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ANNUAL

RESEARCH REPORT

Number 4

1979

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In support of:

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

This project initiated its activities in Yemen in early 1977. It had to build on and go forward with what was available from 1976 regarding personnel, facilities, equipment and supplies, research materials and results of past efforts.

Reports covering detailed information on project research oriented activities not previously reported elsewhere were submitted to cover individual calendar years. These reports are as follows:

Number One is a brief report on information on results of the 1976 calendar year which was prior to this contract. This project had to build on and go forward from this 1976 base.

Number Two is a detailed report on project research oriented activities carried out in 1977.

Number Three is a detailed report on project research oriented activities carried out in 1978.

Report Number Four is a detailed report dealing primarily with research oriented activities carried out in-country in the calendar year 1979.

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1979

- Section 1 -

Introduction to the 1979 Season

The 1979 cropping season represents the third full year of in-country field research and other development of a Sorghum-Millet Improvement Program under this contract.

Annual Research Report Number 3 (1978) contains the background information for research activities and materials carried out and treated in 1979.

The two professionals, Dr. Robert L. Voigt (Chief-of-Party and Plant Breeder) and Dr. Donald M. Stewart (Agronomist) were not replaced on schedule when their duty tours terminated 14 March 1979 and 3 November 1978, respectively. Drs. Markarian and Sandhu were selected and their nominations presented to USAID and the Yemen Ministry of Agriculture for approval on 26 April 1979 and 4 May 1979 respectively. Considerable delay occurred in obtaining clearances for Drs. Markarian and Sandhu, resulting in the 1979 season being directed by Dr. Voigt while stationed at the University of Arizona. Dr. Voigt planned the 1979 research program before leaving Yemen at the end of his tour on 14 March 1979. Voigt returned on 10 April through 17 May 1979 on TDY to plant most of the research materials and again on 10 October through 20 November 1979 to collect research data, select improved genotypes, and direct the harvest program.

Mr. David Robinson came to Yemen in December 1978 on TDY status to serve as a technician and alleviate the problem of no professionals in-country in 1979. He performed in an excellent manner during 1979 in learning fast on the job and following the directions of Drs. Voigt and Stewart who were in the U.S.

Dr. Voigt prepared rather detailed written instructions for the major

field activities that needed to be carried out at Sana'a. Dr. Voigt was acting Chief-of-Party and Plant Breeder while actually being based at the University of Arizona. These written instructions covering the following items follows on pages 6 through 14.

A. Immediate Requested Actions

B. Planting Millet

C. Thinning

D. Spray for Stem Borer

E. Irrigation

F. Fertilizer

G. Weeding

H. Cultivation

I. Farm Labor

J. Care of Pollination of Sweet Corn and Popcorn

K. Field Notes

L. Bird Watchers

M. Outreach

N. Jobs To Do

The USAID Mission was actively trying to develop the newly selected Al Jarubah Experimental Research Station in the Tihama during 1979. In carrying out this effort the Mission used Sorghum-Millet project vehicles, equipment, supplies and personnel. Also administrative delays on the part of AID to furnish in-country funds for operational costs during July and August caused the shut-down of the larger irrigation well for lack of repairs. This caused the complete loss of all materials in Field D and hurt all other research materials. This diversion of project resources and lack of timely operational support caused considerable loss of research efforts in 1979. Lack of vehicles alone nearly eliminated the outreach program.

Drs. Markarian and Sandhu arrived in-country on 8 November and 9 November 1979 respectively. A short project orientation period with Dr. Voigt was possible before his departure on 20 November 1979.

A. **REQUESTED ACTIONS - PROJECT 0030**
Complete NLT 4/10/79

1. Chisel field D -- both ways diagonally.

2. Plow alfalfa (field C), disc, smooth out to furrow out to plant if possible.

3. Level south end of field D (south of Presidents Road) for planting to alfalfa. Level when Acharya returns from al-Jarouba--if he has time.

4. Try out furrow openers by new well--space at 70 cm (.7m) if possible.

5. Furrow out fields A, B, C, and D (at .7m spacing if possible). Start parallel on one side of field or other--if possible.

6. Count ridges (rows) per field and measure length of rows at several places for calculations as to number of plots possible per field.

7. Acharya tells me he plans a west to east irrigation pipe through field D to split it in half. (Would irrigation from both ends at once help?) I would suggest that the pipe parallel either the Presidents Road or the north edge of field D so at least the north half or south half of field D is square and not have both halves varying in row length from one end to the other.

8. Museid, Robinson and Ahmed arrange outreach test cooperators--numbers and location as per Mission desires. I suggest a rental payment payable after harvest by USAID.

9. Return small "land plane" to British Mech. Unit at Taiz with all parts and bolts and in good shape. An operator's manual in my office should also be returned. Tell them how much we gained from using it and give them our sincere thanks.

10. We planned to "float" (smooth) fields A, B, C, and D with float from Engleberger at Amran before furrowing out. Dutch have it at Dahmar but should have returned it by now or will soon. I don't know whether it will go to German Farm or to Amran. It will take some running around to find it and find Engleberger.

RLVoigt:cr:3/13/79

B. PLANTING MILLET

The millet seed are smaller than sorghum or corn and do not have quite the emerging "power". Therefore do not plant these seed quite as deep as the corn or sorghum, but do not get carried away and plant too shallow. You still need good moisture for germination and emergence. The main thing to help this situation is plant at 0600 for optimum (maximum) moisture in the soil around the seed when planting at somewhat shallower depth. Go deeper if necessary to get moisture. Break up the soil well that is put in the hole over the seed. It is more important here not to have a lot of clods covering the seed.

C. THINNING

Sorghum:

1. Thin to two typical and healthy plants per hill. If there are a couple of plants per hill to pull out - pull out the atypical ones if there are any differences among plants. If there is only one plant in a hill, then try to leave three plants in a hill on either side of the single plant hill. If there is a blank hill then try to leave three plants in each hill on either side of the blank hill.
2. Thin all sorghum plots in all tests except 79011 and 79012 unless authorized to do so by the German Farm.
3. 79007 is the SXS Forage Test and is a little different type of plant so thin to three plants per hill. Leave an extra one if possible in hills next to hills of less than three plants or completely blank.
4. Thin when ten to twenty cm in height. It is advisable to thin just after an irrigation or a rain so that the plants pull easier and DO NOT BREAK OFF. A broken off plant will grow out again! This means thinning when the time

is right. It may be necessary to schedule an irrigation followed by thinning as soon as dry enough.

Corn (Maize):

1. Thin to one plant per hill in much the same manner as for sorghum.
2. Tests 79015 and 79016 are the maize tests to thin.
3. Do not thin the corn borders, sweet corn or popcorn. Don't thin "corn" borders.

Millet:

1. Thin to two plants per hill when the plants are about ten cm tall.
2. Thin in the same manner as for sorghum regarding single plants per hill or blank hills.
3. Tests 79017 and 79018 are the millet tests to thin.

D. SPRAY FOR STEM BORER

1. Sorghum and SXS only. The corn shouldn't be bothered.
2. Watch for dead or wilting plants as a sign. This may start happening in the seedling stage around thinning time.
3. Museid should be able to set up this operation.
4. Buy chemicals from German Farm.
5. German Farm should be able to answer all questions.
6. DO NOT SPRAY sorghum tests 79011 and 79012 and their surrounding bulk sorghum borders. This to allow the stem borer infestation to build up some. At any rate, follow the desires of the German Farm.

E. IRRIGATION

1. Most all research materials should be stressed somewhat for water before

irrigating. Undoubtedly there will be parts of the fields that will show moisture stress before other parts. It will be necessary to irrigate them before some areas even get dry. Waiting for all areas of the field to dry up will likely result in too severe drought damage to the first plots to dry up so don't do this. Some plots then will get nearer optimum irrigation. Do not try too much manipulation of irrigation water between wet and dry spots.

2. Field A - If possible, the sweet corn on the east end should be given irrigation water as needed without stressing it.

3. Field B - Irrigate as necessary to maintain optimum growth in rows 109 through 164 (end of field) inclusive. Do not stress these rows 109 through 164.

   Also irrigate, as necessary, the corn in rows 1 through 6 on the east end of the field if possible.

4. Field C - Do not stress any of this field. Irrigate often enough to maintain a reasonably good moisture supply.

5. Field D - Stress all of field except 79011 and 79012. I think the German Farm will want a fairly good moisture supply.

6. The corn borders will be stressed too if next to sorghum plots being stressed.

F. FERTILIZER

1. Amounts to apply:

   Stressed plots (sorghum): Put on at the rate of 30 lbs per acre of actual "N" (nitrogen). For example 45% N fertilizer would be put on at about 66.6 lbs per acre of actual fertilizer material to give a rate of 30 lbs per acre of N.

   1 lb N per acre = 100/45 = 2.22 lbs of fertilizer
   30 lbs N per acre = 30 X 2.22 = 66.6 lbs per acre

Irrigated plots (corn and millet plus some sorghum): Fertilize at rate of 60 lbs per acre of actual "N" (nitrogen).

60 lbs per acre = 60 X 2.22 = 133.3 lbs per acre

2. Apply just after thinning and before plants are about 30 cm tall.

HIRE MORE LABOR to do this thinning, and weeding all at the same time - if necessary.

G. WEEDING

1. The weeding will have to be done manually. Yahya Abdo (Little Yahya) will instruct and run the weeding operation.

Keep up on weeding. Do not let the weeds compete with and cover the small sorghum plants.

A good growth of weeds will use up fertilizer meant for the sorghum and corn.

Weed the corn borders only after the plots are weeded. Don't let the limited farm labor supply waste time on weeding corn. HIRE MORE LABOR to keep up.

H. CULTIVATION

Yahya Abdo has a hand operation (tied in with the weeding) which moves dirt from the high ridge just west of the row across the low furrow up against the plants on the east side of the other ridge to give additional plant support.

THIS WILL TAKE LOTS OF ADDITIONAL FARM LABOR TO BE FINISHED IN A TIMELY MANNER, or you will be finishing about harvest time with only a small farm labor crew.

I. FARM LABOR

Keep hiring more farm laborers as necessary to get jobs done on time. Farm labor may be idle between jobs. Just keeping farm labor busy every day is not the objective.

TIMELY FARM OPERATIONS is the MAJOR OBJECTIVE.

It may be necessary to hire extra temporary farm labor for a week, then lay them off for a week, and then rehire for a week.

It may be advisable to hire permanently some of the better temporary labor.

1978 = 8 farm labor inadequate assume 12 = adequate
1979 = 50% more plots
= 12 + 6 = 18 to 20 farm labor estimated to even try to keep current re: weeding, fertilizing and thinning.

Inadequate farm labor resulted in some sorghum plots getting bad weed competition for most of season, thinned late and fertilized late. Other plots may be weeded on time but thinned late and fertilized late, etc., etc., etc. The result was that among plots there were drastic manmade environmental differences with sufficient influence on the research results as to exceed the genotypes influence which we are trying to select for.

J. CARE OF POLLINATION OF SWEET CORN AND POPCORN

Detassel field corn borders adjacent to and within about 20 meters of Sweet Corn and of Popcorn if the field corn happens to be shedding pollen about the same time as either the sweet corn or popcorn. This is to reduce somewhat the amount of cross-pollination onto the sweet corn and popcorn.

Hopefully the sweet corn will flower early and the field corn late so that there will be no cross-pollination possible at all. The popcorn is an

unknown, but probably will flower after the sweet corn but before the field corn.

K. FIELD NOTES

Check over tests in the field every few days for growth and general progress and check the field book and other sources or instructions as to notes to be taken or activities to be carried out on the plots. This entails continual daily thinking about all research tests, frequent visits to the tests along with a thorough knowledge of what is to be done on each test throughout the whole year.

Take notes on all plots of all crops, as appropriate. Do not omit taking notes on corn, for example, as was done in 1978 for some reason.

L. BIRD WATCHERS

There may be trouble with birds eating small emerging seedlings and digging down and eating the planted seed. We had this problem in 1978. Inspect planted plots daily for evidence of starting bird damage of consequence so that bird watchers may be hired.

Bird watchers are necessary when sorghum plots have started blooming and seed is developing. Morning (sun-up) and evening (sunset) are the most critical periods; however the birds eat all day. The bird watchers seem to work when you (research people) are in the field during regular working hours. I used to go to the field at sunup or sundown (irregular off-duty hours) and at first find no bird watchers in sight or bird watching activity and birds would be eating. One bird watcher would spot me and start his yelling and scaring birds off. Then all 6 or 8 bird watchers would come out of hiding in a few

seconds and start in. It was almost funny if not sad. It points up the need for non-regular periodic visits to the plots to try to keep the bird watchers somewhat active.

M. OUTREACH

I strongly suggest that Mr. Robinson stay in residence in Sanaa assuring the timely operations of the basic research program.

Museid Attic and Andy Tacadao should be able to handle the outreach trials.

I suggest a limited outreach program in line with resources available (vehicles and manpower).

The outreach program is only viable after the basic research program has operated a while and has something to sell.

N. JOBS TO DO

1. Prepare stakes:
   - sandpaper
   - paint - white
   - dip in DDT emulsion + oil or diesel fuel
   - repack in boxes
   - (save all empty boxes from stakes in field)
2. Clean ramada

   Put large thresher in ramada out of weather
3. Hang more wires in ramada
4. Make hooks from sections of barbed wire. (Sharpen on grindstone in admin garage - Robinson or Andy only use - if permitted. Don't let Yemeni use or help.)

5. Finish Field Books

6. Count sacks on hand (by sizes)

   - estimate sack needs

   - buy more sacks NOW if needed (don't wait until the day you need them to try to buy them).

7. Robinson - read National Cooperative Test Instructions for activities in tests 79014, 015, 016, and 017.

- Section 2 -

Research Objectives and Field Test Descriptions

A brief discussion is presented as to the purpose and objectives of the project research efforts for 1979 along with proposed long range goals that are commensurate with the current situation in-country.

Descriptions of the 17 separate field research tests conducted at the Bero-Al-Gohoume Agricultural Research Station at Sana'a are presented. A list of these tests is presented in Table 1.

The 1979 Outreach Test plans are presented on page 17 and 18.

The basic series of field research tests that were designed for this project to determine improved sorghum and millet genotypes were outlined in previous reports but are presented here again. The series of tests are:

First year	-	make single head (plant) selection from new germplasm source
Second year	-	grow single head in Head Row and select on a row basis
Third year	-	yield test selected entries in two-replication Preliminary Yield Test and select better ones
Fourth year	-	Yield test selected entries in 3 to 4 replication Advanced Yield Test for both grain and forage. Select better ones.
Fifth year	-	Yield test selected entries in 4 replication Elite Yield Test. May also enter concurrently in Outreach tests.
Sixth year	-	Outreach tests
Seventh year	-	seed increase for release to growers

This series of progressive tests is a simple program that hopefully the relatively untrained Yemeni on the project could follow on their own. A particular genotype that appears to be outstanding and of a very homogeneous

genotype and phenotype may be advanced to the Elite and/or Outreach tests from any of the earlier testing steps. Intermediate steps may be skipped over. There are other tests for other items of interest to the project.

Table 1. Sana'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

Table 1. (Cont'd) 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)			

Sana'a Experiment Farm Research - 1979

Background Information

It is expected that the majority of the sorghum and millet grown in Yemen in the future will be grown on marginal lands. The primary marginal factor being water or irrigation resources. Agricultural lands with higher water resources whether from higher rainfall or irrigation are going out of sorghum production and into other crops with a higher economic value. Already in the beginning of 1979 near Sana'a there are areas where the sorghum acreage has been cut in half from 1978 in favor of other crops that pay better economic returns and not because of the weather. Sorghum and millet do possess some physiological characteristics making it possible for them to be a little more productive under droughty or moisture stress conditions than many other crops. The prices paid to farmers for grain produced on the farm is competitive with the cost of imported grain so farmer income cannot be increased through raising the farm price. The sorghum plant forage produced along with the grain is of equal or more economic value than the grain. This forage cannot be imported very easily. Thus the sorghum and millet improvement program should and does place equal emphasis on both grain and forage improvement. Traditional breeding programs as usually found in the United States are not directly suited to the problem in Yemen. Most United States programs focus on grain or forage and with environmental resources somewhat above near desert conditions.

The variable moisture stresses on plant growth associated with limited or sporadic rainfall or limited moisture resources of any nature makes the use of fertilizers quite risky. Thus the use of fertilizers to boost production is very limited compared to the usual expectation of using more and more fertilizer to increase yields.

The low profit or near subsistence level of sorghum and millet production under the existing conditions limit financial inputs by the farmer. Currently, seed of adapted genotypes are saved from year to year by farmers in all of the thousands of different environments. The cost of buying hybrid seed would be an additional cost to the farmer. Many, many hybrids would have to be developed and evaluated to fit the thousands of production environments. This in itself would be a large, long-term task

with doubtful return value. At least for the moment improved varieties is the first step in improvement of genotypes for farmer use. Development of a sorghum sterile with both grain and forage potential under environmental conditions existing about Sana'a is underway as a more long-term objective.

The lack of suitable research equipment and procedures resulted in a probably rather high degree of unreliability of previous research data. Some equipment was received in time to change procedures some in 1978 which resulted in better, more uniform stands in the plots and hopefully gave better research data.

Objectives

1. The most pressing objective of this project is to develop the research techniques necessary to obtain reliable research data.

Short-term objectives, up to five years involve:

2. Development of improved varieties for rainfed or low moisture environments.

3. Development of gene pools of adapted germplasm from which to select recombinations of improved genotypes.

4. Attempt to develop more moisture stress tolerance in the breeding materials.

5. Development of a second research station at Al Jarubah.

Longer term objectives, from five to twenty years involve:

6. Development of sorghum steriles of a dual grain and forage potential for eventual development of hybrids from improved varieties for when hybrid seed production and farmer acceptance and use reaches an acceptable economic level.

7. Develop improved agronomic practices tailored to the particular improved variety and/or hybrid genotypes developed.

8. Develop a greater drought tolerance within an already drought tolerant species.

9. Eventual incorporation of miscellaneous characteristics such as insect and disease resistances, amount and quality of protein and other nutritional factors, and other factors appropriate with the state of the art of sorghum and millet improvement and for which the project has the capabilities.

TEST NO. 79001

Head-to-Row

Test Description and Purpose:

This test consists of 433 single head selections to be grown out in single unreplicated plot rows. The purpose is to visually evaluate each of these single head selections on a row basis for potential as a dual purpose variety for both grain and forage. Some of the phenotypic agronomic characteristics to be considered are maturity, sufficient plant height of one meter or more, sturdy stalk, leafiness, good grain head and medium to large seed size.

Plot Size and Treatment:

Plot size is one row, six meters long and .75 meter wide. Seeding rate of four to five seeds per hill spaced at 25 cm (25 hills per plot) and thinned to two plants per hill. Three to four heads of typical plants from selected rows to be selfed at tip bloom. Seed size to be determined later. The plots are to be grown under a somewhat limited moisture regime (rainfall permitting) in order to enhance expression of drought tolerance. Selected genotypes to be grown in a preliminary yield trial with three or four replications in 1980.

Seed Source:

These single head selections were selected from 1978 test numbers 097, 098, 099, 100, a composite population and from 76026. The pedigrees are given in the field book.

TEST NO. 79002

Head-to-Row

Test Description and Purpose:

This test consists of 479 single head selections to be grown out in single unreplicated plot rows. The purpose is to visually evaluate each of these single head selections on a row basis for potential as a dual purpose variety for both grain and forage. Some of the phenotypic agronomic characteristics to be considered are maturity, sufficient plant height of one meter or more, sturdy stalk, leafiness, good grain head and medium to large seed size.

Plot Size and Treatment:

Plot size is one row, six meters long and .75 meter wide. Seeding rate of four to five seeds per hill spaced at 25 cm (25 hills per plot) and thinned to two plants per hill. Three to four heads of typical plants from selected rows to be selfed at tip bloom. Seed size to be determined later. The plots are to be grown under a somewhat limited moisture regime (rainfall permitting) in order to enhance expression of drought tolerance. Selected genotypes to be grown in a preliminary yield trial with three or four replications in 1980.

Seed Source:

These single head selections were selected from 1978 test numbers 101, 111, 112, and 113. The pedigrees are given in the field book.

TEST NO. 79003

Elite Yield Test

Test Description and Purpose:

This test consists of 33 entries, including checks, replicated four times in a yield test. The purpose is to evaluate each entry for yield of grain and forage in addition to visual evaluations for other agronomic characteristics. These replicated yield evaluations are normally the third ones for these experimental genotypes.

Plot Size and Treatment:

Plot size is two rows six meters long with .75 meter between rows and replicated four times in a randomized complete block design. The seeding rate is four to five seeds per hill spaced at 25 cm (25 hills per row) and thinned to two plants per hill. The following characteristics will be measured on each entry in each replication: date of 50% bloom, average plant height to the top of the head in cm, agronomic phenotypic rating regarding head, stalk and leaves, bird damage, percent stand, percent lodging, grams per plot of grain yield, grain test weight, seed size as measured by weight in grams per 300 seed, grain color, and grams per plot of air dried forage. Any other appropriate descriptive data of research value should be collected during the season. Ten heads of each entry to be selfed to furnish pure seed for increase if the genotype proves to be superior and is selected for release.

The test is to be grown under a somewhat limited moisture (irrigation) regime in order to enhance expression of drought tolerance. Selected superior genotypes to be increased and evaluated in on-farm tests for a broader adaptation and production evaluation. Local varieties and other appropriate checks to be included as test entries as standards against which experimental entries will be selected or discarded.

Seed Source:

Ten trial entries came from the 1978 Elite Yield Test (78103), thirteen entries came from the 1978 Advanced Yield Test (78102), five entries came from the 1978 National Cooperative Sorghum Observation Nursery, and five entries are checks of a local nature.

TEST NO. 79004

Advanced Yield Test

Test Description and Purpose:

This test consists of 16 entries, including checks, replicated four times in a yield test. The purpose is to evaluate each entry for yield of grain and forage in addition to visual evaluations for other agronomic characteristics. These replicated yield evaluations are normally the second ones for these experimental genotypes.

Plot Size and Treatment:

Plot size is two rows six meters long with .75 meter between rows and replicated four times in a randomized complete block design. The seeding rate is four to five seeds per hill spaced at 25 cm (25 hills per row) and thinned to two plants per hill. The following characteristics will be measured on each entry in each replication: date of 50% bloom, average plant height to the top of the head in cm, agronomic phenotypic rating regarding head, stalk and leaves, bird damage, percent stand, percent lodging, grams per plot of grain yield, grain test weight, seed size as measured by weight in grams per 300 seed, grain color, and grams per plot of air dried forage. Any other appropriate descriptive data of research value should be collected during the season. Ten heads of each entry to be selfed to furnish pure seed for increase if the genotype proves to be superior and warrants further evaluation.

The test is to be grown under a somewhat limited moisture (irrigation) regime in order to enhance expression of drought tolerance. Selected superior experimental genotypes are to be grown in the Elite Yield Test with four replications in 1980. Local varieties and other appropriate checks to be included as test entries as standards against which experimental entries will be selected or discarded.

Seed Source:

Eight trial entries came from the 1978 Preliminary Yield Test (78101), one entry came from the 1978 National Cooperative Sorghum Yield Trial (78105), one entry came from the 1978 National Cooperative Sorghum Observation Nursery (78106), and six entries are checks of a local nature.

TEST NO. 79005

Preliminary Yield Test

Test Description and Purpose:

This test consists of 210 entries (200 experimental and 10 check genotypes) replicated four times in a yield test. The purpose is to evaluate each entry for yield of grain in addition to visual evaluations for other agronomic characteristics. This replicated yield evaluation is normally the first one for these experimental genotypes.

Plot Size and Treatment:

Plot size is one row six meters long and .75 meter wide and replicated four times in a randomized complete block design. The seeding rate if our to five seeds per hill spaced at 25 cm (25 hills per plot) and thinned to two plants per hill. The following characteristics will be measured on each entry in each replication: date of 50% bloom, average plant height to top of head in cm, agronomic phenotype rating regarding head, stalk and leaves, bird damage, percent stand, percent lodging, grams per plot of grain yield, grain test weight, seed size as measured by weight in grams per 300 seed, and grain color. Any other appropriate descriptive data of research value should be collected during the season. Four or five typical heads of each entry to be selfed to furnish seed for further testing if the genotype proves to be superior and warrants further evaluation. Local varieties and other appropriate checks to be included as test entries as standards against which experimental entries will be selected or discarded.

The test is to be grown under a somewhat limited moisture (irrigation) regime in order to enhance expression of drought tolerance. Selected superior genotypes to be grown in an Advanced Yield Test with four replications in 1980.

Seed Source:

Fifty-eight trial entries came from the 1978 Head-to-Row Test (78097), thirty-eight from 1978 Head-to-Row Test (78098), sixty-five from 1978 Head-to-Row Test (78099), twenty-nine from 1978 Head-to-Row Test (78100), three from 1978 Preliminary Yield Test (78101), and seven from 1978 Nursery (78113). Ten entries are checks of a local nature.

