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Blue Nile Integrated Agricultural Development Project

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SEED PRODUCTION ADVISER'S END OF TOUR REPORT

by Frank D. Burkhart

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This is the end of tour report for Blue Nile Integrated Agricultural Development Project's Seed Production Adviser, Mr. Frank D. Burkhart. It was prepared by Mr. Burkhart and edited by the Experience, Incorporated home office staff.

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I. INTRODUCTION

The developing seed industry in Sudan is challenging, exciting, and moving forward.

This is the second year of large-scale production of Hageen Durra-1 seed in the Sudan. Table 1 lists feddans already planted. Some fields have been visited as described in Trip Reports in the Appendix.

TABLE 1. 1985 PRODUCTION: HAGEEN DURRA-1 SEED, SUDAN

Name	Feddans	Location
Twakel	250	Khartoum
BNIADP	23	Damazin
Chemi Import Co.	60	Rahad
George Bursam	80	Sennar
Tenneco	40	Dongola
Radison Trade Co.	90	Managil
El Kidir Co.	30	Gezira
Adbel Wahab	40	Managil
Bahig	40	Sennar
Canadian Sudan Co.	50	Simsim
Arkel International-Dekalb	640	Abu Naama
Sudan Gezira Board	970	Bezira
NSA	200	Sennar
Mechanized Farming Co.	50	Sim Sim
NSA	50	Kel Girba
Rahad Corp.	30	Rahad
Other Sorghum Seed Production		
Gezira Location	30	of Foundation ATX 623 at Sennar
Sennar Location	10	of Foundation ATX 623 at Gezira
Pioneer 980 Sorghum Sudan Grass Rahad Location	30	of Hybrid Forage Sorghum Seed Production at Rahad

SOURCE: Seed Production Adviser compilations
8537A

Recommendations presented in this report are based on field observations, literature review on Hageen Durra-1 seed production, and many years of experience in United States private sector production of hybrid sorghum seed.

The cultural practice recommendations could be applied to the production of any hybrid sorghum seed, as well as to the production of hybrid sorghum grain crops.

The production of hybrid sorghum seed requires higher levels of expertise and management over traditional farming and should give a higher return to the grower who uses this expertise and for taking the risk involved. The seed production field is a good place to develop new and improved agricultural practices such as hybrid sorghum seed production. Experience has shown that the seedsman is a leader in moving agriculture to new and improved practices.

II. OBJECTIVES

The objectives of the assignment were as follows:

A. Advise and assist on the cultural and production aspects of Hageen Durra-1 hybrid sorghum seed production.

- o Blue Nile Integrated Agricultural Development Project
- o Government of Sudan Ministry of Agricultural Entities
  - National Seed Administration (NSA)
  - Sudan Gezira Board
  - Other GoS entities
- o Private sector seed producers

B. Advise and assist BNIADP on seed production development and other areas as requested by the BNIADP director.

C. Provide advice for monitoring hybrid sorghum seed production for follow on activities.

D. Provide recommendations on role of NSA and its relationship with private seed producers.

E. Provide recommendations on how the private sector seed industry can be strengthened in Sudan.

III. SORGHUM SEED PRODUCTION RECOMMENDATIONS FOR PRODUCERS OF HAGEEN DURRA-1 SEED IN SUDAN

The following is not intended as a complete guide to production of Hageen Durra-1 seed. It is a response to problems and questions presented during visits to seed production fields at Damazin, Abu Naama, Barakat, Sennar, and Dongola. Trip reports are presented in the Appendix. Fields owned by the National Seed Administration, Sudan Gezira Board, and private sector producers were inspected. Recommendations generally apply to all Hageen Durra-1 seed growers in Sudan.

A. Nicking Problem

"Nicking" is very important to all hybrid sorghum seed producers. A good nick (sychronized blooming of male and female parents) is essential in producing high quality yields of Hageen Durra-1 seed. In 1984 examination of production seed fields of Hageen Durra-1 showed that in many cases the male parent (Karper 1597) bloomed three to five days later than the female (ATX 623).

