potential in the Tihama than sorghum. The first work will involve development of the research station followed by development of research procedures to successfully grow reliable test plots. At this point efforts will be made to identify millet germplasm containing the proper genotypes for superiority under the specific Tihama environmental conditions. A study (survey) of production and use of millet in the Tihama will have to be made in order to become knowledgeable of the desirable plant characters and to be able to make good selections.

3. Resources permitting, a Yemen Millet Collection is highly desirable.

SANA, YEMEN 1976 FIELD RESEARCH
EFFORTS ON SORGHUM AND MILLET

TEST NO.	TEST TYPE	ROWS PER PLOT	REPS	NO. ENTRIES	ROW PLOTS	COMMENTS
76019	Prop.	8	1	9	72	Off-type Hds - 1975
76016	Sel.	1	1	66	66	Head selns. from 75016
76076	Seg. Popn.	4	1	76	304	F_2 from 1975 Lebanon crosses
76025	Sel.	1	1	55	55	Nutritional Quality Purdue
76015	Sel.	1	1	127	127	F_3 Sel - F_4
76027	Y.T. Obs.	6	1	6	36	F_2 of Hybrids
76013	Sel.	1	1	204	204	From USDA bulks
76055	X Block		1	22	22	Crossing block
76032	Sel.	1	1	47	47	From USDA bulks
76036	Reg. Y.T.	2	3	60	360	Alad Reg. Y.T.
76033	Sel. (Row)	1	1	173	173	Proso & foxtail millet alad reg. nursery
76042	Sel. (Row)	1	1	71	71	From 74002 - 74004
76065	Silage Y.T.	3	4	4	48	Alad reg. Y.T. (silage)
76039		1	1	111	111	?
76018	Y.T.	3	4	5	60	?
76041	UNREP. Y.T.	3	1	13	39	High yielding lines UN-replicated
76044	Obs.	5	1	5	25	New crops
76070	Obs.	2	1	10	20	Chick peas
76071	Obs.	2	1	10	20	Broad beans
76073	Obs.	7	1	5	35	Beans
76030	Y.T.	4	4	4	64	Fertilizer trial
76035	Y.T.	1	4	18	72	Selns from 75013
76012	Adv. Y.T.	1	4	15	60	From 75012 - adv. yield trial
76061	Y.T.	4	4	4	64	Pearl millet
76057	TESTS	2	4	9	72	Off type hd. selns.
76017	ABANDONED	1	4	15	60	Hd. sel. from 75012
76018	- DRIED UP	3	4	5	60	Reg. Y.T.
76064	Y.T.	4	4	5	80	Pearl Millet
76028	Prel. Y.T.	2	4	26	208	From 75016 Prelim. Y.T.
76029	Adv. Y.T.	1	4	14	56	From 74009 Adv. Y.T.
76021	Obs. yield	1	1	81	81	Obs. + yield
76014	Prel. Y.T.	2	4	23	184	From 75014 Prelim. Y.T.
76018	Reg. Y.T.	3	4	5	60	Regional Y.T.
76056	Prelim. Y.T.	1	4	9	36	Prelim. Y.T.
76031	Reg. Y.T.	4	4	5	80	Alad Regional Y.T.
76020	Y.T.	1	4	14	56	F_1 vs F_2 Hybrids in-breeding depression
76060	Nursery	3	1	33	99	Pearl millet
76005	Obs.	1	1	36	36	Sudan grass
	Total			1400	3323	