TEST NO. 79006

Short Grain Yield Trial

Test Description and Purpose:

This test consists of 42 entries replicated three times in a grain and forage yield test. The purpose is to evaluate each entry for unusual yield of grain and forage yet with a short height. These same entries are in the nursery (79010) where they are to be crossed onto CK60A for evaluation as to B or R type in 1980. High grain yielding types could fit well into a hybrid development program of adapted genotypes.

Plot Size and Treatment:

Plot size is two rows six meters long with .75 m between rows and replicated three times in a randomized complete block design. The seeding rate is four to five seeds per hill spaced at 25 cm (25 hills per row) and thinned to two plants per hill. The following characteristics will be measured on each entry in each replication: days to 50% bloom, average plant height to top of head in cm, bird damage, percent stand, percent lodging, grams per plot of grain yield, grain test weight, seed size as measured by weight in grams per 300 seed, and grams per plot of air dried forage. Four to five typical plants of each entry to be selfed to furnish seed for further research use. Local variety to be used as a check for comparison of production of grain and forage.

The test is to be grown under a somewhat limited moisture (irrigation) regime in order to enhance expression of drought tolerance.

Seed Source:

Three entries came from 1978 Head-to-Row (78097), seven from 1978 Head-to-Row (78098), six from 1978 Head-to-Row (78099), fifteen from 1978 Head-to-Row (78100), eight from 1978 Elite Yield Test (78103), and one from 1978 Nursery (78113). Two entries were of a local check.

TEST NO. 79007

Sorghum X Sudangrass Green Forage Test

Test Description and Purpose:

This test consists of six sorghum X sudangrass commercial products from the United States to be grown in a forage yield test for multiple harvests. The purpose is to evaluate some of these typical genotypes for adaptation and production of forage dry matter in this environment.

Plot Size and Treatment:

Plot size is four rows spaced .75 meter apart, six meters long and replicated four times in a randomized complete block design. The seeding rate is four to five seeds per hill spaced at 25 cm (25 hills per row) and thinned to three plants per hill. The plots are to be cut at about boot stage of plant development. The center two rows weighed green and a moisture sample taken and weighed wet and dry in order to calculate dry matter production. Plants to be cut off at about 10 to 15 cm above ground level. Cut as many harvests as the growing season will permit. Irrigate as necessary to maintain an optimum moisture supply. Research data desired is grams per plot of air dry forage and plant height in cm of each cutting.

Seed Source:

All six entries are commercial sorghum X sudangrass hybrids produced and sold in the United States.

TEST NO. 79008

Forage Sorghum Grain and Forage Test

Test Description and Purpose:

This test is to compare five commercial United States forage type sorghums with a local variety for a single harvest production of grain and air dried forage. In addition other observations will be made for maturity, height, weight per 300 seed, and grain test weight.

Plot Size and Treatment:

Plot size is four rows spaced .75 meter apart, six meters long and replicated four times in a randomized complete block design. The seeding rate is four to five seeds per hill spaced at 25 cm (25 hills per row) and thinned to two plants per hill. The following characteristics will be measured on each entry in each replication: days to 50% bloom, average plant height to top of head in cm, percent bird damage, percent stand, percent lodging, grams per plot of grain yield, grain test weight, seed size as measured by weight in grams of 300 seed, grain color and grams per plot of air dry forage.

The test is to be grown under a somewhat limited moisture (irrigation) regime in order to properly compare the experimental entries with the local variety.

Seed Source:

Five entries are commercial forage sorghum hybrids produced and sold in the United States. One is a local check variety.

TEST NO. 79009

Sorghum X Sudangrass and Hybrid Forage Sorghum Demonstration Test

Test Description and Purpose:

This test consists of fifty-two commercial sorghum X sudangrass and hybrid forage sorghum types sold in the United States for observation as to general adaptation to local environmental conditions.

Plot Size and Treatment:

Plot size is two rows spaced .75 m apart six meters long and unreplicated. The seeding rate is four to five seeds per hill and thinned to two plants per hill. The following characteristics will be measured on each entry: days to 50% bloom, average plant height to top of head in cm, and percent lodging. The demonstration is to be grown under a somewhat limited moisture (irrigation) regime.

Seed Source:

All entries are commercial hybrids produced and sold in the United States.

TEST NO. 79010

Sorghum Nursery

Test Description and Purpose:

This test contains sixty-eight two-row plots of various genotypes. These genotypes are to be selfed or crossed in the following manner to accomplish specific purposes.

Plots one through five: bag steriles in plots one, three and four which are to be pollinated with pollen from plots two and five.

Plots six through twenty-five: Self about ten good, typical heads in each plot. Eliminate off-types. Self about 20 or 30 heads in plots 12 through 15 and 22 through 25 if possible.

Plots twenty-six through sixty-eight: bag all possible steriles in plots 26, 47, and 68. Make two or three good pollinations from each plot 27 through 46 and plots 48 through 67 onto steriles in plots 26, 47, or 68. You may re-pollinate these steriles two or three days running using pollen from the same male row to obtain more seed set.

Plot Size and Treatment:

Plot size is two rows spaced .75 meter apart, six meters long and unreplicated. The seeding rate is four to five seeds per hill spaced at 25 cm (25 hills per row) and thinned to two plants per hill. The test is to be grown with adequate noisture for optimum growth.

TEST NO. 79011

Head Smut Control Test

Test Description and Purpose:

This test contains treatment of a uniform smut-infested sorghum genotype with four experimental chemicals for control. A check or non-control is included making five treatments in four replications. This test is designed and is to be supervised by Dr. Gossert or the German Farm.

Plot Size and Treatment:

Plot size is four rows spaced .75 meter apart, six meters long and replicated four times in a randomized complete block design. The seeding rate is four to five seeds per hill spaced at 25 cm (25 hills per row) and unthinned. The following data will be collected on each entry in each replication: days to 50% bloom, average plant height to top of head in cm, percent stand, and percent lodging. Grain yield in grams per plot if desired.

Seed Source:

The uniform genotype seed to be furnished and treated at time of planting by German Farm.

TEST NO. 79012

Sesamia (Stem Borer) Control

Test Description and Purpose:

This test involves the application to seedlings of a uniform sorghum genotype with three experimental chemicals to control stem borer. A check or non-control is included making four treatments. This test is designed and is to be supervised by Dr. Deckert of the German Farm.

Plot Size and Treatment:

Plot size is seven rows spaced .75 meter apart, six meters long and replicated four times in a latin square design. The seeding rate is four to five seeds per hill spaced at 25 cm (25 hills per row) and unthinned. The following data will be collected on each entry in each replication: days to 50% bloom, average plant height to top of head in cm, percent stand and percent lodging. Grain yield in grams per plot if desired.

Seed Source:

The uniform genotype seed to be furnished by the German Farm.

TEST NO. 79013

National Cooperative Sorghum Yield Test

(No test seed distributed by the Yemen Ministry of Agriculture)

TEST NO. 79014

National Cooperative Sorghum Observation Nursery

Test Description and Purpose:

This test contains 18 entries replicated once in an observation nursery. The purpose is to visually evaluate and measure each entry for general adaptation of agronomic characteristics to the Sana'a area of about 2,300 meters elevation. This is a regional type of test in which all agricultural research organizations may enter grain sorghum genotypes from early stages of development in their breeding programs which show promise of proving to be a superior genotype. An evaluation in this test gives an early indication to the breeder of the potential wide adaptation of his breeding material without the expense of yield testing by all agencies involved. Several agricultural research organizations are cooperating in growing this test to give an evaluation of each entry in several different environments and elevations in The Yemen.

Plot Size and Treatment:

Plot size is two rows spaced .75 meter apart, six meters long and replicated once. The seeding rate is four to five seeds per hill spaced at 25 cm (25 hills per row) and thinned to two plants per hill. The following characteristics will be observed on each entry: days to 50% bloom, average plant height to the top of the head in cm, agronomic phenotypic rating (involving head, stalk and leaves), bird damage, percent lodging and grain color.

This test is to be grown under a somewhat limited moisture (irrigation) regime in order to evaluate the entries for adaptation to a droughty rain-fed environment.

Seed Source:

Entries were contributed by different research organizations.

TEST NO. 79015

National Cooperative Maize Yield Test

Test Description and Purpose:

This test contains nine maize genotypes for evaluation as to adaptation to the Sana'a area of about 2,300 meters elevation for grain yield and other agronomic characteristics. This is a regional type of test in which agricultural research organizations may enter their superior maize selections for an evaluation in various environments in Yemen.

Plot Size and Treatment:

Plot size is three rows .75 meter apart and six meters long replicated three times in a randomized complete block design. The seeding rate is three seed per hill spaced at 30 cm (21 hills per row) and thinned to one plant per hill. The following data will be collected on each entry in each replication: days to tassel (flowering), average plant height in cm to the flag leaf, average height in cm of ear node, lodging percent, days to maturidy (when husk cover turns pale brown and grains are hard), population, grams per plot of newly picked ears, dried ears, and of dried shelled corn, and any diseases or insects of consequence.

This test will be irrigated as necessary to maintain optimum moisture for growth. Fertilizer is to be applied at planting and later as per instructions.

Seed Source:

Entries were contributed by different research organizations in Yemen.

TEST NO. 79016

National Cooperative Maize Observation Nursery

Test Description and Purpose:

This test contains eighteen maize genotypes for a general visual adaptation of agronomic characteristics to the Sana'a area of about 2,300 meters elevation. This is a regional type of test in which agricultural research organizations may enter maize genotypes from rather early stages of development in their breeding programs which show promise of proving to be a superior genotype. An evaluation in this test gives the breeder an early indication of the potential wide adaptation of his breeding material. Several agricultural research organizations in Yemen cooperate in growing this test to give an evaluation of each entry in several different environments in Yemen.

Plot Size and Treatment:

Plot size is three rows .75 meter apart and six meters long replicated once. The seeding rate is three seeds per hill spaced at 30 cm (21 hills per row) and thinned to one plant per hill. The following characteristics will be observed on each entry: days to tassel (flowering), average plant height in cm to the flag leaf, average height in cm of ear node, lodging percent, days to maturity (when husk cover turns pale brown and kernels are hard), and any diseases or insects of consequence.

This test will be irrigated as necessary to maintain optimum moisture for growth. Fertilizer is to be applied at planting time and later as per instructions.

Seed Source:

Entries were contributed by different research organizations in Yemen.

TEST NO. 79017

National Cooperative Pearl Millet Yield Test

Test Description and Purpose:

This test contains six pearl millet genotypes for evaluation as to adaptation to the Sana'a area of about 2,300 meters in elevation for grain yield and other agronomic characteristics. This is a regional type of test in which agricultural research organizations may enter their superior millet selections for an evaluation in various environments in Yemen.

Plot Size and Treatment:

Plot size is four rows .75 meter apart and six meters long replicated four times in a randomized complete block design. The seeding rate is about five seed per hill spaced at 20 cm (31 hills per row) and thinned to two plants per hill. The following data will be obtained on each entry: days to 50% bloom, plant height in cm to ear node, percent lodging, days to maturity (hard grain), percent stand, average number of heads per plant, unthreshed dried head weight per plot in grams, threshed grain weight per plot in grams, air dried stover weight per plot in kilograms, and notes on any diseases or insects of consequence.

This test will be irrigated as necessary to maintain optimum moisture for growth. Fertilizer is to be applied as per instructions.

Seed Source:

Entries were contributed by different research organizations in Yemen.

TEST NO. 79018

National Cooperative Pearl Millet Observation Test

(No test seed distributed by the Yemen Ministry of Agriculture)

OUTREACH (ON-FARM) TESTS - 1979

During March-April this year Project 030 personnel plan to contact farmers to cooperate on the 1979 Sorghum Outreach Program. We will present our plans to make rental payments for land on which we locate our sorghum yield trials. One-third of the total land rental will be paid at the time of planting with the agreement that the remaining two-thirds will be paid upon harvest of the trial sorghum by the USAID team. Payments will be 100 YR per 44 m2 of non-irrigated land and 150 YR per 44 m2 of irrigated area.

If a farmer agrees to cooperate we will visit the proposed location, make preliminary measurements, and discuss planting dates and procedures with the farmer.

Below is a preliminary list of locations we plan to visit first. Farmers in some of these areas last year expressed their willingness to cooperate in 1979. We hope to eventually engage 15 or 16 farmers for the program this year. Additional locations will be determined once our success with those described below are evaluated.

	Location	KM From Sana'a
A.	1) Hizzez	17 km - Taiz Road
	2) Sanhan	27 km - Taiz Road
B.	3) Yazle	35 km - Hodeidah Road
	4) Maf-Dan	43 km - Hodeidah Road
C.	5) May Moon	34 km - Sa'ada Road
	6) Wadi Khaywan	140 km - Sa'ada Road
	7) Al Asha (Battina)	148 km - Sa'ada Road
D.	8) Wadi War War (Bilsin)	101 km - Sa'ada Road
	9) Al Boun Project near Raydah	68 km - Sa'ada Road

To visit the sites at Al Asha and Wadi Khaywan north of Sana'a may entail a 3-day, 2-night trip.

Personnel Involved	Transport Involved
David Robinson	Project 030 vehicle
Museid Attic (translator-technician)	No. 1468 (Blazer)
Ahmed Ismael (technician)	Driver: David Robinson

Dr. Stewart's recommended Outreach plot design for 1979:

4 entries

4 rows (x 9 meters) per entry

4 replications of each entry

Furrow width is determined by each farmer: last year they averaged about 62 cms wide (varying between 38 and 85 cms). Allowing for 50 cm aisles between each replication, the total plot size for one Outreach test should average about 10 x 39 meters or 390 m2.

At a cost of 100 YR per 44 m2 of unirrigated farmland, we would pay about 886 YR per year. An irrigated plot of the recommended size would cost about 1329 YR per year.

Possibly the plot size can be reduced; the odd-shaped terraces found at many locations may require it. This will have to be decided at planting time. On this initial contact with the farmers only the cost per unit area land will be discussed. No firm commitments about plot size are planned.

Additionally this year some locations near Sana'a will include a forage sorghum test.

- Section 3 -

Field Plans of 1979 Tests

The 1979 field research plots at the Bero-Al-Gohoume Agricultural Resear Farm were prepared, preirrigated and planted in the manner designed by short-term professionals in 1977 and 1978. A complete description of the needs for development of improved field research plot techniques, the development of the new procedures, and a description of the actual field plot procedures are presented in Section 3, pages 28 through 34 of Annual Research Report Number 3, 1978. This information will not be repeated here.

The overall field configuration for 1979 is shown in Figure 1. The fields were deep-chiseled to a depth of about 20 inches, furrowed out in a north-south orientation and pre-irrigated in "field blocks" as shown in Figures 2, 3, 4 and 5. The pre-irrigation schedule preceded the planting in an orderly manner allowing the planting to be carried out just as soon as the soil moisture conditions were optimum. These two operations moved along in unison and were separated in time only by the time (days) necessary for the soil to dry down to the proper moisture content to plant. This methodical sequence of activities was necessary to assure us of optimum plots with minimum variability among and within.

Following are the field maps (Figures 2, 3, 4 and 5) which show the location of all tests in the various fields. Replications of various tests were spread among different planting dates to reduce the chance of total loss if a particular "date of planting" was lost.

The 1979 Outreach tests were established in accordance with the farmer-cooperators usual procedures.

FIGURE 1. BERO - AL-GOHOUME AGRICULTURAL RESEARCH FARM FOR YEMEN MINISTRY OF AGRICULTURE AND USAID AT SANA'A, YEMEN. GENERAL FIELD DESIGN IN 1979.

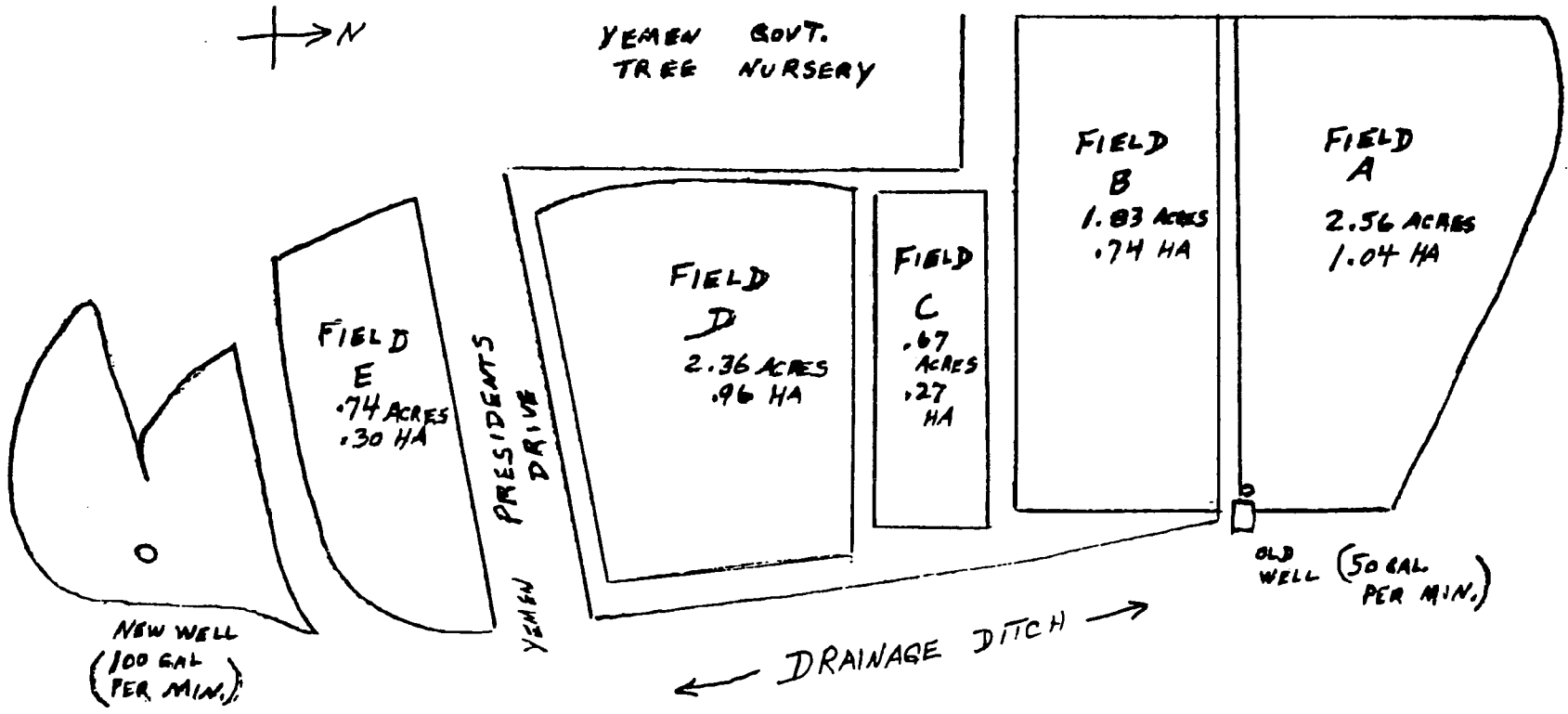


FIGURE 2: 1979 - FIELD A (2.56 ACRES)
BIR-AL-ROUME - - SANAA

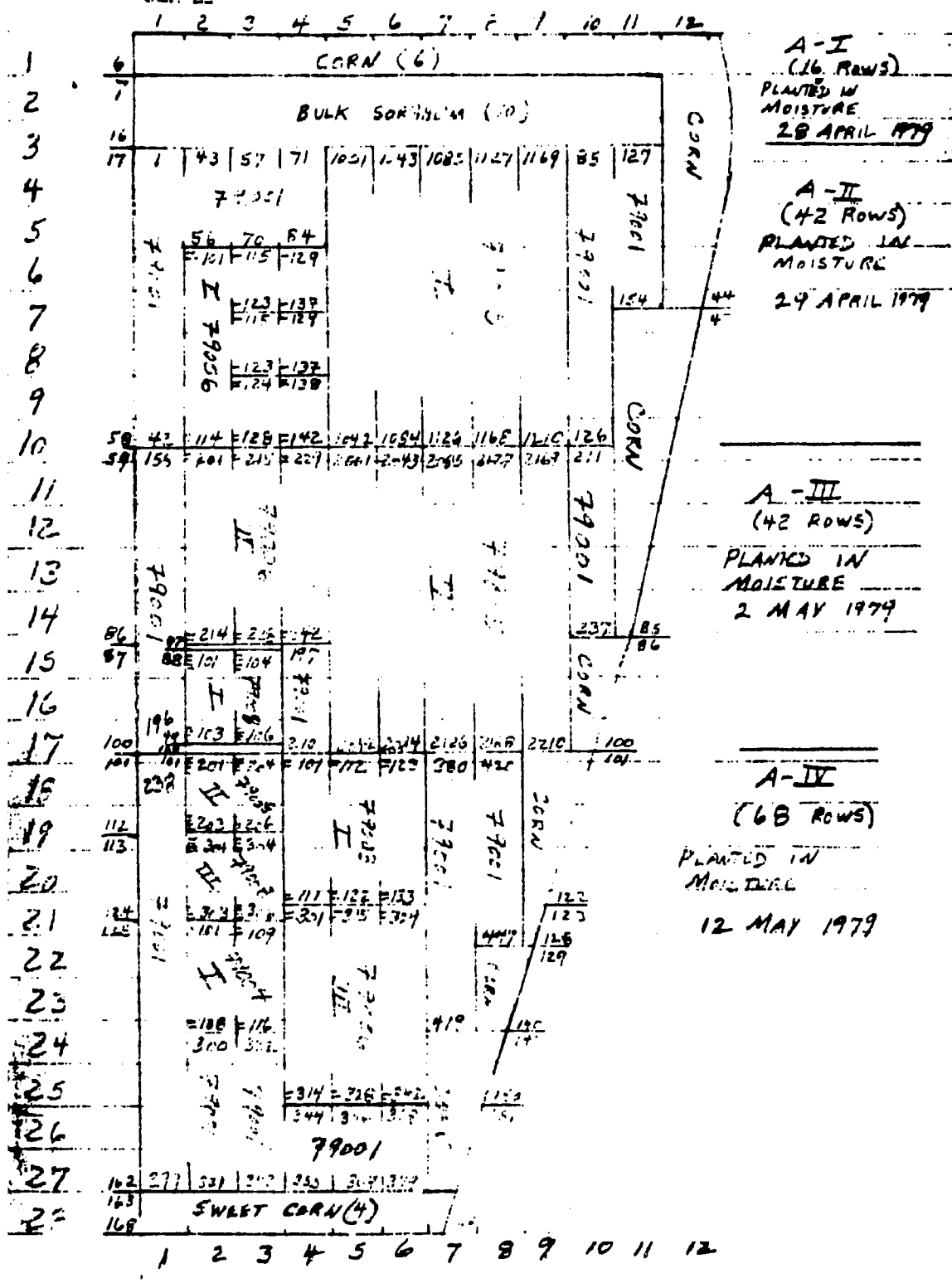


FIGURE 3. 1979 - FIELD B

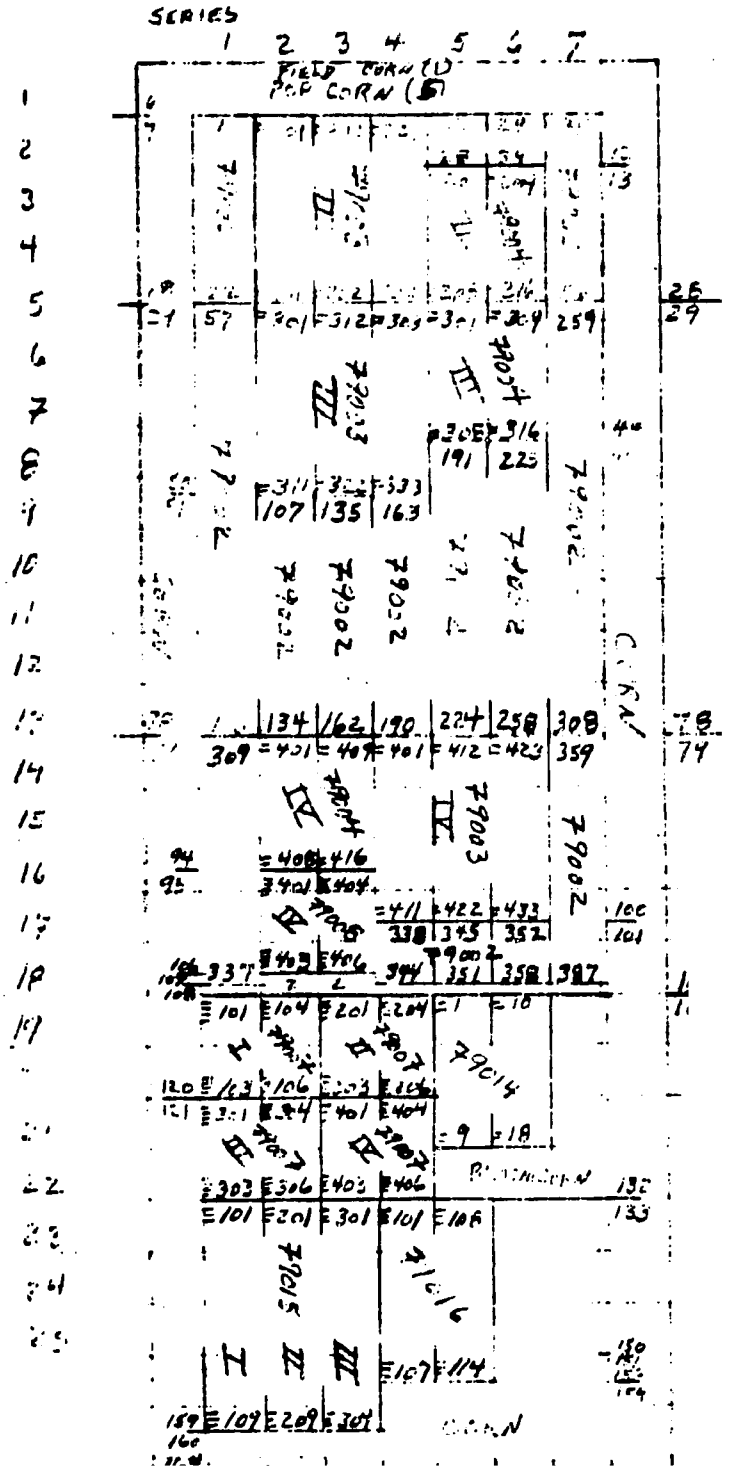
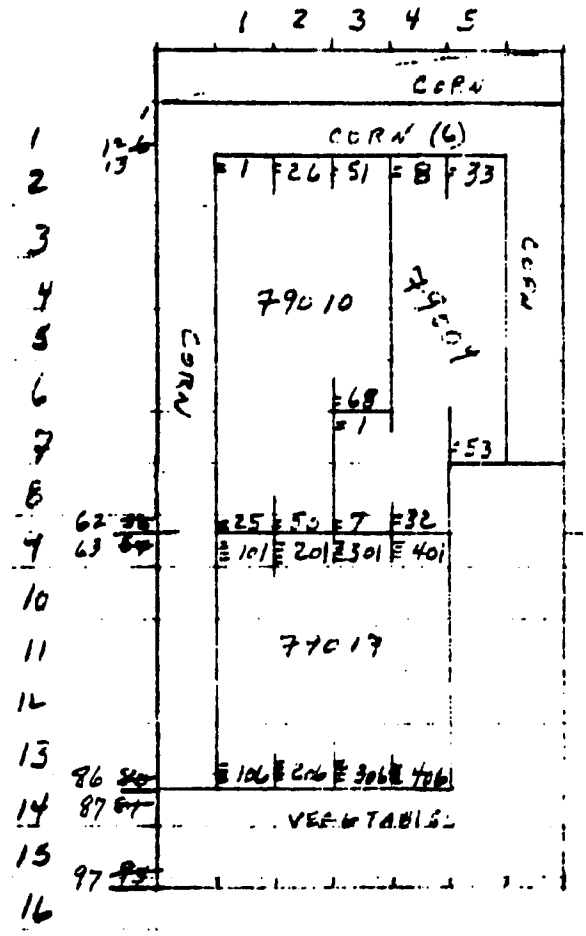