Data from previous years indicate that these lines have bloomed at the same time. Inspection of fields this year shows the male and female bloom at the same time when equal plant populations are established. Many fields have a good stand of female and a poor stand of male. This has created a nicking problem in these fields. A thick stand will bloom three to five days earlier than a thin stand. Planting half of the male thick (50 to 100 percent more than the normal rate used for male and female), with good stand establishment, will ensure an adequate supply of early pollen, barring other environmental problems which would stress the more sensitive male parent. The use of thick and thin planting of male parents to spread the time of pollen shed is recommended for all hybrid blocks as well as female stock increases.

About 30 days after planting, the stalks of both parents should be regularly dissected to check the size of developing heads. If the male parent appears to be growing faster than the female parent, one-half the male parent should be mutilated by cutting just below the developing head to force the male parent to produce more tillers. If the female parent is ahead, an application of nitrogen (N) and/or phosphorus (P) and water to the male parent might be advisable to stimulate growth. Simple N and P trials in the seed production field in each area should be established to assess the effects of fertilizer. Each treatment should contain both male and female parents. Data should include: initial bloom, 50 percent bloom, and final bloom of each parent. This data should be used as a guide for correcting unpredictable nicking problems.

Eight to twelve border rows of male parents should be planted around each field. Borders should be planted seven to fourteen days ahead of the female, one-half planted at normal rate and one-half at the thin (50 percent less than the the normal) rate. If planted at the same time as the female, plant one-half thick and one-half normal.

Most hybrid sorghum seed production is irrigated. Consequently, much of the above planting recommendations are for irrigated land. By necessity, some hybrid seed production in Sudan is rainfed. The thick planting of male as the only tool to ensuring a nick is somewhat risky for rainfed conditions.

For both rainfed and irrigated seed production, a four to eight, or four to twelve row pattern should be planted. Plant one-half the male, one row normal and one row thin. Wait five to seven days and plant the other one-half male at the normal rate. The female parent should be planted at the normal rate when making the second planting of male.

B. Reducing Undesirable Outcrossings

When hybrid sorghum seed has been produced from wild sorghum outcrosses, a hybrid weed has been produced with more vigor than the original weed. Buyers of hybrid sorghum seed need to be informed that outcrosses should be removed along with other weeds.

1. Site Selection

Site selection is the best and easiest way to eliminate undesirable outcrossings. The ideal site would have no other sorghum species and be at least 3.2 kilometers away from another sorghum field. A site should be found which most nearly fits this ideal. Particular emphasis should be put on the amount of wild sorghum species within the field itself. Emphasis should also be placed on the amount and kind of sorghum on the downwind side of the field if prevailing winds exist during bloom.

2. Land Preparation

Properly prepared land should have ridges wide enough to facilitate furrow irrigation, inter-row cultivation, and roguing while watering. Planting patterns should permit planting of male and female parents by machine or even distribution of seed by hand planting in lines rather than hills. Fields should be pre-watered or enough rainfall should be collected to germinate weeds, including indigenous sorghum. Fields should then be cleaned before planting seed stock. Planting on ridges in rain-fed areas should also aid control of seedling disease triggered by excessive moisture. Sudan research reports indicate that sorghum which is planted on ridges is less infected with striga than sorghum planted on the flat.

When making ridges, each pass through the field with the ridger should make enough ridges to be used in all subsequent operations, i.e., planting and cultivation. Matched ridges should be used for all operations. Straight and uniform ridges can only be made by setting the marker so that on each pass through the field with the ridger, the center of the tractor is aligned with the mark made (the center of the tractor and not the front tire, as appears to be common practice in Sudan). If the tractor driver enters and exits the field straight, and keeps the tractor center aligned with the mark, then straight and uniform ridges can be accomplished.

Land preparation prior to ridging should include operations necessary to break the plow pan to facilitate water penetration and root development. Operations should also be employed to eliminate clods and trash to facilitate ridging and planting.

3. Foundation Seed Selection

Foundation seed which contains excessive amounts of outcrosses only adds to the problem of roguing in the seed field. Without excellent quality [1/] parent seed, production of quality hybrid seed is almost impossible.

Seed producers should select parent seed of the highest quality, based on grow-out information. Foundation seed production has a unique set of problems requiring extra expertise and exceptional isolation. Seed producers should be free to produce their own parent seed. However, in the formative years of the hybrid sorghum seed industry, it is recommended that all parent stocks be sourced in the United States.