SANA YEMEN 1977 FIELD RESEARCH EFFORTS ON SORGHUM AND MILLET

Field	1977 Test No.	Crop Type 1/	TEST NAME	NO. ENTRIES	NO. REPS.	NO. PLOTS	ROWS/ PLOT	NO. ROWS
B	77074	S	Early-Preliminary Yield Test	126	2	252	1	252
B	77075	S	Late-Preliminary Yield Test	113	2	226	1	226
A	77076	S	Early-Advanced Yield Test	85	4	340	1	340
A	77077	S	Late-Advanced Yield Test	90	4	360	1	360
B	77078	S	Hybrid-Adv-Gen-Yield-Depr-Test	20	4	80	2	160
B	77079	S	Pest Resistance Nursery	24	4	96	4	384
B	77080	S	Exper. Hybrid Yield Test	49	3	147	1	147
B	77081	S	Exper. Hybrid Observ. Test	82	1	82	1	82
E	77082	S	Head-to-Row-Early	345	1	345	1	345
E	77083	S	Head-to-Row-Late	342	1	342	1	342
B	77084	S	Miscellaneous Prel. Yield Test	155	2	310	1	310
A-B	77085		Demonstration	77	1	77	2 +	146
A	77086	S-M	Date-of-Planting Test	24	4	96	4	384
E	77087	M	IPMAT #2	22	3	66	1	66
A	77088	S-M	Nursery	664	1	664	1 +	664
E	77089	S	Int. Sorg. Coop. Nursery	34	3	102	1	102
E	77090	S	East African Maize Var. Trial	27	2	54	3	162
B	77091	S	Sana - Yield Test	7	4	28	1	28
E	77092	M	Millet-Yield Test	44	2	88	1	88
A	77093	S	F_3 Selections	76	1	76	1	76
E	77094	S	Sorghum Y. Test (Lhakany)	8	3	24	1	24
E	77095	M	Millet Y. Test (Lhakany)	4	3	12	1	12
E	77096	SG	Sudan Grass	28	1	28	2	56
A		M	Marana Millet Composite					45
A		S	Sorghum Composite					101
B		S	Sorghum Composite					24
D		M	Big-Headed Millet POPN.					60
D		S	Snowflake Fert. + Ster. R.M.					180
E		S	NP3R Dry Steriles (Sorg.)					85
E		M	Senegal Millet POPN.					69
1977 = 30 Tests = Totals =				2446	[redacted]	3895		5320
1976 = 38 Tests = " =				1400		--		3131

1/ S = Sorghum, M = Millet, SG = Sudan Grass

List of Sanaa Experiment Farm
Field Experiments - 1978

Test No	Experiment Title	Number of Entries	Rows Per Plot	Reps	Total Field Rows
78097	Head-to-Row	328	1	1	328
78098	Head-to-Row	251	1	1	251
78099	Head-to-Row	352	1	1	352
78100	Head-to-Row	158	1	1	158
78101	Preliminary Yield Test	56	1	2	112
78102	Advanced Yield Test	36	2	4	288
78103	Elite Yield Test	30	2	4	240
78104	International Sorghum Disease and Insect Nursery	37	1	2	74
78105	National Cooperative Sorghum Yield Trial	5	3	3	45
78106	National Cooperative Sorghum Observation Nursery	21	3	1	63
78107	National Cooperative Maize Yield Trial	6	3	3	54
78108	National Cooperative Maize Observation Nursery	18	3	1	54
78109	National Cooperative Pearl Millet Yield Trial	3	3	3	27
78110	National Cooperative Pearl Millet Observation Nursery	10	3	1	30
78111	F_4 Generation of Populations	76	1	1	76
78112	Advanced Hybrid Generation Populations	15	1-10	1	28
78113	Nursery	158	2	1	316
78114	1978 International Food Grain Sorghym Yield Trial	30	3	3	270
78115	Early Maturity and Tall Hybrid Yield Test	18	2	3	108
		1608			2874

Sama'a Experiment Farm Field Experiments - 1979

Test No.	Experiment Title	Number of Entries	Rows Per Plot	Reps	Total Field Rows
79001	Head-to-Row	447	1	1	447
79002	Head-to-Row	498	1	1	498
79003	Elite Yield Test	33	2	4	264
79004	Advanced Yield Test	16	2	4	128
79005	Preliminary Yield Test	210	1	4	840
79006	Short Grain Yield Trial	42	2	3	252
79007	Sorghum X Sudangrass Green Forage Test	6	4	4	96
79008	Forage Sorghum Grain and Forage Test	6	4	4	96
79009	Sorghum X Sudangrass and Hybrid Forage Sorghum Demonstration Test	53	2	1	106
79010	Nursery and Increase Plots	68	2	1	136
79011	Head Smut Control Test	5	4	4	80
79012	Sesamia (Stem Borer) Control	4	7	4	112
79013	National Cooperative Sorghum Yield Test	(No test seed distributed)			
79014	National Cooperative Sorghum Observation Test	18	2	1	36
79015	National Cooperative Maize Yield Test	9	3	3	81
79016	National Cooperative Maize Observation Test	14	3	1	42

Sana'a Experiment Farm Field Experiments - 1979

Test No.	Experiment Title	Number of Entries	Rows Per Plot	Reps	Total Field Rows
79017	National Cooperative Pearl Millet Yield Test	6	4	4	96
79018	National Cooperative Pearl Millet Observation Test	(No test seed distributed)			