FIGURE 4 1979

FIELD C

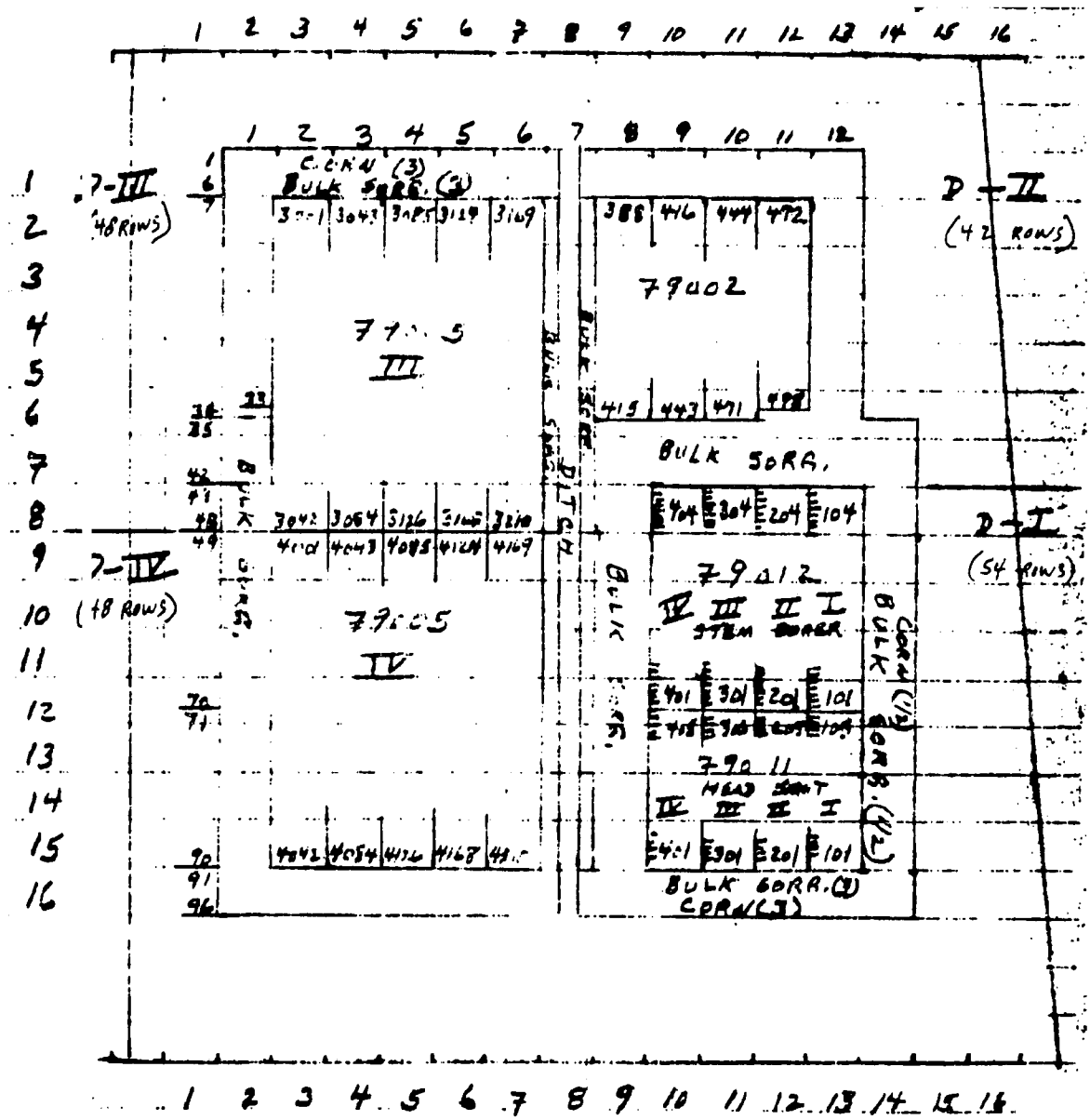
N ← → S



C - I
(62 ROWS)
PLANTED IN MOISTURE
26 MAY 1979

C - II
(35 ROWS)
PLANTED IN MOISTURE
28 MAY 1979

FIGURE 5 1979 FIELD D



PLANTED IN MOISTURE:

D I 79011 – 3 JUNE 1979
79012 – 7 JUNE 1979
D II – 4 JUNE 1979
D III – 10 JUNE 1979
D IV – 11 JUNE 1979

- Section 4 -

Explanation of Items of Research Data

Following is a listing of various data that were collected from among the research materials being tested with a description of the data and how they were collected and calculated.

1. Pedigree: This is a plant breeding term generally referring to the cross or test and plot from which a single plant or genotype was selecte to thereafter have its own identity. It may also be a number from a germplasm collection.

2. Source: refers to the project test and plot from which actual seed was obtained for this particular planting or the name of the outside source.

3. Stand Count: the actual number of hills that grew in a plot expressed as a percent of the total number of hills that were planted in the plot. A hill with only one surviving plant was counted. These counts were made after thinning.

4. Days to 50% bloom: When the heads had emerged from the boot and were starting to bloom the date was recorded when all heads had bloomed half way down (half of the florets in the row had bloomed). This simple situation never really existed because of a range of beginning and ending of blooming among plants in the plot. An educated guess had to be made as to when the entire plot was about half way through blooming.

Considerable experience with sorghum is necessary to correctly estimate this character under these conditions.

The days to this bloom date are calculated from the date of planting in moisture or the date of first irrigation if planted dry.

5. Height: For general evaluation and comparison purposes in sorghum this is simply the average distance from the ground level to the top of

the head of typical plants in the plot. Considerable judgment may be needed to estimate this character under these conditions of considerable variation among plants within plots.

The value of this character is usually expressed in centimeters.

6. Agronomic Rating of the Plant and of the Head: The average or typical plant in a plot was usually rated on a scale of 1 to 3 with a score of 1 being equal to "good", 2 equal to "average" and 3 being "poor". These evaluations are professional and experienced comparisons to the typical plant desired and needed by the Yemeni farmer. The heads on an average or typical plant in a plot was visually rated in a similar manner on a similar scale but independent of the evaluation rating given to the plant.

These evaluations by experienced personnel are necessary to initially select experimental materials with potential for further testing. There is no other way to initially sort out promising genotypes for actual testing. There is a high degree of correlation of these visual ratings with actual grain and forage production values with experienced personnel.

7. Lodging: Just prior to their harvest for grain all plots were evaluated for lodging. These evaluations were expressed in a percent value composed of a combination of a value for number of lodged plants combined with degree of lodging. It is necessary that the same person be experienced and do all of the evaluations since estimates would differ by individuals.

8. Grain Production: The grain was allowed to mature and dry down on the plant in the field plot in a normal manner. However, due to continual bird problems we did not delay harvest much beyond hard dough stage of development. There was variation in maturity among plants within plots so some heads were high in moisture. The harvested plots were hung up to dry under an open sided roofed area.

Bird watch personnel during daylight hours were very successful in keeping down bird damage of the plots. Most plots had little or no bird damage at all. Plot yields were adjusted for these estimated bird damages. Estimating bird damage correctly takes years of experience. The new or inexperienced researcher will always over-estimate bird damage by several times the real amount. This results in plots with the greatest bird damage always coming up with the greatest yields. Many years of experience are necessary to calibrate one's self on this. It is necessary for uniformity of data that the same individual do all estimating, at least within tests.

The harvesting of the heads from each plot was done by hand. Each test was harvested separately. The total time taken to hand harvest the grain of all of the tests for 1978 was only about 3 days. The actual harvesting was spread out over a greater period of time because of differences in planting dates and general maturities among tests. By hand harvesting carefully every head was harvested. Nothing was lost. This sort of accuracy is not possible with machine harvesting.

As reported earlier the sacks of heads were allowed to dry down to an air dry condition suitable for threshing. No suitable mechanized threshing equipment was available on the project for threshing these yield heads. The equipment available cracked or broke much of the local type seed which is much larger than U.S. type sorghum grain for which all of the threshers had been developed. The greatest problem was the loss of grain during threshing by throwing it out of the machine and not fully threshing out of the glumes. Threshing of the grain from the glumes by pounding by sticks on the closed sacks of dry heads was very quick and efficient with absolutely no grain loss, or cracked or broken grain. The chaff was gently fanned from the grain and then the grain was weighed for plot yield of grain.

These plot grain yields were then corrected for any percent bird damage followed by correction for percent stand count less than 100%. The resulting plot grain yield then reflected the theoretical performance of a full plot undamaged by birds.

These plot yields of grain were then converted to yields per hectare. Other grain yield values for individual genotypes were then calculated relative to height and days to maturity.

The current market values of grain by the kilo was checked in several locations and monetary values of production per hectare for each genotype were calculated.

9. Forage Production: The sorghum plant itself is of equal if not greater value than the grain in the Yemen economy. Consequently it is necessary to evaluate the experimental genotypes in the advanced or elite tests for actual forage production as well as grain production. Traditionally much of the sorghum was harvested as follows: first the leaves except for the top 2 or 3 were stripped from the stalk near soft dough and sold for feed. Second the heads were harvested by hand at maturity. Third the stalks were cut off at or near ground level, bundled and sold for feed or fuel. Fourth and last the stubble was sometimes plowed up and used for fuel. Currently the great on-farm labor shortage has eliminated the labor intensive leaf stripping on many farms. Most of the bundles of sorghum stalks sold in the suks have all dried leaves attached. Because of the great labor requirement to strip leaves this project also eliminated this step.

Immediately after grain harvest the plants in each plot of the advanced yield test were cut and weighed green in the field. A forage sample of 4 or 5 typical complete plants were immediately taken from the harvested plot material, cut up, put in a sack and reweighed green as a sample. This

representative sample was hung up to completely air dry under roof and then reweighed dry. This drop in moisture for the sample (less the sack) gave us a percent dry matter which was applied to the original total plot yield of green material to give a forage dry matter production figure. This initial plot dry matter production figure was corrected for percent stand less than 100% to bring it up to a theoretical full plot.

These plot yields of forage per hectare were then converted to yields per hectare. Other forage yield values for individual genotypes were then calculated relative to height and days to maturity.

The current local market values of bundles of dry sorghum stalks were obtained by having Yemeni employees buy several bundles at different market locations. These bundles in the Sana'a area usually have the dried leaves fairly intact. There has not been enough labor at the farm level to strip leaves as used to be done. The bundles were air dried like the plots and monetary values per kilo of dry matter calculated.

Dry sorghum stalks = YR .75 per kilo
= $ .1654 per kilo

Sorghum grain was selling as follows:

Sorghum grain = YR 1.4 per kilo
= $ .3087 per kilo
= $ 14.00 per 100 pound

10. Grain Test Weight: A measure of the quality of grain produced by each genotype was obtained by measuring their test weights in kilos per hectoliter.

- Section 5 -

End-of-Season Research Results

Following are summarized tabular data for all sorghum and millet research plots. The tables for each test contain the particular data that was collected for that particular test. In the case of replicated data the averages given are for all of the replications involved. No statistical analyses were made on any of these data. The resources (equipment, personnel and time) were not available to do this in Yemen. It is not possible to do this here in the United States since most of the original replicated plot data had to be left in Yemen, nor is personnel, time and other resources available here to do all of these.

The higher performing genotypes can be selected by averages. Professional judgment of other characteristics can be utilized to discard some genotypes that give the appearance of good yield performance but have faults in other areas. Statistics does not make these judgments. The final judgment of what to keep or discard has to be made by the experienced professional who considers all characteristics. A lower yielding genotype may have superior stands, proper maturity and height, no lodging, etc., where a high grain yielding line may be deficient in many other characteristics.

Interpretations and conclusions are presented for each test.

Test Number 79001

Head-to-Row

End of Season Results:

This test contained a total of 433 entries which included a local check variety entered in the test at periodic intervals. These check plots were adapted phenotypic standards against which the agronomic performance of the surrounding entries could be compared for selection purposes. A description of this test, its purpose, seed sources, plot size and treatment during the season is given on page 22.

A total of 198 of these head-to-row experimental genotypes were selected for further testing in 1980. The basic and appropriate agronomic data collected on these selected genotypes are given in Table 2. The pedigree is given for each genotype making it possible to trace the source of the selection. These pedigrees relate to and are found only in the field books of this project.

The percent stand that is given is the ratio of the actual number of hills in the plot that produced plants during the season divided by the number 25 that was planted. This value of percent stand can be regarded as some measure of the relative ability of the particular genotype to germinate, emerge and survive during the growing season in this environment.

The days to 50% bloom of the plot row is a measure of the maturity of the genotype. Late maturities or long season genotypes are not particularly desirable under low moisture situations where the moisture may be depleted before physiological maturity.

Height of sorghum is rather important as an indication of forage production. Taller plants will likely produce greater yields of forage dry matter.

The selections were made with the intent of entering each genotype into one or more of four tests in 1980. These are indicated in the final table

column under Type of Selection. Professional judgments were rendered in the field at the time of selection of the intact plot rows as to their greatest future potential in the program. Those rows that were of a uniform and very desirable agronomic genotype were selected for inclusion in the preliminary yield test (P) in 1980. The rows that were apparently segregating for phenotypic characters were reselected for one or more agronomically desirable individual plants (H) and entered in head-to-row tests in 1980. If these head-to-row plots in 1980 will be of a desirable uniform agronomic phenotype, then they will be selected for future evaluation for yield. Certain head rows were shorter than generally desired for forage production but possessed extremely large heads of grain. These were selected as short grains (SG). These genotypes were selected to be saved as a possible production variety for use in those areas of Yemen where fields are large enough, smooth enough, and the total acreage is great enough to justify mechanized harvest. Early maturity genotypes (EM) were selected for possible use where very short maturities might be quite superior.

The local check plots had agronomic data of: stands of 50 to 60%, about 125 days to 50% bloom, and about 120 cm in height.

Research data on the other 435 entries which were discarded and were not carried forward in the breeding program are not shown here. These genotypes and their data have no further value.

Table 2. Agronomic Data From Single Head Selections From 1978 Grown in Head Rows in Test 79001 in 1979. Sana'a, Yemen.

Table No.	Test Entry No.	*1 Pedigree	Seed Source	% Stand	*2 Days to 50% Bloom	Height in cm	*3 Type of Selection
1	14	76026-027- 2	78097- 78	60	120	75	EM
2	16	" -037- 5	" -114	84	130	140	P
3	24	" -065- 9	" -229	48	108	50	EM
4	29	" -071- 3	" -263	56	137	70	SG
5	31	" -073- 2	" -268	36	139	135	P
6	34	76019-001- 9	" -279	32	153	130	H
7	35	" -002- 7	" -287	40	154	160	P
8	38	" -002-10	" -290	28	136	140	P
9	40	" -003- 6	" -296	20	137	120	H,SG
10	41	" -004- 1	" -301	12	131	125	H
11	42	" -004- 2	" -302	36	151	110	P
12	44	" -004- 5	" -305	84	135	115	P
13	57	76026-035- 4	78098-104	72	137	120	P
14	59	" -040- 3	" -115	80	123	120	H
15	62	" -040- 6	" -117	68	136	150	P
16	66	" -042- 1	" -121	64	134	150	P
17	69	" -043- 1	" -126	84	138	150	P
18	73	" -053- 2	" -140	84	150	140	H
19	77	" -053- 7	" -143	80	156	170	H,P
20	78	" -054- 2	" -145	100	156	120	P
21	79	" -054- 4	" -147	76	149	110	H
22	81	" -054- 6	" -149	72	150	120	H,P
23	82	" -055- 1	" -150	84	125	110	H
24	83	" -056- 1	" -155	72	150	160	H
25	86	" -059- 3	" -164	80	132	165	P
26	87	" -059- 3	" -164	92	167	170	H
27	89	" -059- 7	" -167	96	154	170	H
28	91	" -060- 5	" -171	100	145	150	H
29	92	" -061- 2	" -175	76	92	100	EM
30	94	" -068-10	" -192	88	130	120	P
31	98	" -070-10	" -213	52	131	185	H
32	99	" -070-15	" -218	68	150	110	H
33	100	" -070-16	" -219	72	130	120	H
34	106	77093-09- 1	78099- 46	84	132	130	P
35	107	" -15- 4	" - 73	60	111	90	EM

*1 Plot size = 1 row (.75m) x 6m (25 hills per row, spaced 25 cm apart).
*2 Planted in Moisture = Plots 1-154 on 29 April, 155-237 on 2 May, and 238-447 on 12 May 1979.
*3 Purpose of Selections = EM = Early maturity; P = Preliminary Yield Test; SG = Short Grain Yield Test; H = Head-to-Row.

Table 2. (continued)

Table No.	Test Entry No.	*1 Pedigree	Seed Source	% Stand	*2 Days to 50% Bloom	Height in cm	*3 Type of Selectio
36	108	77093-20-3	78099- 87	56	143	140	P (white)
37	108	" -20-3	" - 87	56	143	140	P (yellow)
38	109	" -24-1	" - 98	20	133	90	H
39	110	" -26-3	" -112	52	131	140	P
40	111	" -33-2-1	" -145	36	144	120	P,H
41	112	" -33-2-2	" -145	80	139	170	P
42	113	" -33-2-3	" -145	36	139	110	P
43	114	" -33-2-4	" -145	48	139	140	SG,H
44	115	" -33-2-5	" -145	72	140	130	P
45	116	" -33-2-6	" -145	80	132	130	H
46	121	" -39-4	" -174	44	153	120	H
47	128	" -55-4	" -243	48	135	130	EM
48	129	" -55-6	" -245	48	152	120	H
49	131	" -58-5	" -263	80	123	100	EM
50	134	" -60-2	" -269	80	92	90	EM
51	136	" -61-5	" -276	76	122	105	P,H
52	139	" -64-4	" -288	68	121	160	P
53	141	" -66-2	" -297	56	132	105	P
54	142	" -71-4	" -325	16	151	140	H
55	143	" -72-1	" -329	44	149	180	P
56	146	" -74-5	" -340	56	132	140	P
57	148	77 COMPOSITE	78100- 14	40	130	70	SG
58	151	"	" - 49	24	121	90	H
59	153	"	" - 78	40	125	100	SG
60	155	"	" -120	16	129	125	H
61	156	"	" -127	52	143	160	P
62	157	"	" -132	32	98	95	P
63	159	"	" -134	36	126	150	P
64	160	"	" -145	48	129	140	H
65	161	"	" -155	20	129	140	H
66	162	"	" -158	36	135	160	P
67	163	78097-R- 1	78097	76	139	140	P
68	164	" -R- 2	"	32	128	210	P,H
69	173	" -R-11	"	64	139	210	H
70	177	" -R-15	"	24	130	155	H
71	178	" -R-16	"	88	130	165	H
72	179	" -R-17	"	36	145	135	P
73	183	" -R-20	"	68	128	175	P
74	186	" -R-23	"	72	128	150	H
75	188	" -R-25	"	20	139	170	P

Table 2. (continued)

Table No.	Test Entry No.	*1 Pedigree	Seed Source	% Stand	*2 Days to 50% Bloom	Height in cm	*3 Type of Selection
76	189	78097-R-26	78097	32	148	160	H
77	191	" -R-28	"	64	127	130	P
78	193	" -R-30	"	52	150	175	H
79	195	" -R-32	"	68	123	160	P
80	204	" -R-41	"	64	131	170	P
81	205	" -R-42	"	4	135	155	H
82	206	" -R-43	"	36	132	180	H
83	207	" -R-44	"	52	138	150	P,H
84	209	" -R-46	"	12	140	135	H
85	214	" -R-50	"	60	137	140	H
86	216	" -R-52	"	60	129	130	P
87*4	218	" -R-54	"	44	160	190	H
88	220	" -R-56	"	88	139	120	H
89	224	" -R-60	"	28	130	170	H
90	226	" -R-62	"	60	133	180	P
91	228	" -R-64	"	28	91	130	EM
92	230	" -R-66	"	48	122	120	P
93	233	" -R-69	"	72	147	190	P
94	234	" -R-70	"	84	122	165	H
95	235	" -R-71	"	40	124	160	H
96	237	" -R-73	"	44	125	80	SG
97	238	" -R-74	"	4	123	105	H
98	239	" -R-75	"	72	119	175	H
99	241	" -R-76	"	80	140	140	P
100	244	" -R-79	"	68	125	165	P
101	245	" -R-80	"	20	135	165	H
102	246	" -R-81	"	24	131	115	H
103	247	" -R-82	"	68	115	170	P,H
104	249	" -R-84	"	84	127	140	P
105	250	" -R-85	"	60	126	135	P
106	251	" -R-86	"	36	134	140	H
107	253	" -R-88	"	68	135	160	H
108	254	" -R-89	"	64	132	140	H
109	256	" -R-91	"	56	120	130	P
110	259	" -R-94	"	56	139	170	H
111	260	" -R-95	"	64	119	140	P,H
112	263	78099-R- 2	78099	64	119	155	P
113	264	" -R- 3	"	64	104	140	H
114	265	" -R- 4	"	36	144	170	H
115	266	" -R- 5	"	48	108	130	H,P

*4 - Long glumes (95% of seed covered)

Table 2. (continued)