1/ The term "quality" as used throughout this report (unless specifically stated otherwise) means a level of quality generally accepted by farmers and seedsmen throughout the international agricultural community.

All parent seed should be treated with a good insecticide/ fungicide such as Apron, a systematic fungicide for control of some seedling diseases and downy mildew. In some cases, a seed safener (treatment) should be applied to the seed as discussed under Section III. B. 7, "Herbicides."

4. Planting

Differential planting dates coordinated with neighbors can eliminate some risk of outcrossing. Furnishing neighbors with the male parent seed, or compatible hybrids or varieties, can also be used to reduce the risk of outcrossings.

When irrigated, it may be possible to plant seed production fields in the off-season to eliminate exposure to undesirable sources of pollen and outcrossing. Test production fields should also be planted.

Some yellow endosperm sorghums will not emerge from planting depths commonly used for other sorghums. This may be part of the reason for the thin stands of Karper 1597. It is recommended that this line be planted as shallow as possible, but in moisture adequate to permit germination.

Row widths, planting patterns, and population can vary widely to fit other planned practices. If it is possible to machine harvest the male line, the male patterns should be planted wide enough to allow for the combine.

Normal planting rates, referred to earlier, are rates established for areas compatible with other cultural practices being used in Sudan. Trials may need to be established by producers to determine their optimum planting rate for their individual situation.

Rainfed seed production plant population should range from 30,000 to 50,000 plants per feddan. Irrigated seed production should range from 60,000 to 90,000 plants per feddan.

Table 2 indicates plant population and seed spacing. When a population is determined, the percent seed germination of each parent should be recognized and an allowance should be made for 5 to 10 percent non-emergence of viable seed due to uncontrolled factors.

TABLE 2. ROW LENGTH EQUAL TO 1/1000 OF FEDDAN FOR VARYING ROW WIDTHS

Row Width	Row Length
(centimeters)	(meters)
17.8	22.4
25.4	15.7
35.6	11.2
38.1	10.4
50.8	7.8
71.1	5.6
76.2	5.2
91.4	4.4
96.5	4.1
101.6	3.9

NOTE: Count seed or plants in the distance according to row width. Multiply by 1,000 to get seed or plants per feddan. Another useful method to determine the amount of seed needed to purchase: each seed to be used per 30 cm. of row on 100 cm. wide beds equals 0.5 kg. per feddan. Ratio and proportion can be used for other widths.

Planting should occur in straight and uniform lines, by hand or machine, with seed evenly distributed. This is not only required for satisfactory yields, but is necessary to permit identification of indigenous sorghums during roguing.

5. Maintenance of Isolation

After a stand has been established in the seed field, weekly trips should be made covering the entire field to remove all undesirable sorghum that can be identified. These must be removed by the roots to prevent recurrence of growth. If closely supervised, this can also be done in conjunction with weeding. Weekly surveys of the entire isolation area should be made to eliminate all wild sorghums, and to plan for the timely removal of small plots of undesirable sorghum which may exist.

The area cleaned of undesirable sorghum should include 3.2 kilometers of the seed field on the downwind side and 1.6 kilometers in all other directions. However, 3.2 kilometers or more is desirable if time, manpower, and money permit. This area of isolation far exceeds the isolation require- ments established for certified seed production in Sudan.

Experience has shown that quality seed cannot be produced by maintaining the minimum isolation requirements as established for distance from Sudan grass or other sorghums of different type or height. Sorghum pollen travels much like smoke. Loss of quality due to outcrossing from a pollen source many miles away has been documented. Obviously, one cannot maintain isolation from all possible sources of contamination. However, the 1.6 kilometers upwind and 3.2 kilometers downwind isolation can be maintained if a proper site is selected. This isolation is essential to produce good quality seed. Maintaining this isolation requires roguing of neighbors' fields containing sorghum, and fields of other crops which contain volunteer or wild sorghum.

6. Crop Rotation

A cropping plan should be reviewed each year to ensure adequate and suitable sites are available for the following year's seed production. It is much easier to clean fields of indigenous sorghum in fallow or broadleaf crops the year prior to seed production. In this way, the following year's problem can be minimized. This rotation aids the control of striga and other objectionable plants. In a legume rotation, the fertility of the soil is maintained. Rotation also aids in the control of insect and disease problems.