Table No.	Test Entry No.	*1 Pedigree	Seed Source	% Stand	*2 Days to 50% Bloom	Height in cm	*3 Type of Selection
116	267	78099-R- 6	78099	56	115	160	P
117	268	" -R- 7	"	52	143	170	H
118	269	" -R- 8	"	72	112	150	P,H
119	271	" -R- 9	"	84	113	150	H
120	272	" -R-10	"	88	109	145	P
121	274	" -R-12	"	72	131	175	H,P
122	275	" -R-13	"	20	103	170	H
123	276	" -R-14	"	84	115	150	P
124	278	" -R-16	"	68	126	150	H
125	279	" -R-17	"	80	113	175	P
126	281	" -R-19	"	76	136	210	H
127	284	" -R-22	"	100	127	200	P
128	285	" -R-23	"	84	96	150	P
129	286	" -R-24	"	16	138	190	H
130	287	" -R-25	"	72	126	180	P
131	288	" -R-26	"	92	103	190	P,H
132	290	" -R-28	"	56	126	210	P,H
133	291	" -R-29	"	84	126	160	P
134	292	" -R-30	"	72	125	230	P,H
135	294	" -R-32	"	92	137	230	H
136	295	" -R-33	"	20	77	150	EM
137	296	" -R-34	"	56	126	230	P
138	297	" -R-35	"	96	109	195	H
139	298	" -R-36	"	84	120	230	P
140	299	" -R-37	"	76	110	190	P
141	301	" -R-38	"	88	128	180	P
142	302	" -R-39	"	76	125	180	P
143	303	" -R-40	"	72	123	160	P,H
144	304	" -R-41	"	64	105	185	H
145	305	" -R-42	"	56	104	180	H
146	307	" -R-44	"	36	112	110	SG
147	309	" -R-46	"	80	103	160	P,H
148	310	" -R-47	"	56	107	150	P
149	312	" -R-49	"	72	100	170	H
150	313	" -R-50	"	80	107	170	P
151	314	" -R-51	"	68	127	130	P
152	315	" -R-52	"	64	105	120	P
153	316	" -R-74	"	80	106	170	P
154	318	" -R-55	"	56	119	130	H
155	319	" -R-56	"	60	96	90	H

Table 2. (continued)

Table No.	Test Entry No.	*1 Pedigree	Seed Source	% Stand	Days to 50% Bloom	Height in cm	*3 Type of Selectio
156	320	78099-R-57	78099	100	113	155	H
157	322	" -R-59	"	76	126	170	P
158	324	" -R-61	"	68	118	160	P
159	325	" -R-62	"	76	125	160	P
160	326	" -R-63	"	76	123	170	H
161	327	" -R-64	"	48	112	90	SG
162	329	" -R-66	"	92	123	90	SG
163	334	" -R-70	"	100	127	175	H
164	335	" -R-71	"	60	100	125	P
165	336	" -R-72	"	64	123	115	H
166	340	" -R-76	"	84	130	140	H
167	342	" -R-78	"	68	119	170	P,H
168	346	" -R-82	"	80	114	120	P
169	352	" -R-88	"	52	129	175	P
170	353	" -R-89	"	56	111	160	H
171	355	78100-R- 2	78100	44	101	95	SG
172	365	" -R-11	"	48	130	70	SG
173	371	" -R-17	"	72	125	160	P
174	380	78 COMP.- 8	BULK	52	110	210	H
175	383	" -11	"	76	119	190	P,P
176	394	" -21	"	20	108	165	P
177	397	" -24	"	52	116	165	P
178	398	" -25	"	40	115	110	SG
179	400	" -27	"	100	124	180	P
180	402	" -29	"	64	120	130	P
181	403	" -30	"	40	141	90	SG
182	407	" -34	"	76	116	135	P
183	410	" -37	"	72	115	220	H
184	411	" -38	"	52	108	80	SG
185	413	76026-005- 2	76026	48	101	150	H
186	416	" -005-10	"	40	95	95	H
187	422	" -006-11	"	28	108	120	H
188	426	" -007- 5	"	56	104	135	H
189	428	" -008- 3	"	24	133	195	P
190	429	" -008- 5	"	16	141	110	H
191	430	" -009- 4	"	36	127	90	SG
192	432	" -009- 7	"	4	120	175	H
193	434	" -010- 1	"	28	138	100	SG
194	435	" -010- 2	"	24	131	140	H
195	439	" -010- 7	"	20	137	160	H
196	440	" -011- 1	"	36	106	140	H
197	443	" -011- 9	"	64	128	200	P
198	445	78 COMP.-39	BULK	88	118	130	H

Test Number 79002

Head-to-Row

End of Season Results:

Four hundred ninety-eight entries including a local check variety repeated at periodic intervals made up this test. The local variety check plots were adapted phenotypic standards against which the agronomic performance of the surrounding experimental entries could be evaluated for selection purposes. A description of this test, its purpose, seed sources, plot size and treatment during the season is given on page 23. A total of 212 of these head rows were selected for further evaluation in 1980. The agronomic phenotypic data collected on these selected genotypes are given in Table 3.

One hundred eleven plots were planted in Field D which could not be properly irrigated at midseason because of a breakdown of irrigation well number 2. This well could not be repaired due to administrative delays by the Mission in supplying operational monies to pay for repairs. These plots were lost. No meaningful observations or selections could be made from these plots due to premature death of the plants from extreme drought.

Research data on the other 175 entries which were discarded, and were not carried forward in the breeding program, are not shown here. These genotypes and their data have no further value.

A detailed explanation of these data is presented in the "End of Season Results" written up for Test Number 79001.

Table 3 . Agronomic Data From Single Head Selections From 1978 Grown in Head Rows in Test 79002 in 1979. Sana'a, Yemen.

Table No.	Test Entry No.	*1 Pedigree	Seed Source	% Stand	*2 Days to 50% Bloom	Height in cm	*3 Type of Selection
1	1	NES110 x Nes 6970	78111- 1-1	64	112	165	P
2	3	" x " 6971	" - 2-2	64	111	110	H
3	5	" x " 6972	" - 3-1	60	111	135	P
4	7	" x " 6972	" - 3-3	56	120	115	P
5	9	" x " 6973	" - 4-1	68	99	85	P
6	11	" x " 6974	" - 5-2	48	115	135	P
7	13	" x " 6975	" - 6-2	24	123	85	H
8	14	" x " 6976	" - 7-1	56	118	110	P
9	16	" x " 6976	" - 7-3	44	115	125	P
10	17	" x " 6976	" - 7-4	76	97	125	H
11	19	" x " 6977	" - 8-2	68	114	130	H
12	21	" x " 6977	" - 8-4	44	109	70	SG
13	23	" x " 6978	" - 9-1	24	125	130	P
14	25	" x " 6978	" - 9-3	64	116	140	P
15	30	LOCAL		36	140	125	H
16	32	NES1500 x NES 6973	" -13-1	44	107	145	H
17	33	" x " 6973	" -13-2	44	105	145	P
18	35	" x " 6973	" -13-4	60	112	155	H
19	42	" x " 6976	" -15-4	48	118	95	SG
20	44	" x " 6983	" -16-1	68	101	140	H
21	48	NES2141 x NES 6971	" -17-2	12	102	150	H
22	49	" x " 6971	" -17-3	44	99	140	P
23	50	" x " 6971	" -17-4	60	122	140	H
24	38	NES1500 x " 6975	" -14-3	36	106	125	H
25	52	NES2141 x " 6972	" -18-1	32	113	140	H
26	53	" x " 6972	" -18-2	44	106	140	H
27	59	" x " 6975	" -21-1	64	118	140	H
28	61	" x " 6975	" -21-2	84	122	155	H
29	62	" x " 6975	" -21-3	76	111	135	H
30	63	" x " 6975	" -21-4	72	113	120	H
31	64	" x " 6975	" -21-5	84	113	120	P
32	65	" x " 6976	" -22-1	92	100	115	H
33	67	" x " 6976	" -22-3	80	94	84	SG
34	68	" x " 6978	" -23-1	72	106	170	P,H
35	70	" x " 6978	" -23-3	56	105	185	P,H
36	71	" x " 6982	" -24-1	96	103	155	H
37	72	" x " 6982	" -24-2	92	108	185	H
38	73	" x " 6983	" -25-1	60	119	180	H
39	74	" x " 6983	" -25-2	92	121	200	P,H
40	75	" x " 6983	" -25-3	84	121	195	H

*1 Plot Size = 1 Row (.75m) x 6m (25 hills/row spaced 25cm apart).
*2 Planted in moisture = Plots 1-56 on 15 May; Plots 57-308 on 17 May; Plots 309-387 on 20 May, Plots 388-498 on 4 June.
*3 Purpose of Selections for 1980 = EM = Early Maturity; P = Preliminary Yield Test; SG = Short Grain; H = Head Row.

Table 3. (continued)

Table No.	Test Entry No.	*1 Pedigree	Seed Source	% Stand	*2 Days to 50% Bloom	Ht. in m	*3 Type of Selection
41	77	NES 2141xNES 6983	78111-25-5	96	112	185	H
42	78	" x " 6983	" -25-6	80	123	185	H
43	82	" 3329x " 6971	" -27-1	68	102	175	H
44	83	" " x " 6971	" -27-2	80	112	190	H
45	85	" " x " 6971	" -27-4	80	95	135	P
46	87	" " x " 6972	" -28-2	64	128	180	H
47	88	" " x "	" -28-3	84	129	190	H
48	89	" " x " 6972	" -28-4	68	116	160	H
49	91	" " x " 6972	" -28-5	56	122	170	H
50	92	" " x " 6973	" -29-1	72	97	155	H
51	93	" " x " 6973	" -29-2	76	97	130	H
52	95	" " x " 6973	" -29-4	96	105	135	H
53	98	" " x " 6975	" -31-1	72	106	140	P
54	99	" " x " 6975	" -31-2	64	135	115	H
55	100	" " x " 6975	" -31-3	72	94	95	H
56	101	" " x " 6976	" -32-1	28	129	90	H
57	102	" " x " 6976	" -32-2	56	137	85	H
58	103	" " x " 6976	" -32-3	64	136	100	H
59	104	" " x " 6976	" -32-4	68	98	75	H
60	106	" " x " 6977	" -33-2	64	107	105	SG
61	108	" " x " 6977	" -33-4	96	115	150	H
62	112	" " x " 6979	" -35-1	92	144	170	H
63	113	" " x " 6980	" -36-1	76	128	170	H
64	114	" " x " 6980	" -36-2	92	113	165	H
65	116	" " x " 6980	" -36-4	92	142	170	H
66	118	" " x " 6982	" -37-2	84	137	175	H
67	119	" " x " 6982	" -37-3	84	133	170	H
68	121	" " x " 6982	" -37-4	100	145	170	H
69	122	" " x " 6982	" -37-5	72	112	130	P
70	124	" " x " 6985	" -38-2	80	101	125	H
71	126	" " x " 6986	" -39-2	12	126	100	SG
72	127	" " x " 6986	" -39-3	40	101	110	H
73	128	" " x " 6986	" -39-4	60	121	120	H
74	129	" " x " 6986	" -39-5	32	108	145	H
75	130	" " x " 6986	" -39-6	48	109	120	H
76	132	IS 509 x " 6970	" -40-2	76	93	125	H
77	133	" x " 6971	" -41-1	76	93	100	SG
78	134	" x " 6971	" -41-2	84	109	120	H
79	138	" x " 6974	" -42-3	76	137	165	H
80	139	" x " 6974	" -42-4	96	130	160	H
81	140	" x " 6978	" -43-1	56	115	130	H
82	142	" x " 6978	" -43-2	84	103	140	P
83	143	" x " 6978	" -43-3	28	117	165	H
84	145	" x " 6978	" -43-5	64	110	135	P
85	146	" x " 6979	" -44-1	96	111	125	SG

Table 3.(continued) Test 79002

Table No.	Test Entry No.	*1 Pedigree	Seed Source	% Stand	*2 Days to 50% Bloom	in cm	*3 Type of Selecti
86	153	IS 509 x NES 6982	78111-46-1	44	51	190	P
87	154	" x " 6982	" -46-2	52	115	175	P
88	155	" x " 6982	" -46-3	60	49	160	H
89	156	" x " 6982	" -46-4	84	143	165	H
90	157	" x " 6982	" -46-5	64	128	185	H
91	158	" x " 6982	" -46-6	68	115	165	H
92	160	" x " 6983	" -47-2	68	116	165	H
93	163	" x " 6983	" -47-5	84	123	140	H
94	164	" x " 6986	" -48-1	84	102	155	H
95	165	" x " 6986	" -48-2	80	114	160	H
96	166	" x " 6986	" -48-3	92	92	130	P
97	168	" x " 6986	" -48-5	88	111	165	P
98	170	NES2197x " 6970	" -49-2	92	102	140	P
99	172	" x " 6970	" -49-4	88	99	155	P,H
100	173	" x " 6971	" -50-1	64	115	170	P
101	174	" x " 6971	" -50-2	96	128	180	P
102	175	" x " 6971	" -50-3	88	129	175	H
103	176	" x " 6971	" -50-4	92	131	175	P
104	177	" x " 6971	" -50-5	80	126	180	H
105	178	" x " 6972	" -51-1	88	109	145	H
106	183	" x " 6973	" -52-4	56	100	174	P
107	184	" x " 6973	" -52-5	68	120	195	P
108	185	" x " 6974	" -53-1	64	133	195	P
109	186	" x " 6974	" -53-2	56	100	110	SG
110	187	" x " 6974	" -53-3	68	137	185	P,H
111	188	" x " 6975	" -54-1	80	118	160	P,H
112	190	" x " 6975	" -54-3	60	122	175	H
113	191	" x " 6975	" -54-4	80	142	175	H
114	192	" x " 6975	" -54-5	96	136	160	H
115	198	" x " 6977	" -56-1	92	98	165	P
116	199	" x " 6977	" -56-2	100	115	170	H
117	200	" x " 6977	" -56-3	100	123	165	H
118	201	" x " 6977	" -56-4	72	115	155	H
119	202	" x " 6978	" -57-1	84	117	160	P
120	204	" x " 6979	" -58-1	100	113	165	H
121	205	" x " 6979	" -58-2	80	129	150	H
122	209	" x " 6980	" -59-2	72	145	195	H
123	212	" x " 6981	" -60-1	72	101	150	P,H
124	215	" x " 6981	" -60-4	28	152	195	P
125	216	" x " 6981	" -60-5	44	132	195	H
126	217	" x " 6982	" -61-1	64	91	160	H
127	220	" x " 6982	" -61-4	56	98	165	H
128	221	" x " 6982	" -61-5	64	97	155	H
129	222	" x " 6985	" -62-1	52	130	185	P
130	223	" x " 6985	" -62-2	60	102	185	P

Table 3. (continued)

Table 79002

Table No.	Test Entry No.	*1 Pedigree	Seed Source	% Stand	*2 Days to 50% Bloom	Ht. in m	*3 Type of Selection
131	224	NES 2197 x NES 6985	78111-62- 3	52	95	150	H
132	231	" x " 6986	" -63- 5	92	114	135	H
133	234	" x " 6970	" -64- 1	56	109	130	H
134	236	" x " 6970	" -64- 3	48	111	150	H
135	237	" x " 6970	" -64- 4	80	113	130	P
136	238	IS 9958 x " 6970	" -64- 5	88	114	140	P
137	239	" x " 6971	" -65- 1	80	113	115	SG
138	241	" x " 6971	" -65- 2	92	111	135	H
139	242	" x " 6971	" -65- 3	84	117	135	P
140	245	" x " 6971	" -65- 6	76	102	125	P
141	247	" x " 6972	" -66- 2	36	94	110	H
142	248	" x " 6972	" -66- 3	32	95	130	H
143	249	" x " 6973	" -67- 1	52	94	70	H
144	250	" x " 6973	" -67- 2	48	81	75	H
145	251	" x " 6973	" -67- 3	40	97	95	H
146	252	" x " 6973	" -67- 4	84	106	110	P
147	253	" x " 6974	" -68- 1	76	95	115	H
148	254	" x " 6974	" -68- 2	12	107	110	H
149	256	" x " 6974	" -68- 4	84	112	170	H
150	251	" x " 6975	" -69- 1	60	102	145	H
151	250	" x " 6975	" -69- 2	84	100	125	H
152	259	" x " 6975	" -69- 3	20	135	125	P
153	262	" x " 6977	" -70- 1	68	121	100	H
154	264	" x " 6978	" -71- 1	48	101	105	H
155	265	" x " 6978	" -71- 2	48	122	125	H
156	268	" x " 6979	" -72- 1	72	123	140	H
157	274	" x " 6981	" -73- 3	72	101	100	H
158	277	" x " 6982	" -74- 3	92	140	150	H
159	279	" x " 6983	" -75- 1	72	102	85	SG
160	283	" x " 6984	" -76- 1	64	114	100	SG
161	286	NES 110 x NES 6970	78112- 1- 1	60	143	100	H
162	287	" x " 6970	" - 1- 2	84	--	100	H
163	289	NES 3329 x " 6976	" - 2- 1	68	114	105	H
164	293	" x " 6976	" - 2- 5	76	134	170	P
165	295	" x " 6976	" - 2- 7	96	152	140	H
166	297	" x " 6976	" - 2- 9	44	137	120	H
167	298	" x " 6976	" - 2-10	44	136	155	H
168	301	" x " 6976	" - 3- 2	72	107	140	H
169	302	" x " 6976	" - 3- 3	60	122	105	H
170	306	(P894F_2 x LOCAL)F_2	" - 5- 1	72	129	150	H
171	308	"	" - 5- 3	68	117	130	H
172	309	"	" - 5- 4	88	112	130	H
173	310	"	" - 5- 5	72	118	80	SG
174	311	"	" - 5- 6	84	90	105	H
175	313	"	" - 5- 8	92	115	130	H

Table 3.(continued) Test 79002

Table No.	Test Entry No.	*1 Pedigree	Seed Source	% Stand	*2 Days to 50% Bloom	Ht. in m	*3 Type of Selection
176	315	(P866 F_2 x LOCAL) F_2	78112 - 6- 1	92	134	170	H
177	316	"	" - 6- 2	84	135	170	H
178	318	"	" - 6- 4	80	90	195	H
179	319	(P8681F_2 x LOCAL) F_2	" - 7- 1	64	89	175	H
180	320	"	" - 7- 2	84	99	125	H
181	321	"	" - 7- 3	20	88	125	H
182	322	"	" - 7- 4	44	98	135	H
183	323	"	" - 8- 1	76	94	100	H
184	326	"	" - 8- 4	96	91	135	H
185	327	"	" - 8- 5	84	97	105	H
186	331	"	" - 8- 8	92	122	155	H
187	333	"	" - 9- 2	72	111	160	H
188	334	"	" - 9- 3	80	139	200	H
189	335	"	" - 9- 4	88	109	195	H
190	337	"	" - 9- 6	60	99	205	H
191	338	"	" - 9- 7	92	117	175	H
192	339	"	" - 9- 8	92	121	135	H
193	341	PB-1BR-DAY NEUTRAL x LOCAL	" -10- 1	60	92	100	H
194	342	"	" -10- 2	68	111	120	H
195	344	"	" -10- 4	64	107	135	H
196	348	"	" -11- 1	68	110	145	H
197	350	"	" -11- 6	76	118	185	H
198	352	"	" -12- 2	92	98	120	H
199	356	"	" -12- 6	80	95	120	H
200	357	"	" -12- 7	80	105	140	H
201	359	"	" -13- 2	68	118	180	H
202	361	"	" -13- 3	52	110	200	H
203	362	"	" -13- 4	40	121	185	H
204	363	"	" -13- 5	44	120	205	H
205	364	"	" -13- 6	48	92	135	H
206		PB-1BR-DAY SENSITIVE x LOCAL	" -14- 4	64	120	190	H
207	369	"	" -14- 5	52	108	150	H
208	372	PB-1BR-DAY NEUTRAL x LOCAL	" -15- 1	56	129	100	H
209	374	"	" -15- 3	72	80	117	SG
210	375	"	" -15- 4	80	105	90	H
211	377	"	" -15- 6	68	112	150	H
212	378	"	" -16- 1	84	109	130	H

Plots 388-498 were planted on preirrigated field D, but could not be further irrigated. It was not possible to make any meaningful observations or selections from these plots due to extreme drought, so all were lost.

Test Number 79003

Elite Yield Test

End of Season Results:

This Elite Yield Test contained a total of thirty-three experimental genotypes. A description of this test, its purpose, seed sources, plot size and planned treatment during the season is given on page 24. These plans for test entry treatment and evaluation were made at the beginning of the season when the entries were first selected from 1978 tests and other source materials available.

This "Elite" yield test represented a second and even a third year of actual field yield testing for most of these entries. A number of the entries from the Elite Yield Test from last year (78103) were rerun in this years Elite Test because of poor test performance in 1978. Other entries were moved up from the Advanced Yield Test last year (78102) as per schedule. There were a few other entries from miscellaneous sources because they looked good.

Experimental genotypes reaching this stage of evaluation need to be quite fully tested before possible release. Hence forage yields were taken as well as grain yields. Test weights of the grain were obtained.

These data are presented in Tables 4, 5, and 6 respectively.

Nine entries were discarded prior to harvest as being definitely inferior and not worthy of being continued in the test. These are indicated in Table 4 .

The data in Table 4 are arranged in order of grain yield production, but the table presents only field agronomic data other than yield. A description of these agronomic measurements is presented earlier in this report.

Grain and forage yields are presented in Table 5 . Grain and forage production per day was calculated. The highest grain yielding entries had the highest grain production per day of growth through to maturity.

Table 6 is a summary table of grain and forage production ranks. A good dual purpose sorghum is in most demand in Yemen. Somewhat different genotypes would be selected if considering grain production, forage production, or combined grain and forage production.

Superior entries from this test should be put into the Outreach tests in 1980 as well as increasing seed for possible release later.

Table 4. Agronomic Field Non-Yield Performance Data on Thirty-three Experimental Sorghum Genotypes Grown in an Elite Yield Test at Sana'a, Yemen A. R. Test 79003. 1979.

Rank by Grain Prod.	*1 Entry No.	*2 Pedigree	Seed Source	% Stand	*3 Days to 50% Bloom	Plant Ht. (cm)	Agronomic Rating Plant	Agronomic Rating Head
1	17	76025-041	78102-114	47	111	151	1	1
2	3	NES 1773	78103-116	26	116	89	2	1
3	7	75012-136	78103-126	54	113	139	1	1.5
4	14	76025-017	78102-110	50	96	130	2.25	1.25
5	5	NES 7003	78103-119	52	101	131	2.5	2
6	25	SANAA-1	------	46	107	125	2	1.5
7	27	SANAA-7	------	68	110	134	1	2
8	6	IS-825	78103-122	24	102	104	2	1
9	9	76014-077	78103-128	44	106	136	2	1.5
10	33	TAKIL	78106-111	82	122	182	1	1
11	16	LOCAL	------	57	108	135	1	2
12	23	76026-032	78102-122	53	100	111	2	1.5
13	30	IBB-16-6	78106-104	80	119	146	1	1.25
14	24	76026-033	78102-123	53	125	115	1.5	1
15	28	LOCAL	------	64	109	139	1	2
16	10	75016-061	78103-129	61	107	135	1.75	1.25
17	19	76026-014	78102-118	50	126	131	1	1.5
18	20	76026-023	78102-119	38	119	138	1	1
19	18	76025-052	78102-116	39	115	124	2	1.75
20	29	IBB-16-2	78106-103	82	126	174	1	1.25
21	22	76026-025	78102-121	46	113	130	1.25	1
22	21	76026-024	78102-120	50	129	146	1	1
23	12	76016-057	78102-104	44	100	96	2.25	1.5
24	31	IBB-17-1	78106-105	87	127	136	1	1.5
(25)	1	NES 843	78103-111	54	116	130	1.5	1.5
(26)	2	NES 864	78103-112	40	118	134	1	1.25
(27)	4	NES 7000	78103-118	13	131	120	1	1.5
(28)	8	76104-071	78103-127	36	96	132	3	2.5
(29)	11	76013-140	78102-104	56	95	109	2.25	2
(30)	13	76015-110	78102-109	44	94	128	2.75	1.75
(31)	15	76025-026	78102-112	39	101	121	3	2
(32)	26	SANAA-6	------	54	109	122	2	1.75
(33)	32	IBB-19-1	78106-106	42	118	112	2	1.75
Average of rank numbers 1 - 24:				54	113	132	1.5	1.4
Average of rank numbers (25) - (33):				42	109	123	2.1	1.8
Local check average:				60	108	137	1	2

*1: Entries under 'Rank by Grain Production' numbers (25) through (33) had no grain or forage production data since these entries were discarded before harvest.

*2: Plot Size: Two rows 6m long with .75m between rows and replicated 4 times; 25 hills per row at 25cm spacing with 2 to 3 plants per hill.

*3: Planted in Moisture: Rep. I on 12 May, Rep. II on 15 May, Rep. III on 17 May and Rep. IV on 20 May.

Table 5. Grain and Forage Field Production Data on Twenty-four Experimental Sorghum Genotypes Grown in an Elite Yield Test at Sanaa, Yemen A.R. Test 79003. 1979.

Rank by Grain Prod.	*1 Entry No.	Grain Yield k/ha	Grain Yield k/ha/day	Test Weight k/hl	*2 Forage Yield k/ha	Forage Yield k/ha/day	Forage Yield k/ha/cm ht	Grain to Forage Ratio
1	17	6258	44.4	67.5	13569	96.2	89.9	0.461
2	3	6023	41.3	67	6730	46.1	75.6	0.895
3	7	5751	40.2	65.6	9595	67.1	69.0	0.599
4	14	5660	44.9	62.2	6230	49.4	47.9	0.909
5	5	5369	41.0	71.2	7827	59.7	59.7	0.686
6	25	5124	37.4	67	6747	49.2	54.0	0.759
7	27	4779	34.1	66.9	11939	85.3	89.1	0.400
8	6	4666	35.3	70	19586	148	188	0.238
9	9	4645	34.2	69	6738	49.5	49.5	0.689
10	33	4348	28.6	72.5	11067	72.8	60.8	0.393
11	16	4326	31.3	64.5	7693	55.7	57.0	0.562
12	23	4200	32.3	66.4	10782	82.9	97.1	0.390
13	30	4095	27.5	68	10058	67.5	68.9	0.407
14	24	4022	25.9	64.4	9074	58.5	78.9	0.443
15	28	3945	28.4	64.4	8169	58.8	58.8	0.483
16	10	3643	26.6	69.9	5140	37.5	38.1	0.709
17	19	3638	23.3	64.5	7567	48.5	57.8	0.481
18	20	3521	23.6	66.5	10095	67.8	73.2	0.349
19	18	3504	24.2	66	7857	54.2	63.4	0.446
20	29	3483	22.3	68	8338	53.4	47.9	0.418
21	22	3407	23.8	68	6533	45.7	50.3	0.522
22	21	2810	17.7	65.5	12593	79.2	86.3	0.223
23	12	2255	17.3	69.5	3697	28.4	38.5	0.610
24	31	2006	12.8	59.5	10073	64.2	74.1	0.199
Table Averages:		4228	29.9	66.8	9071	63.6	69.7	0.511
Local Check Averages:		4136	29.8	64.4	7931	57.2	57.9	0.522

*1: Pedigree and other agronomic performance data are given in Table 4.

*2: Forage yield data obtained only from replications one, three and four.

Table 6 . Presentation of Grain and Forage Production Ranks and their Average Ranks for 24 Experimental Sorghum Genotypes in an Elite Yield Test (79003) at Sana'a, Yemen Arab Republic. 1979.

Table Rank No.	Entry No.	Pedigree	Grain Prod. Rank	Forage Prod. Rank	*1 Avg. Grain and Forage Prod. Rank
1	17	76025-041	1	2	1.5
2	6	IS825	8	1	4.5
3	27	Sana'a 7	7	4	5.5
4	7	75012-136	3	10	6.5
5	33	Takil	10	5	7.5
6	23	76026-032	12	6	9
7	5	NES7003	5	15	10
8	3	NES1773	2	20	11
9	30	IBB-16-6	13	9	11
10	25	Sana'a 1	6	18	12
11	20	76026-023	18	7	12.5
12	21	76026-024	22	3	12.5
13	24	76026-033	14	11	12.5
14	14	76025-017	4	22	13
15	16	Local Check	11	16	13.5
16	9	76014-077	9	19	14
17	28	Local Check	15	13	14
18	29	IBB-16-2	20	12	16
19	31	IBB-17-1	24	8	16
20	18	76025-052	19	14	16.5
21	19	76026-014	17	17	17
22	10	75016-061	16	23	19.5
23	22	76026-025	21	21	21
24	12	76016-057	23	24	23.5

*1 - The values in this column are numerical averages of the production ranks for grain and for forage of each entry genotype.

Test Number 79004

Advanced Yield Test

End of Season Results:

This Advanced Yield Test contained a total of sixteen experimental genotypes. A description of this test, its purpose, seed sources, plot size and planned treatment during the cropping season is presented on page 25. Most entries into this test came forward from the Preliminary Yield Test (78101) last year. Seven entries out of the sixteen were discarded just prior to harvest due to segregation, late maturity, and thin stands. These entries are identified in Table 8 .

Agronomic field data except for yield of grain and forage are presented in Table 7 . These yields of grain and forage have also been translated into units of yield per day of growth through to maturity.

Table 9 presents the rankings for yield of grain and forage and the averages for the nine remaining entries of this test.

The superior entries from this test should be advanced into the Elite Yield Test in 1980 as well as some being considered for entering into Outreach Tests.

Table 7 . Agronomic Data from an Advanced Yield Test (79004) of Selected Experimental Sorghum Genotypes at Sana'a, Yemen Arab Republic. 1979.

Entry No.	*1 Pedigree	Origin	% Stand	*2 Days to 50% Bloom	Plant Ht. (cm)	*3 Agronomic Rating *4 Plant	Head	% Bird Damage
1	76026-019-6	78101-113	32	77	124	2.25	2	4
2	76026-019-13	78101-118	44	105	95	2.5	1.5	0
3	76026-023-1	78101-123	34	121	126	1.75	1	1
4	76026-025-2	78101-124	50	126	169	1	1	6
5	76026-025-6	78101-126	69	126	150	1	1	6
6	Rahda Local	78101-138	80	120	179	1	1	1
7	Local	---	70	111	139	1	2	2
8	76041-004	78101-142	56	106	95	2.75	2.25	3
9	76026-019	78101-153	40	122	126	1.25	1.25	1
10	AWASH 1050	78105-102	58	--	--	2	--	0
11	IBB24-1	78106-110	62	134	146	1.25	1	2
12	SANA'A-1	---	58	108	118	2	1	4
13	SANA'A-4	78106-118	76	120	105	1.5	1.25	1
14	SANA'A-6	---	68	115	121	1.5	1.25	1
15	SANA'A-7	---	58	110	130	1	2	2
16	Local	---	52	111	129	1	2	2

*1 - Plot size = two rows each 6m long with .75m between rows, 25 hills per row and four replications in a randomized complete block design.

*2 - Planted in moisture: replication I on 12 May 1979, II on 15 May, III on 17 May and IV on 20 May 1979.

*3 - Agronomic ratings of plant and head: 1 = good, 2 = average, 3 = poor.

*4 - No measurable lodging in any entries except entry 13 (Sana'a 4), which showed about 2% lodging.

Table 8 . Grain and Forage Production Data from an Advanced Yield Test (79004) of Selected Experimental Sorghum Genotypes at Sana'a, Yemen Arab Republic. 1979.

Entry No.	Grain Prod. k/ha	*1 Grain Prod. k/ha/day	Grain Test Wt. k/hl	*2 Forage Prod. k/ha	*1 Forage Prod. k/ha/day	Forage Prod. k/ha/cm/ht	Grain to Forage Ratio
1	-*3-	--	--	--	--	--	--
2	2856	21.2	71.5	4,967	36.8	52.3	.57
3	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--
5	2427	15.6	68	15,276	97.9	102	.16
6	4500	30.0	75	19,718	131	110	.23
7	4516	32.0	65.5	14,314	102	103	.32
8	2390	17.6	69	4,431	32.6	46.6	.54
9	--	--	--	--	--	--	--
10	--	--	--	--	--	--	--
11	--	--	--	--	--	--	--
12	3110	22.5	72	5,337	38.7	45.2	.58
13	2382	15.9	66.5	--	--	--	--
14	--	--	--	--	--	--	--
15	4372	31.2	67.5	15,294	109	118	.29
16	4163	29.5	67	7,079	50.2	54.9	.59

*1 - Grain and forage production of kilograms per hectare per day is based on number of days from planting in moisture to 30 days past 50% bloom.

*2 - Forage production data obtained only from replications I and IV due to a shortage of labor.

*3 - Entries 1, 3, 4, 9, 10, 11 and 14 were discarded prior to harvest and no grain or forage data were taken. Reasons for discard were segregation, late maturity and thin stands.

Table 9 . Presentation of Grain and Forage Production Ranks and their Average Ranks for 9 Experimental Sorghum Genotypes in an Advanced Yield Test (79004) at Sana'a, Yemen Arab Republic. 1979.

Table Rank No.	Entry No.	Pedigree	Grain Prod. Rank	Forage Prod. Rank	*1 Avg. Grain and Forage Prod. Rank
1	6	Rahda Local	2	1	1.5
2	7	Local Check	1	4	2.5
3	15	Sana'a 7	3	2	2.5
4	16	Local Check	4	5	4.5
5	5	76026-025-6	7	3	5
6	12	Sana'a 1	5	6	5.5
7	2	76026-019-13	6	7	6.5
8	8	76041-004	8	8	8
9	13	Sana'a 4	9	-	-

*1 - The values in this column are numerical averages of the production ranks for grain and for forage of each entry genotype.

Test Number 79005

Preliminary Yield Test

End of Season Results:

This Preliminary Yield Test had 203 experimental genotypes and a local check variety entered seven times for a total of 210 entries. A description of this test, its purpose, seed sources, plot size and planned treatment during the crop season is given on page 26 . These plans were made at the time the entries were selected from the 1978 tests and other sources of genetic materials.

Most characteristics were measured as planned on the two replications of each genotype. These average data are presented in Table 10 . Bird damage of the grain was estimated and the grain yields of the affected plots were adjusted accordingly.

The plots (entries) were visually evaluated at maturity in the field and a number of decisions made as to their future potential. A number were discarded. These were judged to be definitely inferior to the local checks and to other test entries. A number were selected for advancement to the advanced yield test in 1980. Others were selected to be re-evaluated in the preliminary yield test in 1980. Some selections were made for head-to-row. There were selections for both early maturity and short grain. All selections were labeled as to their proposed 1980 evaluation when harvested in 1979. This selection information on these selections was not available at the time of tabulation of the field plot phenotypic data and thus it is not presented here. This information is on the seed envelopes of the selections and is marked in the field books in the project.

Table 10. Grain Yield and Other Agronomic Data From a Preliminary Yield Test (79005) of Grain Sorghum Experimental Variety Genotypes at Sana'a, Yemen in 1979.

Rank By Grain Prod.	Entry No.	*1 Pedigree	Source	% Stand	*2 Days To 50% Bloom	Plant Ht. cm	Grain Prod. k/ha	Grain Prod. k/ha/day	Test Wt. k/hl	Agronomic Plant	Agronomic Head	% Lod-ging	% Bird Damag
1	176	77 Comp. - 74	78100-74	37	152	132	5727	31	----	1	2.5	-	0
2	49	76026063	78097-205	56	130	168	3522	22	70.8	1	1	-	0
3	63	76026036-2	78098-108	30	123	162	3331	22	63.5	1	1	0	1.5
4	155	77093-65-1	78099-289	70	120	105	3132	21	69	2.5	1.5	15	0
5	135	77093-56-1	78099-247	58	122	175	3068	20	66.5	2	1.5	0	0
6	60	LOCAL	---	50	126	135	2877	18	63	1	2	0	2.5
7	101	77093-09-3	78099-48	64	111	175	2821	20	68	1.5	1.5	0	0.5
8	61	76026011-6	78098-56	34	119	148	2762	20	55.2	1	2	0	0
9	92	76026072-3	78098-222	62	134	172	2734	17	70	1	1.5	0	1.5
10	209	SANAA - 7	---	34	114	122	2643	18	64	1	2	0	1.5
11	42	76026052-4	78097-182	46	103	125	2582	19	59.5	2	1.5	0	3.5
12	4	76026002-11	78097-13	30	131	115	2457	15	----	1.5	1.5	0	0.5
13	98	76026074-5	78098-235	30	126	132	2447	16	71	1.5	1	0	1.5
14	208	SANAA - 6	---	38	122	115	2393	16	64	2	2	0	0
15	93	76026072-7	78098-226	62	132	180	2363	15	71	1.5	1.5	0	0.5
16	124	77093-50-5	78099-223	62	122	138	2360	16	67.5	2	2	2.5	0
17	2	76026002-4	78097-6	42	124	120	2277	15	66	1	2	0	0.5
18	86	76026061-8	78098-182	68	105	128	2234	17	67.5	2	2	0	3.5
19	90	LOCAL	---	56	122	135	2219	15	62.5	1.5	2	0	1.5
20	150	LOCAL	---	50	130	122	2211	14	63	1	2	0	2

*1 Plot size: 1 row (.75m between rows) x 6m long, 25 hills per row spaced 25cm apart, replicated two times.
*2 Planted in moisture: Rep. I on 29 April and Rep. II on 2 May.

Table 10. (continue) Test 79005

Rank By Grain Prod.	Entry No.	*1 Pedigree	Source	% Stand	*2 Days To 50% Bloom	Plant Ht. cm	Grain Prod. k/ha	Grain Prod. k/ha/day	Test Wt. k/hl	Agronomic Plant	Agronomic Head	% Lod-ging	% Bird Damage
21	133	77093-55-5	78099-244	56	118	138	2206	15	67.8	2	2	0	3.5
22	120	LOCAL	---	56	131	122	2200	14	63	1	2	2.5	1
23	165	77093-75-4	78099-344	64	116	100	2191	15	72	2.5	2.5	10	0
24	181	77 Comp. - 80	78100 - 80	44	125	130	2109	14	----	1	1.5	0	0.5
25	131	77093-55-2	78099-241	56	133	155	2084	13	67.2	1	2	0	0
26	138	77093-56-4	78099-250	56	129	152	2079	13	67.5	1	1	0	0
27	20	76026037-1	78097-110	54	103	132	2058	15	64	1.5	1.5	0	4
28	196	77 Comp. - 142	78100-142	64	130	135	2007	13	63.5	1	2	0	0.5
29	24	76026037-10	78097-119	46	132	135	1995	12	65.5	1.5	2	0	0.5
30	187	77 Comp. - 113	78100-113	44	128	135	1964	12	60	1.5	2	0	0
31	57	76019001-3	78097-273	38	126	112	1963	13	----	2	2	1	0
32	46	76026063-3	78097-198	56	114	130	1935	13	57	1.5	1.5	0	0.5
33	8	76026024-2	78097-53	42	126	162	1907	12	----	1.5	1.5	0	0.5
34	103	77093-20-2	78099-86	36	130	145	1904	12	----	1	2	0	0
35	143	77093-57-3	78099-256	56	134	155	1901	12	69.5	1	1.5	0	0
36	129	77093-53-1	78099-233	52	120	135	1867	12	68	1.5	2	0	4
37	136	77093-56-2	78099-248	86	130	150	1864	12	65.5	1.5	2	0	0
38	178	77 Comp. - 77	78100-77	72	126	125	1833	12	65.5	1	1.5	0	0.5
39	32	76026041-7	78097-147	72	137	122	1820	11	53	1.5	2	0	0
40	85	76026061-7	78098-181	72	136	175	1801	11	64	1	1	0	0
41	78	76026057-4	78098-160	76	107	135	1796	13	65.8	2	2	0	0
42	157	77093-65-3	78099-291	66	130	122	1776	11	69.5	1.5	2	0	0
43	84	76026061-6	78098-180	60	138	145	1773	11	65	1	2	0	0
44	55	76026067-12	78097-260	56	122	112	1753	12	63	2	2	0	0
45	22	76026037-6	78097-115	58	126	128	1743	11	63.5	1	1	0	0

Table 10. (continue) Test 79005

Rank By Grain Prod.	Entry No.	*1 Pedigree	Source	% Stand	*2 Days To 50% Bloom	Plant Ht. cm	Grain Prod. k/ha	Grain Prod. k/ha/day	Test Wt. k/hl	Agronomic Plant	Agronomic Head	% Lod-ging	% Bird damage
46	68	76026040-2	78098-114	36	120	125	1742	12	----	2	1.5	0	2.5
47	80	76026060-4	78098-169	60	116	145	1738	12	67	1	1	0	0.5
48	144	77093-57-4	78099-257	84	128	108	1714	11	57.2	3	2	2.5	0
49	145	77093-57-5	78099-258	58	136	165	1702	10	59.8	1	2	0	3
50	116	77093-42-1	78099-184	60	131	132	1701	11	64.5	1.5	1.5	0	0
51	89	76026070-13	78098-216	68	134	162	1663	10	68.5	1	1.5	0	0.5
52	151	77093-61-3	78099-274	72	122	142	1639	11	66	1	1.5	0	0.5
53	58	76019001-4	78097-274	32	138	130	1617	10	55	1	2	0	0
54	161	77093-69-1	78099-311	52	131	128	1612	10	----	2	1.5	0	0
55	91	76026072-2	78098-221	40	136	158	1607	10	69	2.5	1.5	0	1
56	79	76026059-4	78098-165	50	129	148	1586	10	----	2.5	1.5	0	0
57	189	77 Comp. - 117	78100-117	60	128	122	1583	10	65	1	1.5	0	0
58	82	76026060-8	78098-173	52	138	175	1567	9	60.5	1	2	0	0
59	111	77093-38-3	78099-168	72	122	115	1566	10	69.5	2.5	1.5	0	0
60	70	76026043-2	78098-127	72	136	188	1551	9	67.5	1	1.5	0	0.5
61	210	LOCAL	---	40	137	118	1536	9	----	1.5	2	0	0
62	125	77093-50-6	78099-224	44	135	140	1513	9	----	1.5	2	0	0.5
63.5	113	77093-39-7	78099-177	78	112	108	1503	11	67.5	3	1.5	0	0.5
63.5	114	77093-41-3	78099-182	60	126	108	1503	10	65	2.5	2	0	0
65	5	76026003-1	78097-14	64	130	160	1496	9	69	1	2	0	2.5
66	128	77093-52-3	78099-231	68	129	138	1479	9	70	1	1.5	0	0
67	40	76026050-6	78097-178	58	126	128	1458	9	----	1.5	1.5	0	0.5
68	88	76026070-3	78098-206	64	126	138	1457	9	65.5	1.5	1.5	0	1
69	3	76026002-8	78097-10	66	138	128	1447	9	64	1.5	2.5	0	0
70	172	77 Comp. - 35	78100-35	62	130	142	1439	9	60.5	1	1.5	0	3

Table 10. (continue) Test 79005

Rank By Grain Prod.	Entry No.	*1 Pedigree	Source	% Stand	*2 Days To 50% Bloom	Plant Ht. cm	Grain Prod. k/ha	Grain Prod. k/ha/day	Test Wt. k/hl	Agronomic Plant	Agronomic Head	% Lod-ging	% Bird damage
71	44	76026052-6	78097-184	68	114	135	1423	10	68	1.5	2	0	0.5
72	132	77093-55-3	78099-242	66	110	128	1414	10	66.5	3	2	5	0
73.5	137	77093-56-3	78099-249	76	134	138	1408	9	65	1	1.5	0	0
73.5	142	77093-57-1	78099-254	70	138	142	1408	8	61.8	1	1	0	0
75	180	LOCAL	---	62	133	128	1392	9	----	1	2	0	1
76	164	77093-72-4	78099-332	66	134	112	1381	8	68	2	2	0	0
77	197	76026019-9	78101-116	44	120	98	1338	9	----	3	2	0	0
78	193	77 Comp. - 126	78100-126	64	142	132	1336	8	62	1.5	2	0	1.5
79	203	NES6983	78113-1095	46	140	160	1324	8	----	1	1	0	0
80	23	76026037-7	78097-116	78	134	135	1323	8	68	1	1.5	0	0
81	45	76026063-2	78097-197	50	103	125	1318	10	----	2.5	2	0	4
82	154	77093-64-3	78099-287	82	117	98	1298	9	69	3	2.5	5	0
83	119	77093-48-2	78099-207	58	116	118	1234	8	----	1.5	2	0	0.5
84	205	NES6986	78113-1098	58	134	155	1179	7	----	1.5	2.5	0	1
85	30	LOCAL	---	68	130	125	1163	7	63	1	2	0	0
86	87	76026070-2	78098-205	68	105	128	1156	9	68	2	2	0	1
87	162	77093-69-3	78099-313	52	142	72	1153	7	---	3	2	0	0
88	146	77093-58-2	78099-260	72	136	115	1149	7	57	2	2	0	0
89	48	76026063	78097-203	86	125	120	1117	7	66	2	1.5	0	0
90	100	77093-02-1	78099-6	78	135	125	1110	7	62.5	1.5	2	0	0
91	179	77 Comp. - 79	78100-79	74	138	122	1088	6	60.5	1.5	2	0	0
92	83	76026061-4	78098-177	78	134	142	1063	6	68	1.5	1.5	0	0
93	43	76026052-5	78097-183	76	133	145	1059	6	61	1	1.5	0	0
94	148	77093-59-1	78099-265	50	136	162	1046	6	---	1	2	0	0
95	118	77093-47-5	78099-204	68	128	112	1043	7	---	2.5	2	0	0

Table 10 . (continue) Test 79005

Rank By Grain Prod.	Entry No.	*1 Pedigree	Source	% Stand	*2 Days To 50% Bloom	Plant Ht. cm	Grain Prod. k/ha	Grain Prod. k/ha/day	Test Wt. k/hl	Agronomic Plant	Agronomic Head	% Lod-ging	% Bird damage
96	184	77 Comp. - 87	78100-87	84	132	118	1042	6	59	2.5	2	0	0
97	15	76026026-10	78097-72	48	139	150	1025	6	---	1	1.5	0	8.5
98	14	76026026-8	78097-70	82	139	170	991	6	---	1	1	0	1.5
99	36	76026047-[illegible]	78097-163	58	132	125	951	6	---	1.5	2	0	0.5
100	169	77 Comp. - 27	78100-27	50	130	122	945	6	---	1.5	2	0	0
101	27	76026041-1	78097-141	72	149	110	930	5	---	1.5	2.5	0	0
102	76	76026054-1	78098-144	76	144	135	898	5	63	1.5	2	0	0
103	74	76026053-1	78098-139	56	143	155	872	5	69	1.5	2	0	0
104	173	77 Comp. - 37	78100-37	88	131	120	846	5	---	1.5	2	0	0
105	28	76026041-2	78097-142	90	128	98	797	5	55	2	2.5	0	0
106	175	77 Comp. - 56	78100-56	72	146	148	725	4	---	1	2	0	0
107	186	77 Comp. -110	78100-110	64	140	90	674	4	---	2.5	3	0	0
108	99	76026075-6	78098-247	82	130	128	616	4	72.5	1.5	1.5	0	0
109	167	77 Comp. - 7	78100-7	68	142	112	531	3	---	2	1.5	0	0
110	194	77 Comp. -130	78100-130	78	152	118	520	3	---	2	2.5	0	0
	Average Of All Entries			60	129	134	1704	11	64.9	1.6	1.8	0.4	0.7
	Local Ck. Ave.			55	130	126	1943	12	62.9	1.1	2	0.4	1.1

Test Number 79006

Short Grain Yield Trial

End of Season Results:

This yield test of large headed "grain" type genotypes with short heights under 1 meter contained 42 entries. A description of this test, its purpose, seed sources, plot size and planned treatment during the cropping season is presented on page 27. These entries of short height were evaluated primarily for grain yield. The objective of this test was to identify short, high-yielding grain types that could be grown for grain in areas of large fields and harvested with a combine.

All data for this test are presented in Table 11. Even forage yields were taken in order to evaluate its production by these short genotypes.

Most of the entries possessed quite large grain-type heads.

Thirteen of these entries were very uniform in phenotype with large grain-type heads, sturdy stalks and good leaves with heights under 100 cm, excellent for mechanical harvesting with a combine. There had been interest expressed through the Ministry of Agriculture about the need for genotypes like these for the few areas of much flat land where big machinery could operate. About ½ kg of seed of each of these thirteen selected lines was prepared and delivered to the Ministry of Agriculture in November 1979. A copy of the release list of entries with their pedigrees and seed source is presented in Table 12.

Copies of this release list were submitted to the USAID Mission in Sana'a and to the Yemen Ministry of Agriculture along with the seed.

Table 11. Grain and Forage Yield and Other Agronomic Data From a Field Production Test (79006) of Short Height Grain Type Sorghum Experimental Genotypes at Sana'a, Yemen, in 1979.

Rank by Grain Yield	Entry No.	*1 Pedigree	Seed Source	Per-Cent Stand	*2 Days to 50% Bloom	Plant Ht. cm	Agronomic Rating Plant	Agronomic Rating Head	Grain Yield k/ha	Grain Yield k/ha/day	Test Weight k/hl	Forage Yield k/ha	Forage Yield k/ha/day	Forage Yield k/ha/cm ht	Grain to Forage Ratio
1	17	77 COMP-1	78100-1	5	120	85	2	1.3	6833	46	----	14,955	99.7	175.9	0.457
2	5	76026068-6	78098-188	51	103	100	1.7	1.7	6698	50	64.3	10,019	75.3	100.2	0.669
3	30	LOCAL	-----	32	113	122	1	2	5723	40	62.3	11,089	77.5	90.9	0.516
4	36	NES1570	78103-15(Y)	17	99	96	2.3	1.7	5512	43	----	10,598	82.2	110.4	0.520
5	23	77 COMP-39	78100-39	37	102	88	2	1	5369	41	69.7	3,587	27.2	40.8	1.497
6	39	IS410	78103-21(R)	34	114	75	2	1.3	5349	37	67.8	5,408	37.6	72.1	0.989
7	32	77 COMP-128	78100-128	49	118	124	1.3	1	4838	33	66.3	9,610	64.9	77.5	0.503
8	19	77 COMP-8	78100-8	38	113	77	2.3	1	4789	33	66.2	4,235	29.6	55.0	1.131
9	16	77093-76-6	78099-352	43	111	79	2.3	1	4742	34	70.3	3,438	24.4	43.5	1.379
10	2	76026032-2	78097-99	38	118	93	2	1	4583	31	66.2	6,253	42.2	67.2	0.733
11	35	NES1570	78103-15(W)	36	100	81	2	1	4521	35	69.2	4,989	38.4	61.6	0.906
12	26	77 COMP-60	78100-60	32	104	70	2	1.7	4429	33	69.5	4,450	33.2	63.6	0.995
13	42	LOCAL	-----	51	117	130	1	2	4321	29	65.	7,145	48.6	55.0	0.605
14	13	77093-08-8	78099-45	77	109	100	2	1	4282	31	68.8	4,863	35.0	48.6	0.881
15	20	77 COMP-20	78100-20	46	117	85	2	1	4265	29	69.3	5,154	41.9	72.4	0.693
16	38	IS410	78103-21(W)	29	102	82	2	1	4263	32	64.2	6,157	46.6	75.1	0.692
17	29	77 COMP-75	78100-75	50	110	68	2.2	1	4067	29	67.5	2,482	17.7	36.5	1.639
18	18	77 COMP-5	78100-5	20	110	77	2	1.2	4012	29	66.	7,381	52.7	95.9	0.544
19	10	76026074-11	78098-241	29	119	87	2	1.3	3957	27	69.2	7,635	51.2	87.8	0.518
20	37	NES1789	78103-17	54	101	107	2	1.5	3953	30	64.5	4,745	36.2	44.3	0.833
21	8	76026074-8	78098-238	68	125	108	1.7	1	3935	25	66.7	8,263	53.3	76.5	0.476
22	27	77 COMP-72	78100-72	55	120	93	1.3	1	3889	26	65.2	6,186	41.2	66.5	0.629
23	1	76026004-4	78097-24	73	112	77	2	1.3	3724	26	69.2	3,456	24.3	44.9	1.078
24	34	NES1559	78103-14	23	102	82	2.2	1.7	3532	27	59.	6,387	48.4	77.9	0.553
25	14	77093-22-2	78099-92	45	110	87	2	1	3482	25	68.8	4,269	30.5	49.1	0.816

Table 11. . (Continued) Grain and Forage Yield and Other Agronomic Data From a Field Production Test (79006) of Short Height Grain Type Sorghum Experimental Genotypes at Sana'a, Yemen, in 1979.

Rank by Grain Yield	Entry No.	*1 Pedigree	Seed Source	Per-Cent Stand	*2 Days to 50% Bloom	Plant Ht. cm	Agronomic Rating Plant	Agronomic Rating Head	Grain Yield k/ha	Grain Yield k/ha/day	Test Weight k/hl	Forage Yield k/ha	Forage Yield k/ha/day	Forage Yield k/ha/cm ht	Grain to Forage Ratio
26	7	76026070-5	78098-208	53	120	82	2	1.3	3478	23	60	6,061	40.4	73.9	0.574
27	15	77093-33-5	78099-148	71	134	101	1.7	1	3414	21	60.2	6,675	40.7	66.1	0.511
28	22	77 COMP-31	78100-31	39	94	69	2	1.5	3372	27	67.8	6,343	51.2	91.9	0.532
29	40	IS2927	78103-23	43	93	85	2.7	1.3	3289	27	63	2,589	21.0	30.5	1.270
30	21	77 COMP-21	78100-21	70	105	87	2	2	3276	24	71.7	4,609	34.1	53.0	0.711
31	24	77 COMP-46	78100-46	53	107	80	2	1.3	3275	24	64.8	5,104	37.3	63.8	0.642
32	41	CIMMYT76BJ197	78113-1082	27	96	80	2.7	2	3220	26	----	3,808	30.2	47.6	0.846
33	3	76026039-3	78097-129	35	125	112	1.3	1	3170	20	66	7,497	48.4	66.9	0.423
34	28	77 COMP-73	78100-73	19	121	82	2	1	3132	21	----	7,465	49.4	91.0	0.420
35	6	76026068-12	78098-194	[illegible]	123	100	2	1.7	2930	19	65.7	5,733	37.5	57.3	0.511
36	33	NES1421	78103-13	67	104	83	2.3	2	2821	21	63.2	3,829	28.6	46.1	0.737
37	25	77 COMP-58	78100-58	65	124	87	2	1	2708	18	62.5	5,593	36.3	64.3	0.484
38	4	76026061-1	78098-174	70	104	82	2.3	2	2661	20	71.8	3,335	24.9	40.7	0.798
39	11	77093-03-5	78099-15	41	100	73	2	2	2542	20	67.5	3,051	23.5	41.8	0.833
40	9	76026074-10	78098-240	69	137	105	1.7	1	1988	12	69	9,249	55.4	88.1	0.215
41	31	77 COMP-92	78100-92	55	95	65	2.7	2	1874	15	----	3,838	30.7	59.0	0.488
42	12	77093-05-4	78099-27	73	97	98	2	1.3	1584	12	65.5	3,808	30.0	38.9	0.416
Average of all entries:				46	108	89	1.97	1.36	3900	28	66.3	6,008	42.4	66.9	0.730
Local check average:				41.5	115	126	1	2	5022	34	63.6	9,117	63.0	73.0	0.560

*1 - Plot size: Two rows (.75 m between rows) x 6 m long, 25 hills per row spaced 25 hills per row spaced 25 cm apart, replicated three times.

*2 - Planted in moisture: Rep. I on 29 April, Rep. II on 2 May and Rep. III on 12 May.

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NO. 85-86

Table 13 . Agronomic Field Forage Production Data From Six Sorghum x Sudangrass Hybrids Grown and Harvested in Multiple Harvests in 1979 (Test 79007). Sana'a, Yemen.

				First Harvest			Second Harvest		
Entry No.	*1 Entry Name	Seed Source	Per Cent Stand	Plant Ht cm	*2 Days to Harvest	*3 Forage Dry Matter Yield kg/ha	Plant Ht cm	*2 Days to Harvest	*3 Forage Dry Matter Yield kg/ha
1	Acco Paymaster Sweet Sioux IV	Univ. of Arizona	74	98	73	1784	112	31	2842
2	Taylor-Evans Haygrazer	Univ. of Arizona	84	106	73	1947	112	31	2836
3	Asgrow Grazer A-2	Univ. of Arizona	88	109	80	2148	104	28	2444
4	Texas Triumph Sooner Sue	Univ. of Arizona	86	104	73	1931	104	31	2483
5	DeKalb ST-6	Univ. of Arizona	82	111	68	1092	89	21	982
6	WAC Hi Ton	Univ. of Arizona	78	84	80	1147	76	24	1084

	Third Harvest			Fourth Harvest			Total Seasonal Production Data				
Entry No.	Plant Ht cm	*2 Days to Harvest	*3 Forage Dry Matter Yield kg/ha	Plant Ht cm	*2 Days to Harvest	*3 Forage Dry Matter Yield kg/ha	*3 Total Forage Dry Matter Yield kg/ha	Total Days of Growth	Forage Dry Matter Yield kg/day Growth	Total Seasonal Plant Ht in cm	Forage Dry Matter Yield per cm Height
1	111	68	3428				10,884	172	63	321	34
2	106	68	3864				10,294	172	60	324	32
3	88	64	3481				9,174	172	53	301	30
4	102	68	3320				8,993	172	52	310	29
5	105	28	2050	88	55	2271	7,799	172	45	393	20
6	70	68	2758				6,396	172	37	230	28

*1 - Plot size: 4 rows (.75 m) x 6 m with 25 hills per row spaced 25 cm apart, replicated 4 times, center two rows harvested for yield.
*2 - Planted in moisture on 24 May 1979.
*3 - Forage dry matter yields adjusted to 100% stand values

Test Number 79008

Forage Sorghum Grain and Forage Test

This test was to compare five commercial United States type sorghums with a local variety for a single harvest production of grain and air-dried forage. A description of this test, its purpose, seed sources, plot size and planned treatment during the cropping season is presented on page 29.

All agronomic field data are presented in Table 14. The local check variety outyielded all other entries in both grain and forage. All of the other entries are hybrids.

These data from this particular experiment certainly indicate that these particular introduced forage sorghum hybrids are inferior to local varieties in the higher elevation environments of Yemen. These particular U.S. hybrids are quite competitive in the U.S. and other parts of the world. These 5 hybrids were selected for this test partly because of their broad range of maturities when grown other places in the world. They all had a quite uniform early maturity here in Yemen and were much earlier than the local type. This early maturity response was most likely the main reason for the poor yield responses.

The heights of the U.S. forage sorghum hybrids were also shorter than the local check variety. This short height response also resulted in decreased forage yield.

A short day response of the 5 U.S. hybrids probably caused the early maturities and short height.

Table 14. Field Forage and Grain Yield and Other Agronomic Production Data From Six Forage Type Sorghums Grown in 1979 (Test 79008). Sana'a, Yemen.

*1 Entry	Per Cent Stand	*2 Days to 50% Bloom	Plant Ht cm	Agronomic Rating		*3 Grain Yield		Grain Bird Damage %	Grain Test Weight kg/hl	Forage Dry Matter Yield		Production Ranks		
				Plant	Head	kg/ha	kg/ha/day			kg/ha	kg/ha/cm ht	Grain	Forage	Ave
Local Check Var.	42	108	140	1	2	4542	32.9	1	61	9541	68.2	1	1	1
ACCO FS 456	61	86	121	2.25	2	3010	26.0	14	67	6503	53.7	4	2	3
ACCO FS 251	58	82	90	3	1.75	4130	36.9	16	70	3931	43.7	2	5	3.5
ACCO FS 451	54	86	100	3	2	2490	21.5	6	68	6058	60.[illegible]	5	3	4
ACCO FS 351	60	84	86	3	2	3790	33.2	8	69	3842	44.7	3	6	4.5
DeKalb FS 1a	66	81	91	3	2	1933	17.4	16	68	5116	56.2	6	4	5

*1 - Plot size = 4 rows (.75m) x 6m with 25 hills per row spaced 25 cm apart, replicated 4 times.

*2 - Planted in moisture: Rep. I - May 2, Rep. II & III - May 12, Rep. IV on May 20.

*3 - Grain yields presented here have been corrected for bird damage. Lodging was zero for all entries.

Test Number 79009

Sorghum X Sudangrass Hybrids and
Forage Sorghum Hybrid Demonstration Test

End of Season Results:

This test contained a total of 53 entries of which 50 were commercial-type hybrids and three were of a local check. These check plots were adapted phenotypic standards against which the agronomic performance of the experimental entries could be compared. A description of this test, its purpose, seed sources, plot size and treatment during the season is given on page 30.

This test was originally scheduled to be grown under a limited moisture (irrigation) regime. However, it was planted in an area (Field C) which needed to obtain more optimum moisture. Field C had also previously been in alfalfa so it had an extremely high level of fertility. The original plans did not call for grain or forage harvest but labor was available to make a grain yield harvest of the single unreplicated plots. Unreplicated data is very tentative. Most of the entries yielded less grain than the local check variety. The heights of the hybrid varied above and below the local check. Most of the hybrids responded with an earlier maturity than the local check which tends toward lower yields of either grain or forage. The dark-seeded hybrids had practically no bird damage compared to the white-seeded local check.

The data from this test are presented in Table 15.

Table 15. Agronomic Field Performance Characteristics of U.S. Type Forage and Sorghum x Sudangrass Hybrids in Unreplicated Field Plots in 1979 (Test 79009). Sana'a, Yemen.

Entry and Table No.	*1 Pedigree	Source of Seed	*2 Plant Type in U.S.	*2 Plant Type in Yemen	Per Cent Stand	*3 Days to 50% Bloom	Plant Ht cm	Per Cent Bird Damage	Per Cent Lodging	*4 Grain Yield kg/ha	*5 Percent of Test Maximum Yield	Grain Test Weight kg/hl
1	Local Variety	Local	---	FS	78	94	180	15	20	6,790	39	64
2	Acco Paymaster-Sweet Sioux IV	UofAZ	SXS	SXS	86	92	220	0	0	6,218	36	63
3	Asgrow-Grazer AZ	UofAZ	SXS	SXS	78	97	230	0	0	6,653	38	64
4	Asgrow-Grazer N-Z	UofAZ	SXS	SXS	66	96	230	0	0	8,598	50	64.5
5	Dekalb-ST 6	UofAZ	SXS	SXS	44	85	230	0	0	8,214	47	63.5
6	Dekalb SX 7+	UofAZ	SXS	SXS	56	95	220	0	0	11,069	64	65
7	Dekalb SX 17	UofAZ	SXS	SXS	64	93	205	1	0	6,223	36	68.5
8	Dekalb SX 162	UofAZ	SXS	SXS	80	102	180	0	0	6,440	37	61
9	PAG - [illegible]one	UofAZ	SXS	FS	60	98	135	0	0	5,430	31	70
10	Tayl[illegible] Haygrazer	UofAZ	SXS	SXS	72	94	205	0	0	6,060	35	62
11	Texa[illegible] - Sooner Sue	UofAZ	SXS	SXS	44	102	205	0	0	8,798	51	64
12	Texa[illegible] - Sooner Sweet	UofAZ	SXS	SXS	36	96	220	5	0	11,375	66	62
13	WAC-HI-TON	UofAZ	SXS	FS	40	106	140	5	0	5,752	33	70
14	WAC-LIC-UM	UofAZ	SXS	SXS	36	96	210	0	0	12,512	72	63
15	WAC-SIL-UM	UofAZ	SXS	SXS	12	99	225	1	0	2,246	13	64
16	Acco Paymaster S99	UofAZ	Unknown	SXS	34	103	220	4	0	16,760	97	67
17	Conlee Domor	UofAZ	Unknown	SXS	34	86	225	2	0	8,260	48	65
18	Conlee Cow Vittles	UofAZ	Unknown	G	76	67	125	0	0	8,224	47	73
19	Conlee-Morgain	UofAZ	Unknown	SXS	72	90	190	0	0	6,952	40	66
20	Conlee-Morgain III	UofAZ	Unknown	SXS	40	95	210	0	0	8,786	51	65
21	Funks-G 103S	UofAZ	Unknown	G	36	78	115	1	0	12,712	73	71.5
22	Funks FP-1	UofAZ	Unknown	SXS	52	104	225	0	0	7,284	42	64
23	PAG 35	UofAZ	Unknown	SXS	30	104	225	0	0	14,429	83	65
24	PAG 33	UofAZ	Unknown	SXS	34	106	235	1	0	13,713	79	66
25	Pioneer 944	UofAZ	Unknown	---	40	---	---	0	0	208	1.2	--
26	Local Check	---	---	FS	20	107	195	30	2	10,104	58	64
27	Pioneer 931	UofAZ	Unknown	SXS	60	72	210	0	0	12,174	70	64.5
28	Pioneer 988	UofAZ	Unknown	SXS	60	93	220	4	0	1,297	7.5	62
29	Taylor-Evans Goldmaker	UofAZ	Unknown	FS	68	104	175	6	0	11,292	65	70
30	WAC Hi Energy	UofAZ	Unknown	FS	68	71	135	0	0	10,028	58	72.5

Table 15. (Continued) Test 79009

Entry and Table No.	*1 Pedigree	Source of Seed	*2 Plant Type in U.S.	*2 Plant Type in Yemen	Per Cent Stand	*3 Days to 50% Bloom	Plant Ht cm	Per Cent Bird Damage	Per Cent Lodging	*4 Grain Yield kg/ha	*5 Percent of Test Maximum Yield	Grain Test Weight kg/hl
31	Acco Paymaster FS-251	UofAZ	Forage Sorghum	G	56	73	105	0	0	9,040	52	73
32	Acco Paymaster FS-351	UofAZ	Forage Sorghum	G	74	71	100	0	0	10,605	61	72
33	Acco Paymaster FS-451	UofAZ	Forage Sorghum	G	72	73	120	3	0	3,389	20	66.5
34	Acco Paymaster FS-461	UofAZ	Forage Sorghum	G-FS	72	72	125	0	0	4,999	29	70
35	Acco Paymaster FS-531	UofAZ	Forage Sorghum	FS	42	79	150	0	0	8,487	49	57
36	Asgrow Titan E	UofAZ	Forage Sorghum	FS	34	93	130	1	0	7,014	40	67.5
37	Asgrow Titan M	UofAZ	Forage Sorghum	G	72	67	120	10	0	5,622	32	71.5
38	Asgrow Beef Builder T	UofAZ	Forage Sorghum	G	44	74	145	6	0	7,184	41	71.5
39	Dekalb FS 1a	UofAZ	Forage Sorghum	G	46	72	100	15	0	10,992	63	70.5
40	Dekalb FS 4	UofAZ	Forage Sorghum	FS	46	95	150	1	0	10,046	58	68
41	Dekalb FS 24+	UofAZ	Forage Sorghum	G	40	86	110	0	0	12,094	70	67.5
42	Dekalb FS 25a+	UofAZ	Forage Sorghum	FS	40	81	145	0	0	13,664	79	71
43	Funks G-83F	UofAZ	Forage Sorghum	SXS	44	105	210	0	1	7,704	44	64
44	Funks G-88F	UofAZ	Forage Sorghum	SXS	50	88	215	1	0	4,964	29	60
45	Funks G-99F	UofAZ	Forage Sorghum	FS	30	117	145	4	0	1,506	8.7	---
46	Funks 102F	UofAZ	Forage Sorghum	G	22	74	130	1	0	17,343	100	71
47	Taylor Evans Milk Maker	UofAZ	Forage Sorghum	G-F	38	71	150	4	0	13,093	75	71.5
48	Taylor Evans Silo Maker	UofAZ	Forage Sorghum	G	50	71	110	3	0	12,181	70	72
49	Taylor Evans Yield Maker	UofAZ	Forage Sorghum	G-F	36	72	145	10	0	9,927	57	71
50	Texas Triumph-BET-R-SIZE	UofAZ	Forage Sorghum	G	30	72	140	75	0	8,938	52	62.5
51	Texas Triumph SS-II	UofAZ	Forage Sorghum	SXS	14	100	220	18	0	9,580	55	60
52	WAC X 7811	UofAZ	Forage Sorghum	G	40	103	105	60	0	9,573	55	68.5
53	Local Check	---	---	FS	24	99	205	98	8	11,905	69	60.5

*1 - Plot size: 2 rows (.75 m) x 6 m with 25 hills per row spaced 25 cm apart
*2 - SXS = Sorghum X Sudangrass (hybrid), FS = Forage Sorghum phenotype, G = Grain phenotype, G-FS = Dual Purpose
*3 - Planted in moisture on 26 May 1979
*4 - Grain yields are from unreplicated single plots and have been corrected for plot stand and bird damage
*5 - Grain yield of each entry expressed in percent of highest yielding test entry

Test Number 79010

Nursery and Line Increase

End of Season Results:

This nursery test contained a number of genotypes for crossing and for seed increase and purification. A description of this test, its purpose, seed sources, plot size and detailed treatment plans for the 1979 season are given on page 31. The purpose of this test varied according to the groups of entries.

Seed was increased of the superior genotypes planted in the nursery. The purpose of this purified increased supply of seed was to plant in Outreach tests in 1980.

Entry pedigrees and treatments are presented in Table 16.

Experimental hybridizations (F_1 hybrid crosses) were made of many of the superior genotypes onto the CK 60 A and CK 60 A X Hydrokafir A lines for hybrid evaluations in 1980.

The detailed data of just what experimental hybridizations were made are not available during the writing of this report. These data are in the field books at the project offices in Sana'a.

Table 16 . Genotypes Grown in the Nursery and Line Increase Test (79010) at Sana'a, Yemen Arab Republic. 1979.

Entry and Table No.	*1 Pedigree	Source	Purpose
1	CK60A	Univ of AZ	Female for entries 2 & 5
2	Hydrokafir	Univ of AZ	Male for entries 1, 3 & 4
3	(CK60A X Hydrokafir) X Hydrokafir	Univ of AZ	Female for entries 2 & 5 and other Yemen types
4	CK60A X Hydrokafir	Univ of AZ	Female for entries 2 & 5
5	Hydrokafir	Univ of AZ	Male for entries 1, 3 & 4
6	Sana'a - 1		Self for seed increase
7	Sana'a - 2		Self for seed increase
8	Sana'a - 3		Self for seed increase
9	Sana'a - 4		Self for seed increase
10	Sana'a - 5		Self for seed increase
11	Sana'a - 6		Self for seed increase
12	Sana'a - 7		Self for seed increase
13	Sana'a - 9	78102-123	Self for seed increase
14	Sana'a - 10	78102-121	Self for seed increase
15	Radah Local	78101-130	Self for seed increase
16	Sana'a - 1		Self for seed increase
17	Sana'a - 2		Self for seed increase
18	Sana'a - 3		Self for seed increase
19	Sana'a - 4		Self for seed increase
20	Sana'a - 5		Self for seed increase
21	Sana'a - 6		Self for seed increase
22	Sana'a - 7		Self for seed increase
23	Sana'a - 9	78102-123	Self for seed increase
24	Sana'a - 10	78102-121	Self for seed increase
25	Radah Local	78101-130	Self for seed increase
26	CK60A	Univ of AZ	Female for experimental crosses
27	76026004-4	78097-24	Self for seed increase
28	76026032-2	78097-99	Self for seed increase
29	76026039-3	78097-129	Self for seed increase
30	76026061-1	78098-174	Self for seed increase
31	76026068-6	78098-188	Self for seed increase
32	76026068-12	78098-194	Self for seed increase
33	76026070-5	78098-208	Self for seed increase
34	76026074-8	78098-238	Self for seed increase
35	76026074-10	78098-240	Self for seed increase

Table 16. (Continued) Test 79010

Entry and Table No.	*1 Pedigree	Source	Purpose
36	76026074-11	78098-241	Self for seed increase
37	77093-03-5	78099-15	Self for seed increase
38	77093-05-4	78099-27	Self for seed increase
39	77093-08-8	78099-45	Self for seed increase
40	77093-22-2	78099-92	Self for seed increase
41	77093-33-5	78099-148	Self for seed increase
42	77093-76-6	78099-352	Self for seed increase
43	77 Comp. -1	78100-1	Self for seed increase
44	77 Comp. -5	78100-5	Self for seed increase
45	77 Comp. -8	78100-8	Self for seed increase
46	77 Comp. -20	78100-20	Self for seed increase
47	CK60A	Univ of AZ	Female for experimental crosses
48	77 Comp. -21	78100-21	Self for seed increase
49	77 Comp. -31	78100-31	Self for seed increase
50	77 Comp. -39	78100-39	Self for seed increase
51	77 Comp. -46	78100-46	Self for seed increase
52	77 Comp. -58	78100-58	Self for seed increase
53	77 Comp. -60	78100-60	Self for seed increase
54	77 Comp. -72	78100-72	Self for seed increase
55	77 Comp. -73	78100-73	Self for seed increase
56	77 Comp. -75	78100-75	Self for seed increase
57	77 Comp. -92	78100-92	Self for seed increase
58	77 Comp. -128	78100-128	Self for seed increase
59	NES1421	78103-13	Self for seed increase
60	NES1559	78103-14	Self for seed increase
61	NES1570	78103-15(W)	Self for seed increase
61	NES1570	78103-15(Y)	Self for seed increase
63	NES1789	78103-17	Self for seed increase
64	IS 410	78103-21(W)	Self for seed increase
65	IS 410	78103-21(R)	Self for seed increase
66	IS2927	78103-23	Self for seed increase
67	CIMMYT76BJ197	78113-1082	Self for seed increase
68	CK60A	Univ of AZ	Female for experimental crosses

*1 - Plot size: 2 rows (.75m) x 6 m with 25 hills per row spaced 25 cm apart. Unreplicated. Planted in moisture on 26 May 1979.

Test Number 79011

Head Smut Control Test

End of Season Results:

A description of this test, its purpose, treatments, plot size and execution plans that were the responsibility of this project are presented on page 32. This test was located in the southwest corner of Field D. This location was actually the extreme southwest corner of the whole Agricultural Research Station and is the downwind corner for the prevailing northeast winds. The purpose was to cause the least drift of chemicals or disease inoculum over the rest of the research tests.

The responsibility of this project was to design, plant and grow a sorghum test. Dr. Gossert, Plant Pathologist of the German Farm, would be responsible for furnishing the seed, applying all treatments and collecting and interpreting all data. This was to be a joint project between two agencies working for the common good of Yemen. Operating fund difficulties on the part of the American half of the team caused the loss of this test, among others, during the growing season. This problem is explained on page 5 .

This test was lost and absolutely no research results were obtained. This situation was very embarrassing to the project personnel and put the American effort in Yemen in a poor light from the German point of view. This project was powerless to control the situation.

Test Number 79012

Sesamia (Stem Borer) Control

End of Season Results:

This test was a joint effort between this project and the German farm at Sana'a. Dr. Deckert, Entomologist, and Dr. Pollen, Seed Storage expert, were the professionals involved from the German Farm. A description of this test, its purpose, plot size, treatments and divisions of responsibilities between this project and the German Farm are presented on page 33. This test was located in the southwest corner of Field D which is the southwest corner of the whole Agricultural Research Station and is the downwind corner for the prevailing northeast winds. The purpose of this location was to cause the least drift of chemicals over the rest of the research tests.

The responsibility of this project was to design, plant and properly grow the sorghum plots. The German Farm Professionals were responsible for furnishing the seed, applying all treatments to the sorghum plants, and collecting and interpreting all treatment response data.

This test was lost and no research data obtained due to lack of USAID mission operating funds to maintain the irrigation well during the growing season. The project was able to preirrigate, plant and obtain an initial test plot stand but lost everything after that. This problem is explained on page 5 . This situation was very embarrassing to the American project personnel and put the American effort in Yemen in a poor light from the German point of view.

Test Number 79013

National Cooperative Sorghum Yield Test

End of Season Results:

The entries for this particular type of test are solicited annually by the Yemen Ministry of Agriculture from various donor agencies operating in Yemen. Seed of each experimental sorghum genotype contributed by the various donor agencies is then divided up and distributed among all donor agencies cooperating. When each donor agency grows out and evaluates each experimental genotype in their yield testing program, a good evaluation of the adaptation potential of each genotype is quickly obtained. Such a program contributes to coordination among donor agencies and the quick recognition of a new, good genotype of value to Yemen.

The Yemen Ministry of Agriculture made no apparent effort to continue this cooperative program among donor agencies. No seeds were solicited or distributed.

Test Number 79014

National Cooperative Sorghum Observation Nursery

End of Season Results:

A description of this test as to purpose, entries, plot size and treatment, and data to be obtained are presented on page 35. The data obtained at the end of the season are presented in Table 17 on page 100.

This test is totally observational with no yield aspect. The agronomic ratings given for plant and head are quite good measurements of adaptation for the Sana'a location. Entries 3, 4, 5, 8, 10, 11, 15, 17 and 18 all appear to be quite well adapted to Sana'a. Entries 2 and 16 did not develop a good stand in this environment for some reason, nor did they have very good phenotypes. The remaining entries all had poor plant or head phenotypes. A number of the maturities were somewhat on the late side relative to local adapted (accepted) types. This would have to be considered in any recommendations. Plant height of all entries was reasonable and relative to local types. Lodging was not excessive in most entries. Entry 10 did indicate a tendency to lodge and should be evaluated for this another year.

In conclusion, there seemed to be a number of diverse genotypes from other donor agencies represented in this test which show potential for use in this local environment.

Table 17. Unreplicated Agronomic Data From National Cooperative Sorghum Observation Nursery (79014) at Sana'a, Yemen, 1979.

Entry No.	*1 Pedigree	Seed Source	Percent Stand	*2 Days to 50% Bloom	Plant Ht cm	Agronomic Rating Plant	Agronomic Rating Head	Percent Lodging
1	Awash 1050	UNDP	74	148	115	3	3	-
2	WS. 1297		28	151	115	3	3	-
3	Sana'a 1	USAID	72	104	190	1	1	10
4	Sana'a 2	USAID	70	104	135	2	1	5
5	Sana'a 3	USAID	78	102	140	1	1	-
6	Sana'a 4	78102-116	64	106	130	2	2	10
7	Sana'a 5	USAID	70	103	140	2	2	-
8	Sana'a 9	USAID	74	105	135	2	1	-
9	Sana'a 10	USAID	76	94	110	3	2	-
10	El Sakel		88	132	180	1	2	20
11	El Khafeep		94	131	185	1	1	10
12	Al Bdun Baida		90	101	125	2	3	10
13	Tenee		68	152	195	1	3	-
14	Harathi		64	142	170	1	3	5
15	Sofera Garra		36	128	220	1	1	5
16	Hamara Jahram		6	102	145	2	2	-
17	Local Check	USAID	34	99	140	1	1	15
18	Local Check	USAID	46	98	145	1	1	15

*1 - Plot Size: 2 rows (.75 m) x 6 m with 25 hills per row spaced 25 cm apart. Unreplicated design.

*2 - Planted in moisture on 24 May 1979.

Test Number 79015

National Cooperative Maize Yield Test

End of Season Results:

A description of this test as to purpose, entries and sources, plot size and treatment, and data to be obtained are presented on page 36. The data obtained at the end of the season have been tabulated and are presented in Table 18 on page 102.

All other entries in the test outyielded to local check. However, all other maturities were much later than the local check, which is not good in a situation of moisture stress. Rapid growth and maturity would be more desirable. Irrigation water was applied as needed in this test. The late maturing genotypes could also be damaged by early frosts in this environment.

This maize test should not be compared directly with other sorghum tests in this report regarding grain yield. The maize received irrigation water when needed for optimum growth whereas the sorghum tests did not. Many of the experimental entries are likely to be hybrids while the local check is a variety. Thus the hybrid experimental types should yield more than non-hybrids.

Table 18 . Grain Yield and Other Agronomic Data from National Cooperative Maize Yield Trial (79015) at Sana'a, Yemen Arab Republic. 1979.

Rank and Table No.	Entry No.	*1 Entry	Origin	Grain Yield k/ha	Per Cent Stand	*2 Days to 50% Bloom	Plant Ht cm	Ear Ht cm	Days to Mature
1	1	Obregon 7442	CIMMYT	5678	79	102	174	69	165
2	5	Rampur	Nepal	5260	86	103	186	86	165
3	7	Tihama 1	Tihama	4358	70	104	185	80	172
4	6	Vijay	India	4257	82	103	185	79	168
5	4	Khumalter	Nepal	4057	90	98	147	63	162
6	2	VL 43	India	3886	76	106	188	90	179
7	8	Tihama 2	Tihama	2676	92	105	191	90	176
8	3	Comp W	Ghana	2422	90	113	187	94	183
9	9	Local Check	USAID	1956	84	70	101	80	120

*1 - Plot size: 3 rows (.75 m between rows) x 6 m long, 21 hills per row spaced 30 cm apart, replicated 3 times.

*2 - Planted in moisture on 24 May 1979.

Test Number 7901E

National Cooperative Maize Observation Nursery

End of Season Results:

A description of this test as to purpose, entries and seed sources, plot size and treatment, and data to be obtained are presented on page 37. The data obtained by the end of the season have been tabulated and are presented in Table 19 on page 104. The original plans indicated there would be eighteen entries in this test but seed of only fourteen entries were finally actually received and planted.

The local check was the lowest yielding entry in unreplicated grain yields in the test. The local entry was also the earliest in maturity. All experimental entries yielded more but took longer to produce this yield, used more irrigation water and risked loss from an early frost. It does seem likely that there are other maize genotypes adapted to this environment with higher yields than the local variety. An unknown number of these entries were hybrids while the local check was only a variety. The hybrids should yield more.

There was no lodging in this test.

Table 19. Grain Yield and Other Agronomic Data from an Unreplicated National Cooperative Maize Nursery Test (79016) at Sana'a, Yemen Arab Republic. 1979.

Rank and Table No.	Entry No.	*1 Entry	Source	Grain Yield kg/ha	Per Cent Stand	*2 Days to 50% Bloom	Plant Ht cm	Ear Ht cm	Days to Mature
1	10	Batna - 1	YCAP	6906	86	80	157	43	144
2	8	Comp-A53-54	ARS	6617	95	91	177	65	169
3	7	Obregon 7542	ARS	6488	86	99	197	92	170
4	3	Amarilos	ARS	6200	90	95	208	98	172
5	11	Batna - 2	YCAP	6167	86	76	126	46	139
6	9	Across	ARS	6033	95	94	188	68	170
7	2	Obregon	ARS	5500	100	97	184	73	172
8	13	Fongsou,105	YCAP	5446	81	85	141	42	136
9	1	ZCA Comp	ARS	4923	100	103	213	103	173
10	5	Sids	ARS	4776	95	102	163	68	173
11	12	Jeminby	YCAP	4282	100	93	158	51	159
12	4	Tlatizan	ARS	4204	100	102	176	70	173
13	6	SYN551	ARS	3577	95	104	210	112	190
14	14	Local Check	USAID	2546	76	66	102	31	119

*1 - Plot Size: 3 rows (.75 m between rows) x 6 m long, 21 hills per row spaced 30 cm apart, unreplicated.

*2 - Planted in moisture on 24 May 1979.

Test Number 79017

National Cooperative Pearl Millet Yield Test

End of Season Results:

A description of this test as to purpose, entries, seed sources, plot size, plot treatment, and data to be obtained are presented on page 38. The data obtained by the end of the season have been tabulated and are presented in Table 20 on page 106.

The local millet yielded less than all of the other 5 entries in the test. The local millet yielded only 59% of the highest yielding entry. The 3 top-yielding entries appear to be composites judging by their names. A mix of genotypes would tend to give a broader adaptation potential. All entries had almost identical bloom dates thus these new genotypes should fit readily into the growing season at Sana'a. The plant heights of the experimental genotypes all exceeded the height of the local variety indicating greater forage yield potential.

The grain yields of even the best millet entries in this test which was irrigated for optimum growth and yield were significantly less than most grain sorghum yields in other tests that were grown under limited moisture conditions. This again illustrates that millets are not well adapted at this elevation and would give poor returns in grain and forage for production resources invested compared to sorghum.

Table 20. Grain Yield and Other Agronomic Data From National Cooperative Pearl Millet Yield Trial (79017) at Sana'a, Yemen. 1979.

Entry and Table No.	*1 Pedigree	Seed Source	Per Cent Stand	*2 Days to 50% Bloom	Plant Ht cm	Total No. of Heads	*3 Grain Yield kg/ha
1	Nigeria Comp	ARS	58	153	210	164	3993
2	Serere Comp	ARS	51	154	190	161	3814
3	World Comp	ARS	54	155	202	152	2974
4	Exbornue	ARS	56	148	210	196	2693
5	D. Tihama	T.D.A.	69	155	199	171	2452
6	Local	USAID	50	154	176	268	2372

*1 - Plot Size: 4 rows (.75 m between rows) x 6 m long, with 31 hills/row spaced 20 cm apart, replicated 4 times.

*2 - Planted in moisture on 28 May 1979.

*3 - Center 2 rows harvested for yield.

Test Number 79018

National Cooperative Pearl Millet Observation Test

End of Season Results:

The entries for this particular test are solicited annually by the Yemen Ministry of Agriculture from the various donor agencies operating in Yemen. The Yemen Ministry of Agriculture made no apparent effort to continue this cooperative program among donor agencies in 1979. No seeds were solicited or distributed.

Outreach Trials - 1979

End of Season Results:

A detailed description of plans for on-farm tests of superior genotypes from the project research program is presented on page 40. Many of the planned tests could not be planted due to a shortage of vehicle and manpower resources. Vehicles and project personnel were diverted by the Mission to work on the development of the Al Jarabah Experiment Farm as explained on page 5 . Three on-farm tests were actually harvested. These harvest data were not forwarded to the University of Arizona in 1980 by project personnel. No field book or data were to be found in the project offices in the fall of 1980 to be written up in this report.

It was observed in the 1979 outreach tests that there were large, easily recognized, phenotypic differences in both grain and forage potential among genotypes among locations. By making evaluations through observations more and faster progress could be made in outreach tests by using smaller plots, no more than two replications, more entries per location (perhaps 20 or 30), and not measure actual yield at first. After two years of outreach trial experience this project found (1) that precise research data is nearly impossible to obtain on farms, (2) that visual observations can provide reliable estimates of adaptation, and (3) that many more genotypes can be evaluated across more locations for much faster and cheaper progress. An experienced sorghum breeder with experience in Yemen can observe and evaluate the entries at a location in an hour or so. Yield trials of entries observed to be highly adapted could be made in future years to provide actual yield data over the local types. These yield trials would be very expensive in that very close supervision would have to be given to them. Most adaptation evaluations of

superior genotypes from the Sana'a Experiment Farm among the various outreach environments can be done initially with observation plots for a small fraction of the cost of yield trials.

This streamlined plan was suggested for 1980 and was put into use.

Rainfall Record For Period of May 1978 to May 1979 at Sana'a

An official weather station rain gauge was installed on the roof of Dr. Voigt's house. The residence of the Chief-of-Party and Plant Breeder was located about 1 km from the Mission and about 2 km from the Sana'a Experiment Farm. No other weather data was being collected near the research farm. Figure 6 on page 111 shows the total rainfall of 4.085 inches (10.38 cm) that was received during the period of 6 May 1978 through 5 May 1979 and its distribution. Eighty-one percent of this rain fell within one 21-day period in July 1978. This illustrates how extremely dry the Sana'a location is most of the time.

Figure 6.

PRECIPITATION RECORD FOR USE WITH YOUR
Taylor 11" CLEAR-VU RAIN GAGE

LOCATION LE 282 - 006 . SANAA - YEMEN, A.R.

COUNTY (VOIGT - HILTON) **STATE**

TIME OF OBSERVATION 6 MAY 1978 THROUGH 5 MAY 1979 **YEAR**

INCHES PRECIP.

1979 → | 1978 →

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
1	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	↑	0	0	0	0	0	
10	0	0	0	0	0	0	.66	.15	0	0	0	0	
11	0	0	0	0	0	0	.26	0	0	0	0	0	
12	0	0	0	0	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	.06	0	0	0	0	↕ .12	
14	0	0	0	0	0	0	0	0	0	0	.28		
15	.18	0	0	0	0	0	.32	0	0	0	0	0	
16	0	0	0	0	0	0	.08	0	0	0	.035	0	
17	0	0	0	0	0	0	.02	0	0	0	0	0	
18	0	0	0	0	0	0	.07	0	0	0	0	0	
19	0	0	0	0	0	0	.16	0	0	0	0	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	
21	0	0	0	0	0	0	.01	0	0	0	0	0	
22	0	0	0	0	0	0	1.27	0	0	0	0	0	
23	0	0	0	0	0	0	.20	0	0	0	0	0	
24	0	0	0	0	0	0	0	0	0	0	0	0	
25	0	0	0	0	0	0	.06	0	0	0	0	0	
26	0	0	0	0	0	0	0	0	0	0	0	0	
27	0	0	0	0	0	0	.03	0	0	0	0	0	
28	0	0	0	0	0	0	0	0	0	0	0	0	
29	0	0	0	0	0	0	0	0	0	0	0	0	
30	0	0	0	0	0	0	.12	0	0	0	0	0	
31	0	0	0	0	0		0	0		0		0	
Total	.18	0	0	0	0	0	3.32	.15	0	0	.315	.12	

TAYLOR

Total Annual 4.085

- Section 6 -

Training of Project Employees

The heart of this project, or of any research project or any business, is the quality of its staff of trained employees at all levels. Without trained employees at all levels of expertise within the project, no research can be conducted that will give meaningful results. One professional scientist cannot accomplish much by himself without capable help.

Most all of the project technicians and farm laborers had been employed on the project during 1977 and 1978. 1979 was the third year on the project for many of these employees. The training efforts made in 1977 and 1978 are presented in the reports for those years. This training proved to be invaluable in 1979 when no professionals (plant breeder or agronomist) were in-country during most of the 1979 season. The project Yemeni employees used their previous training and carried out the ongoing research in a very capable manner.

Very little new or advanced training could be given to these project staff members in 1979; however, they gained a great amount of experience and self-confidence in being forced to do the job on their own.

- Section 7 -

Equipment Acquisition

Supplies and equipment continued to arrive in Yemen in 1979 that were purchased in the United States on this contract. By the end of 1979 the project had acquired much of the routine field and laboratory equipment necessary to conduct most simple field crop field research.

Air freight shipments seemed to be about the best shipment method; however, delays and losses still occurred. During 1979 the University of Arizona saved up a large number of items, filled a land-sea container, and shipped it sealed to prevent theft. However, this sealed container was opened and emptied at the seaport of Hodiedah before delivery to the project. All of the items shipped in the sealed land-sea container were hauled from the port to Sana'a piled in the open on flat-bed trucks subject to theft. The land-sea container proved to be potentially worse than air freight shipments.

- Section 8 -

Development of Second Agricultural Research Station at Al Jarubah

The original project objectives include the development of several agricultural research stations in order that research may be conducted under various environments to develop sorghum and millet genotypes and cultural practices suited to the various environments found in Yemen. In 1977 a site in the Tihama at Al Jarubah was selected. Work on the development of an agricultural experiment station at Al Jarubah proceeded in 1978 by the Mission. The Mission had no resources of vehicles or personnel to work on this development other than to divert the limited resources of this project.

A large and continuous effort was made in 1979 by the Mission to continue work in developing the Al Jarubah Experiment Farm. Another well was dug, plus other items. In doing this work vehicles, drivers, and other project technicians were diverted to Al Jarubah during the peak of the project field research in 1979. As a result, most of the outreach program plans had to be abandoned. The other field research at Sana'a also suffered by not being done well or in a timely manner.

The Mission seemed to feel that it was best that research progress of this project at Sana'a should be sacrificed for their progress in developing Al Jarubah.

- Section 9 -

Personnel Movements In and Out of Country

A listing of regular and short-term consultants and their dates of arrival and/or departure in 1979 are listed below:

1. Dr. Robert L. Voigt and family, Chief-of-Party and Plant Breeder: End of tour departure from country on 14 March 1979.
2. Dr. Robert L. Voigt, Chief-of-Party and Plant Breeder: TDY to plant 1979 research plots at Sana'a; in-country from 10 April 1979 through 17 May 1979.
3. Dr. Robert L. Voigt, Chief-of-Party and Plant Breeder: TDY to collect data and harvest 1979 research plots; in-country from 13 October 1979 through 20 November 1979.
4. Dr. Deran Markarian, new Chief-of-Party and Agronomist; began regular tour in-country on 8 November 1979.
5. Dr. Harnek S. Sandhu, Plant Breeder: arrived in-country on TDY for project orientation and assist with 1979 harvest on 9 November 1979.
6. Dr. R. P. Upchurch, Project Administrative Director, arrived in-country on TDY Administrative visit on 14 October 1979. Departed Yemen on 18 October 1979.

- Section 10 -

Status of Yemen Sorghum Collection

The "Yemen Sorghum Collection" of approximately 4500 individual items has been described in previous reports as to its origin and need. Resources to go forward with this collection in Yemen were not available in Yemen. This collection was shipped to the Plant Introduction Germplasm Resources Laboratory in Washington, D.C. in late 1978 and early 1979 for proper storage and safekeeping.

These materials were then all shipped on to the University of Arizona for processing by those project individuals familiar with the collection. The collection items were repackaged, labeled and records initiated towards an increase program. Nearly all of the items in this collection are photoperiod sensitive making it necessary to grow the collection under day-lengths found in the lower latitudes. The Mayaguez Institute for Tropical Research at Mayaguez, Puerto Rico is the only proper facility available.

Seed of 1500 lines was put up in the summer and shipped to Puerto Rico for an approximate planting date of 1 November 1979. Those collection items of only 10 or 20 seed that could not be risked in the field had to be planted in pots in a greenhouse. Only about 100 could be accommodated at one time in University of Arizona Sorghum Project greenhouse spaces.

Adverse field conditions of soil and planting conditions in Puerto Rico resulted in the grow-out and increase of only about 1000 of the 1500 entries sent to Puerto Rico for the 1979-1980 season.

The Research Station at Puerto Rico contributed the majority of the resources of land, facilities, field care and personnel to make the grow-out. The Sorghum Project at the University of Arizona contributed half of its greenhouse space and about one-half of a man-year to this effort.

About 3500 lines remain to be grown out for seed increase and characterization.

- Section 11 -

Miscellaneous Reports

1. Preliminary Progress Report - March 1977-October 1979

Final detailed reports of in-country project research activities and progress for years 1977, 1978 and 1979 were not available to the Yemen Ministry of Agriculture in early November 1979. The desire for such reports was expressed to Dr. R. P. Upchurch during his administrative visit on November 14 - 18, 1979. A brief summary report of major progress and accomplishments was written and submitted to USAID and the Ministry of Agriculture in November 1979. This report is presented in pages 120 through 151.

2. Trip Report for R. L. Voigt TDY to Yemen in October-November 1979

Dr. R. L. Voigt, Chief-of-Party and Plant Breeder, visited the project on TDY in-country from 13 October through 20 November 1979. The primary purpose of this TDY was that it was absolutely necessary for the professional sorghum and millet breeder and researcher personally to collect final field data, make selections among segregating genotypes and direct the season harvest. A trip report was submitted to cover this TDY period. Since this TDY was directly and wholly involved with the 1979 in-country project activities, it is presented as a part of this report in pages 152 through 173.

3. Trip Report for R. L. Voigt TDY to ICRISAT in November 1979.

Dr. R. L. Voigt, Chief-of-Party and Plant Breeder, visited the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) on November 22-24, 1979. The purpose of this TDY was to investigate the resources of ICRISAT towards training of project Yemeni and investigate the potential for greater coordinated research between this project and

ICRISAT that would be of maximum benefit to Yemen. The TDY trip report filed with USAID is presented on pages 174 through 194.

DEVELOPMENT OF A NATIONAL SORGHUM-MILLET IMPROVEMENT PROGRAM FOR YEMEN

PRELIMINARY PROGRESS REPORT

MARCH 1977 - OCTOBER 1979

UNIVERSITY OF ARIZONA

USAID, SANA'A

PROJECT 030

20 October 1979

Prepared by

Dr. Robert L. Voigt

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. H. 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.

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1977 - List of Field Research Tests.
1978 - List of Field Research Tests.
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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 ABANDONED - DRIED UP	2	4	9	72	Off type hd. selns.
76017		1	4	15	60	Hd. sel. from 75012
76018		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 inbreeding 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	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	Sudân 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

Table

Sana'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 Test	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
79017	National Cooperative Pearl Millet Yield Test	6	4	4	96
79018	National Cooperative Pearl Millet Observation Test	(No test seed distributed)			
		1435			3310

Trip Report

Trip to Yemen to Complete Field Research Activities for the 1979 Crop Season

Dates of Visit in country:

13 October - 20 November, 1979

Contract No:

AID/NE-C-1304 Yemen

by:

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

Distribution:

Contracting Officer (3)
Mission (4)
AID Reference Center (2)
Yemen, Chief-of-Party (2)
Director, International Agriculture Programs (1)
Head, Department of Plant Sciences (1)
Department of Plant Sciences File (4)

In support of:

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

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V. Professional contacts relative to this project

1. Dr. R. P. Upchurch

2. Mr. Robert G. Huesmann

3. Mr. Yahya Shuga

4. Mr. Arthur Britton

5. Dr. Deran Markarian

6. Dr. Harnek S. Sandhu

7. Mr. Tracy Atwood

8. Dr. "Sam" Freeburg

9. Mr. Elco Greenshields

10. Ministry of Agriculture meeting

VI. Attachment

1. Short-Grain seed list of releases

I. Summary of Outstanding Results of this Project to Date

Nearly three years ago (in 1977) there was very little germplasm available with well adapted phenotypes (and genotypes) from which to make selections for further evaluations. Much of the material in the program was from outside Yemen and unadapted to Yemen environments. The 1979 season saw a wealth of adapted germplasm with a wide range of varieties. This makes possible a broad solid base for future breeding work.

More selections were made in 1979 than can be tested in 1980 with the research land area available. Selections were made of a range of genotypes for possible use under various situations in the future. Genotypes were selected with ranges in height, maturity, multiple heads, and in addition a full range of all plant, head and seed characteristics were selected. Some characteristics will not be tested for immediate use but this adapted germplasm will be available if needed. These resources had not been available previously.

I am very pleased with the above situation which gives great potential for the future.

There is a need to find and develop a new field research site for this project. Plans are underway to do this. I strongly recommend that in the selection of this new site consideration be given to having a location and sufficient area for the conduct of field research by the new and developing Sana'a University. This project, and the Horticulture project, could become leaders in developing research for Sana'a University. I think this situation represents a rare opportunity for the future.

II. Introduction and Purpose of Visit to Sana'a, Yemen

For various reasons a plant breeder was not in-place in Yemen for the 1979 crop season to replace me when my two year assignment was up in 15 March 1979. I had made all of the field research plans for 1979. I returned in April and May 1979 to supervise the field planting of the 1979 research plots. A Technician (Mr. David Robinson) was in-country during the growing season to supervise care of the growing and developing research plots. It was necessary for me to return just prior to maturity and harvest to complete field data collection, make appropriate field selections and initiate and supervise harvesting of all plots. A Plant Breeder to replace me (Dr. H. S. Sandhu) became available to make a trip to Yemen on TDY during the final days of field harvest. A replacement Chief of Party and Agronomist (Dr. Deran Markarian) was also able to arrive in-country on a permanent basis during the final days of this trip. Orientation of Drs. Markarian and Sandhu was conducted as much as possible in the few days overlap of our visits in-country.

This trip to Yemen was combined with a trip to India to visit ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) which is a world center for research on Sorghum and Millet for adaptation to environments quite similar to much of 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 a visit was made to ICRISAT.

I departed Yemen on 20 November 1979 and arrived at ICRISAT headquarters on 22 November. I departed ICRISAT on 24 November and arrived in Tucson, Arizona at 0203 a.m. on 26 November, 1979. A separate trip report has been prepared and distributed concerning my visit to ICRISAT.

Dr. Deran Markarian arrived in Yemen at 0345 a.m. on Thursday 8 November, 1979 on IY 523. Dr. Harnek S. Sandhu arrived in Yemen at 1030 a.m. on Friday 9 November 1979 on MS (Egypt Air) 767.

I left Tucson on 10 October and arrived in-country on this visit at about 0510 a.m. on Saturday 13 October, 1979 on IY (Yemen Air) 521 and departed about 0800 a.m. on Tuesday 20 November, 1979 on IY (Yemen Air) 418.

III. Sana'a Field Research Activities

1. I walked through all plots of all tests during my first days in Sana'a. I noted the following conditions of the research materials in the field plots at around 15 October, 1979:

   a. Nearly all genotypes had bloomed. Some tillers still blooming but generally the main head of adapted genotypes was mature.

   b. No more irrigations were to be applied and plots were stressing and drying as were farmer rain-fed fields in the surrounding uplands.

   c. Very late maturity experimental genotypes would never produce grain or even produce heads and bloom due to a combination of moisture stress and rapidly cooling day and night temperatures.

   d. Stands (populations) varied by location in the fields due to natural soil variability, levelness of the field and weather conditions at the time of planting and emergence.

e. Development of individual plants within the plots was very uniform in most cases thus giving a reliable indication of the genotypes involved. The hill or spaced planting system instituted in 1978 seemed to be working well. This type of planting system of planting in hills is used by most all Yemeni farmers under rain-fed conditions. It is also used by all other agricultural research organizations in Yemen who work with sorghum under dry land conditions.

f. According to project research personnel the weed problem had become very severe during early summer. This was to be expected as a regular annual event. However reductions in project labor, particularly farm labor, made for budgetary reasons by USAID and/or the Ministry resulted in a more serious weed competition problem then had existed in previous years. University of Arizona project supervisory personnel had little input as to what type of project employees (labor) should be let go. This situation undoubtedly created undesirable aberrations in the relative physiological development of genotypes among plots. The research plots have to be hand weeded. Proper chemicals for weed control are not available in Yemen nor are there any specifications for chemical control of the specific problem weed(s). Indiscriminate use of chemicals (even if available) to control the weeds could also inflict aberrations in the physiological development of the experimental sorghum genotypes.

g. The south or newest irrigation well, which has about twice the output of the old well, broke down and could not be used for about 3 weeks

at a critical time during midseason. Repairs were not immediately possible due reportedly to administrative delays in making already allocated funds available for local use.

Mr. Robinson advanced over $500 of his own money in an attempt to keep the project equipment repaired and operating but further breakdowns occurred and he didn't feel he should put more of his own money into running the project.

The following test plots were lost due to the broken down irrigation well:

Preliminary Y.T.	(79005) Reps III and IV	=	420 field rows
Head-to-Row	(79002)	=	101 field rows
Head Smut Control Test	(79011) whole test	=	112 field rows
	(79012) whole test	=	80 field rows
	Total		713 field rows

713 single rows of material were lost out of a total planted of 3310. Thus approximately 21.5% of our research field rows were completely lost due primarily to our inability to repair this pump and well. Tests 79011 and 79012 were cooperative tests with the German Farm research personnel. This has been very embarassing for the U.S. research effort in Yemen as seen by research professionals from other nations.

h. Reportedly the activities of thinning, crossing and selfing and spraying for stem borers was not always done in a timely manner. This was due to labor shortages, vehicle shortages and in some cases to project personnel not getting to the field immediately after arrival at work. Two restaurants on or near the mission

are open for breakfast and many workers eat brakfast after reporting for work. One restaurant is run by USAID and the other by the Yemen Government.

i. There was a very acute vehicle shortage during most of the season. Farm help and project research personnel were many times, unable to get to and from the plots. Part of the problem in "h" above was due to a lack of transportation. Two project vehicles went into the shop for repair in early summer (May or June) and were still there upon my departure about 6 months later on 20 November. Most of the delay in their repair apparently has been lack of funds to pay for high priced repairs in Yemen.

j. Only three outreach (on-farm) tests were put out this year, as compared to 14 last year (1978). The major difficulty was lack of vehicles.

2. Field Research Data Collection:

Field data such as stand counts and dates of 50% bloom were about all complete. Height measurements were partially completed and had to be finished up. I made agronomic ratings of plants and heads in appropriate plots. I estimated bird damage and lodging for grain yield plots just prior to harvest. Bird damage was about zero for more than two thirds of the grain yield plots. Most of those plots with some bird damage were estimated at one to five percent. Very few plots suffered bird damage in the range of 10 to 25%.

3. Germplasm Selections

At mid-October the mature heads of these plants with proper maturities for this environment were quite easily distinguished from

the greener heads of later maturities. The entire research farm was rapidly drying up so germplasm selections had to be made in the latter part of October for those plots planted first last spring. The mature genotypes had to be selected while they could still be distinguished from later less desirable maturities that were rapidly drying up to an apparent "mature phenotype". Since the original planting schedule covered 3 to 4 weeks, the selection and harvest at the seasons end could be spread over a couple of weeks thus allowing better use of our limited supply of farm-labor.

A number of lines with very early maturities of only 80 to 90 days versus the usual 120 to 150 days to 50% bloom were selected for possible future use. Early maturity is a form of drought tolerance through escape.

4. Initiation and Supervision of Field Harvest of Yield Test Plots

Tags to label sacks of hand-harvested grain and forage from yield plots had already been made out by project personnel. There were not enough sacks to make a complete harvest of all tests. The Mission disallowed the purchase of additional sacks from the local market with mission project funds for budgetary reasons. After my arrival I purchased 200 sacks locally with funds I carried to Yemen from Arizona. We were still harvesting over 500 fewer plots than were planted due to loss of these plots from the irrigation well break down earlier in the season.

5. Data Tabulation

Project personnel under the supervision of Mr. Tasawar Hussain kept current with field data tabulation as rapidly as it was available.

By harvest time around the first of November tables of data on % stand, days to 50% bloom, height, etc. had all been made out ready for inclusion in an annual report. Project personnel would work in the fields in the mornings and in the laboratories in the afternoon, on data, tags, and other harvest preparations and activities.

IV. Other Project Activities of an Administrative Nature

1. Interim Report for Period of March 1977 thru October 1979

A narrative type of interim report was prepared during 16-19 October for the Yemen Ministry of Agriculture covering the period of March 16, 1977 to mid-October, 1979. A detailed report containing data for this period is still under preparation in Tucson and is overdue because of a backlog of activities. Copies of this interim report have been distributed to appropriate personnel by the University of Arizona.

2. Current status of development of the Al Jarubah Research Farm from detailed discussions with Mr. Madhu Acharya (project Agricultural Engineer).

Development of the Al Jarubah Experiment Station area includes an obligation (written or unwritten) to furnish water for human needs of all immediate area residents or anyone desiring water. Research needs then come next. This priority is almost a law in Yemen.

The priority water requirements may be listed as follows:

First = human needs

Second = research with current horticultural plantings taking priority over field crop research which is not yet in operation.

The needed area of land to be developed for field research purposes is set at 25 hectares. This area of land is considered what

is necessary to initiate and conduct both Horticulture and Sorghum and Millet research at this location in the near future.

The research water requirement for this area of land is calculated as follows:

Two crops per year @ 500 mm/crop = 1000 mm/year

Water sources: rain = estimated 100 mm/year

needed irrigation = 900 mm/year

Irrigation requirement of 900 mm for 25 hectares = 225,000 cu. meters of water per year.

Considering a 20% loss between pumping and use of the 225,000 cu m makes necessary the pumping of 270,000 cu m of water per year.

Well operating time is estimated at 300 days per year at 10 hours per day with a required 25 liter per second discharge capability.

A general rule is one liter per second per hectare well capability. Thus an irrigation well capability for this 25 hectare area needs to be 25 liters per second per hectare.

The one existing well, which has a 6 inch casing is currently delivering about 4.5 liters per second. It is estimated that the appropriate total output of this one small well currently in use will be used almost entirely for local human needs.

The obvious conclusion is that any sorghum and millet research depends on the development of new irrigation wells.

Bids on a new well were being solicited at the time I left on 20 November. A 12 inch casing was being asked for in the bid however if a 12 inch drill is not available in-country a 10 inch casing may have to be installed. The well is estimated to be 200 meters deep.

A maximum output for the new well is estimated at 10 liters per second. It could be less than this under sustained operation.

This experiment farm will need a third and maybe a fourth well, depending upon the output of the second well now under bid.

If everything runs very smoothly the new well could be in operation by mid-January. However there was a question of availability of money to drill and install this new well.

Currently about 5 hectares have been only partially (70%) levelled.

Horticultural plantings are now in about one hectare but there are horticultural materials under a shade house which need to be set out.

Building plans are complete for:

a. Renovation of ground floor of the existing residence (3 rooms for 2 people).
b. Trailer shed (to cover a trailer = 2 people).
c. Pump house
d. Garage for equipment
e. Warehouse
f. Generator house
g. Waste disposal system
h. Water supply system

The current estimated cost of these buildings is over $300,000 and rapidly rising. Only about $110,000 of funds are currently available.

No contractor will bid on only a few of the job items because of the inaccessibility and high cost of operation at the site.

Contractors seeing the site say they will bid on all or none.

Mr. Acharya, who is the professional with all of the expertise and knowledge of the job, is leaving in mid December and no replacement is scheduled to carry on the work.

3. Suggested plans for the first field plantings of sorghum and millet at Al Jarubah

Successful operational field procedures for growing sorghum and millet have not been tried or worked out for this site. Thus it is unadvisable to commit seed of valuable germplasm which is in limited quantities. The first requirement is to learn how to successfully plant, care for, grow and produce a crop of both sorghum and millet.

The research land area has not been levelled to give uniform field conditions from plot to plot. Currently no equipment is available to this project to do this therefore entirely reliable research data will probably not be available.

Suggested plantings are:

a. Planting of bulk seed composed of many genotypes. Such a uniform bulk population will give visible gross phenotypic differences such as height in areas of the field of differing soil environments. Uniformity of the field may be assessed. Also individual plants with adapted phenotypes and genotypes may be selected for future evaluation and/or breeding work.

   There is a large supply of such bulk sorghum and millet seed on hand.

b. A date-of-planting of the bulk seed described above could be made every month. This would accomplish the objectives of a above

but in addition an evaluation of the general response of sorghum and millet planted at different times of the year could be made. Problems of growing and developing a crop throughout the year could be assessed.

c. Some uniform local genotype could be grown in one planting or date-of-planting but no selections for breeding work would be possible.

4. Seed of short, grain-type genotypes.

I made 40 selections in 1978 of individual plants of a combine height (less than 1 meter) but with large heads. The plants selected were leafy with a sturdy stalk. The objective was for a combine-type variety for areas where mechanization of grain production would be possible.

These selections were grown in 1979 in a yield test for grain and forage. Most continued to be true to type.

Research personnel at the Tihama Development Authority and Surdud Experiment Farm expressed a strong desire to obtain seed of some of these lines. I selected the best ones at harvest and selected seed of these lines. Seed of 13 of these short, grain-type lines (or varieties) were sent to Surdud via Mr. Yahya Shuga and the Ministry of Agriculture. See Attachment 1.

These lines should give even larger plants and heads under the more mild environments at the intermediate elevation of Surdud.

It is hoped that these releases of germplasm will enhance the standing of this project in Yemen.

5. A religious holiday (Big Eide) occurred from Tuesday (30 October) through Sunday (4 November). This was a 6 day holiday which all personnel took off. This was at the height of the field selection work and midway through harvest. Two of the project technicians consented to work (overtime) for a couple of half-days. Mr. Hussain also worked extra. I spent most of the holiday in the field making selections and plot evaluations.

   Mr. David Robinson had not taken any vacation since coming to Yemen last December 1978. He left on leave on Monday 22 October to Greece. He returned Monday 12 November, 1979.

   Mr. Andreas Tacadao IVS Agronomist, had departed from Yemen at the end of his 2 year tour, in early October before I arrived.

6. As stated earlier in this report, Mr. Madhu Acharya is scheduled to leave Yemen in mid-December at the end of his 2 year tour with IVS. Mr. Tasawar Hussain, Agronomist with IVS, is also scheduled to complete his 2 year tour in Yemen.

   Mr. Acharya needs to be replaced with someone else with engineering capabilities to continue development of the Al Jarubah Experiment Station. Mr. Hussain wishes to continue in Yemen and is badly needed on the project. He has assumed almost full responsibility for assembly and tabulation of the field research data into table form in 1978 and 1979. Mr. Hussain has an application pending with the UNDP-FAO at Taiz if this project does not hire him.

7. The lease on the Voigt house (Voigt Hilton), which had been rented by USAID for TDY use of the sorghum-millet project, expires on 6 December. USAID is not going to renew the lease due to landlord difficulties.

The house Dr. Stewart formerly occupied is being readied for use by the sorghum-millet project.

The office furniture being used by Title XII design team was borrowed from the sorghum-millet project and should be returned to the project for use in development of the sorghum-millet research center in the Tihamas.

8. The open, screened laboratory spaces for drying harvested plots of grain and forage is less than half of what is needed for what was harvested this year. This is not counting the 21½% loss of plots referred to earlier in this report.

My original request in 1977 for this area was nearly double in size. The plans that went forward for construction were modified in the approval process to include an automotive wash rack, a grease rack and an auto supply room but at the expense of the research material drying and processing area.

Currently field materials are being stored after harvest to dry in interior rooms where they will not dry very well, they dirty up clean storage areas normally used for long term seed storage and auto supply storage, and prevent on-going work of a different nature planned for these areas. A reassessment of research laboratory space needs should be made.

V. Professional contacts were made in-country during this visit with the following individuals regarding various phases of project activities.

1. Dr. R. P. Upchurch, Project Director. A brief tour of the project research plots at Sanaa was made on 15 Oct. with Dr. Upchurch.

Progress and goals were discussed while in the field and at other times in the writing of an interim report for March 1977 to Oct. 1979. Discussions were held relative to criticisms of the project.

2. Mr. Robert G. Huesmann, Director, USAID, Sanaa. Mr. Huesmann requested and was given a personal tour and description of the Sanaa research plots on 24 Oct. Objectives of various experiments were explained, examples of progress were illustrated, and current research problems were discussed.

3. Mr. Yahya Shuga, Plant Breeder Counterpart and Ministry of Agriculture

   A detailed tour of various research tests was made to view and discuss progress for the season. Mr. Shuga briefed me on activities and problems that occurred during the growing season.

4. Mr. Arthur Britton, Agricultural Division, USAID, Sanaa.

   A brief description of some of the research tests at Sanaa was made in the field. Mr. Britton accepted an invitation to visit one of the outreach (on-farm) tests when we went out to harvest it. This was also an opportunity to view sorghum fields, just prior to harvest, for about 30 kilometers south of Sana'a along the Taiz highway.

5. Dr. Deran Markarian, Agronomist and Chief-of-Party, Yemen Sorghum Millet Project.

   Dr. Markarian arrived in-country on 8 Nov. 1979. From this date to my departure on 20 Nov. brief explanations and discussions were held at various times on numerous topics relative to activities in Yemen in an attempt to brief Dr. Markarian.

6. Dr. Harnek S. Sandhu, Plant Breeder, Yemen Sorghum-Millet Project.

Dr. Sandhu arrived in-country on 9 November 1979. From this date to my departure on 20 November Dr. Sandhu accompanied me in most of my activities to try to become familiar with the project and its progress, objectives and procedures. Dr. Markarian was anticipating spending his time in Hodeidah so Dr. Sandhu was briefed on administrative activities regarding project supplies and equipment, technician training and promotion, all research activities, etc. The outreach tests had all been harvested as had the majority of the field research plots at Sanaa when Drs. Markarian and Sandhu arrived in Yemen. Dr. Sandhu did assist with the last of the field selections to be made.

It was not feasible to delay research activities until Drs. Sandhu and Markarian arrived since the field labor force had been reduced during the season to cut costs and the mission was making plans to take all farm labor off the payroll - whether we were finished with our field harvest and theshing or not. I pushed everything as fast as possible right through the holiday week of Eide.

7. Mr. Tracy Atwood, Yemen Desk, AID Washington, D.C.

Mr. Atwood arrived in country on 9 November on the same flight as Dr. Sandhu. Mr. Atwood was still in-country at my departure on 20 November. Mr. Atwood requested and received a complete tour of the field research plots and a detailed explanation of various tests and research materials on 16 November.

Mr. Atwood later had an opportunity to use his information in discussions with a member of a UN-FAO Advisory Team, Mr. Elco

Greenshields, regarding the status of progress of this project in Yemen.

8. Dr. "Sam" Freeburg, World Bank.

I participated in a conference on 28 Oct. with Dr. Freeburg and Messrs. R. G. Huesmann, Harry Johnson and Art Britton relative to this project. Dr. Freeburg requested and received a tour and explanation of on-going field research in Sana'a on 30 Oct. Dr. Freeburg was on a tight schedule so his field visit was too brief to cover much more than a fast trip around some of the plots.

9. Mr. Elco Greenshields, Member of Evaluation and Advisory Team, UN-FAO.

Mr. Greenshields was in-country as a consultant and member of a team to advise the Ministry of Agriculture on the many different agricultural projects operating in Yemen. Mr. Greenshields consulted with Mr. Atwood in some detail about this project and then extended an invitation to me to have dinner with him at the Sam City Hotel for some discussion of the project. Messrs. Atwood and David Beach and Drs. Markarian and Sandhu also joined the meeting.

Mr. Greenshields was quite emphatic about past rather derogatory advice that had been given the Ministry of Agriculture regarding this project by a past Ministry advisor. Mr. Greenshields did not visit the field plots.

10. A Meeting was held at the Ministry of Agriculture on 20 Oct.

The following USAID personnel were in attendance: Huesmann, Johnson, and Britton plus Shuga, Mayberry, Lee and myself in addition to others. Mr. Jagmann chaired the meeting. The agenda included

discussions of the Poultry Project, Horticulture Project, Sorghum-Millet Project, and a planned Water Resources Project.

At this meeting the Ministry gave verbal approval for Dr. Markarian to come to Yemen and to reside in the Tihama and Dr. Sandhu to come to Yemen to work at Sana'a in the uplands.

VI. Attachment

1. Short-Grain seed list of releases.

ATTACHMENT 1

Sorghum-Millet Project
University of Arizona and USAID - Sana'a, Y.A.R.

Grain Varieties of Short Height for Surdud

No	Seed Source	Pedigree
1	79006-101	76026-004-4
2	79006-107	76026-070-5
3	79006-113	77093-08-8
4	79006-114	77093-22-22
5	79006-116	77093-76-6
6	79006-119	77 Composite-8
7	79006-123	77 Composite-39
8	79006-125	77 Composite-58
9	79006-128	77 Composite-73
10	79006-129	77 Composite-75
11	79006-135	NES 1570
12	79006-138	IS 410
13	79006-139	IS 410

November 1979

Dr. Robert L. Voigt

To: Mr. Abdul Momen Hazza
Tihama Development Authority
Wadi Zabid Project
Tihama
Yemen A.R.

Seed to: Surdud Farm (Ghazi Nasser)

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:

Contracting Officer (3)
Mission (4)
AID Reference Center (2)
Yemen, Chief-of-Party (2)
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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1. ICRISAT Striga Resistance Breeding Program

2. Training at ICRISAT

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.

RCVD: 23 JAN 1979

ATTACHMENT 1.

ICRISAT STRIGA RESISTANCE BREEDING PROGRAM

DR. M. S. 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 materia 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 reso.rce 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.

- Section 12 -

Summary of Accomplishments to Date

Accomplishments of note for 1979:

1. An increasing number of better adapted experimental sorghum genotypes are coming through the breeding system and are now available for outreach testing.
2. Thirteen high-yielding grain type varieties of short height were released by the project to the Yemen Ministry of Agriculture. These are varieties of about 60 to 70 cm in height with large grain type heads. These varieties have been developed and released for use in large, flat areas where combines can be used in mechanized harvesting.
3. A more efficient and faster outreach test evaluation procedure was devised to evaluate 5 to 10 times as many experimental materials. This was suggested for use in 1980.
4. The first experimental hybrids were made using early backcrosses of the line being developed and several of the superior lines from the Advanced and Elite Yield Tests as pollinators.
5. Further backcrosses were made in developing an A and B line for future hybrid sorghums.
6. U.S. Forage Sorghum Hybrids were evaluated for grain and/or forage phenotype and production under local conditions. Most U.S. forage sorghums were much shorter in height and of early maturity at Sana'a and would be considered to be nearly a short grain type.
7. Sorghum X Sudangrass hybrids were evaluated for forage production under repeated clipping regime and were found to have considerable potential for use as a green forage.
8. Millet again was shown to be less adapted than sorghum to the Sana'a environment.

9. Project technicians and farm personnel received the opportunity to use their previous training and carry on project research activities on their own. They did a good job and earned much experience and self-confidence in doing so.
10. An extensive effort was made all summer long by the Mission to develop the Al Jarubah Experiment Farm. The Mission had no other resources to use other than project vehicles, personnel and supplies, which were diverted from project work to development of the new farm.

Other Accomplishments for 1977 through 1979:

1. Devised and instituted a basic but simple systematic plant breeding selection and genotype evaluation process sequence of head-to-row, preliminary yield test, advanced yield test and elite yield test. Forage yield as well as grain yield data would be taken on elite test entries. Elite test entries may also be evaluated in outreach tests.
2. Improved soil management and experimental field plot procedures to obtain more precise field research results on the Bir El Gohoume Research Farm at Sana'a.
3. Developed a second irrigation well and cleared and leveled more land on the Bir El Gohoume Farm to increase research efforts.
4. Developed laboratory and office spaces to suit the type of research to be done on this project.
5. Acquired and put into use various essential field and laboratory equipment items for obtaining proper research data.
6. Trained a basic staff of Yemeni research technicians and farm field personnel in simple research methods and procedures through on-the-job and classroom training.
7. Gave English language training to most of the project Yemeni staff.
8. Obtained and set up an academic and scientific book library in all facets of Agriculture for use by and training of the Yemeni technical staff.

9. Areas of need for TDY consultants to help solve problems were identified and scheduling of these selected personnel was done. These consultants were encouraged to be available for repeat TDY trips on which they could be much more effective than on a first-time trip.

10. Developed germplasm resources with wide genetic variability from which to select superior genotypes. These resources and systems were developed to give superior germplasm for different environments, not just Sana'a.

11. A cytoplasmic male sterile line (A line) with a maintainer line (B line) with good phenotype for the higher elevations of Yemen was identified and developed for production of hybrids.

12. Determined that recombinations of sorghum genotypes adapted to Yemen are <u>much</u> more likely to give adapted new genotypes than importing sorghum types adapted to other different parts of the world.

13. Gave segregating germplasm materials to the UNDP/FAO project at Taiz for their selection of new and adapted sorghums for their area.

14. Completed quite an extensive sorghum seed collection of native varieties throughout most of the sorghum growing areas of Yemen.

15. A collection of the more prominent weeds and other plants was made and identified for future use by project personnel.

16. The Yemen Ministry of Agriculture adapted a procedure for national use in Yemen among donor agencies that was suggested by this project. This procedure was to have unreplicated observation trials of newly selected sorghum and millet materials among donor agencies making it possible to screen more material at more locations for each other with less work and expense than full scale yield trials.

17. Initiated outreach testing in 1978 and continued in 1979. Valuable experience was gained by the project and useful contacts established in many villages.

18. A uniform set of project personnel job descriptions for job classification and promotions were devised by the project and adapted by USAID.

19. Made major contributions of project resources toward the Mission's efforts to develop the Al Jarubah Experiment Farm in 1978 and 1979.

20. Numerous research results were obtained and are presented throughout the various reports.