7. Herbicides

Ciba-Geigy and Monsanto have seed safeners and also compatible herbicides to be used with the safeners seed. These herbicides will control all sorghum species, other grasses, and broadleaf weeds, yet allow the safener seed to be unaffected. This approach may be the only means to ensure quality seed production in some areas.

Trials should be established for parent seed treated with the safener and for herbicide treatments applied in seed fields with high populations of undesirable sorghums. Other herbicides labeled for use on sorghum should be included in these trials for control of striga and broadleaf weeds. Atrazine and oil, propozine, 2,4-D type and the "yellow" dinitroanilinc compounds (for late season weed control) should be included.

The use of the yellow herbicides (Treflan, Prowl, Balan, etc.) after the crop is well established is reported to give good control of striga and will control late germination of wild sorghum and other weeds. Use of the yellow herbicides in adjacent broadleaf crops to control wild sorghums and striga not only aids the present seed crop, but is also beneficial to seed crops grown on these sites the following year.

MSMA type herbicides are inexpensive and useful in spraying over some broadleaf crops or on a non-crop area where there is a large quantity of wild sorghum.

Non-selective herbicides such as Paraquat and Roundup can be used on non-crop areas for control of wild sorghum and striga. Chlorate type compounds might also be used on non-selective areas.

When using any chemical, always follow label instructions. When applying chemicals to seed production, use the lowest rate in the recommended range.

8. Irrigation

Hybrid sorghum seed production is not best accomplished under the basin type irrigation which is currently used in Sudan. Many inbred lines, such as the Karper 1597, have a low tolerance to any stress. The basin-type irrigation tends to stress the parent because of too much water at some times and too little at other times. Furrow irrigation is recommended and facilitates the more timely and uniform application of water. Furrow irrigation and alternate furrow irrigation can facilitate roguing during irrigation which is necessary in some fields to remove wild sorghum. Furrow irrigation also aids split planting of parents if necessary. If properly managed, it will also result in production of a greater quantity of seed of better quality.

9. Roguing

In fields with volunteer or wild sorghum present, daily roguing of the entire field while the sorghum is in bloom is recommended. This includes daily roguing during irrigation. All roguing should be closely supervised to ensure that off-type plants are removed before or on the same day of flowering of the

off-type. All off-type should be removed by the roots, dirt shaken from the roots, stalks broken in half and placed in a position so as not to interfere with irrigation. With very high quality stock seed, and in the absence of any wild sorghum in the fields, roguing should be performed as explained above on a two to four day interval while the female is in bloom. A common mistake made is not roguing the male rows regularly. The male should be rogued as often, or more often, than the female since all tall plants in the male are pollen producers.

Tall plants, to be removed in both male and female, are those plants in which the base of the flag leaf is 15 or more centimeters above the base of the flag leaf of other plants within the row.

Grass-type plants and plants with greatly different head-types should also be removed. When removing any off-type, all plants in the cluster in which the off-type appears should be removed, or there will usually be some tillers of the off-type left in the field which may not exert and, consequently, never be removed.

All plants shedding pollen should be removed from the female rows as well as other off-types. Shedders are easily identified by their larger and more colorful anthers.

Roguing is best performed by a crew of 20 or fewer people with a well-trained supervisor. Two or three persons in the crew should be trained to rogue male rows only, with one person taking the entire set of male rows (two or four) on each pass. Persons roguing the female should take two or four rows per person. Speed should be at normal walking pace. Workers should be trained to look for shedders and other off-types 3 to 6 meters in front of them at all times. Every 15 to 30 meters, roguers should look behind, going back to remove any plants

missed due to angle of sun or location of off-type. Each roguer should be trained to help persons adjacent to them to spot off-types. The entire crew should understand that a clean field is essential to good seed; hence, a successful business and continuing work roguing for the people of Sudan, plus other benefits of the hybrid seed to Sudan.

In fields with wild sorghum and/or striga, special trips should be made across the field with one person per middle or enter-row looking only for these problems. When one attempts to correct these problems while doing normal roguing, the result is the removal of neither wild sorghum nor striga being satisfactorily accomplished.

A roguing prior to harvest of the seed rows and after the male rows have been harvested should be done by a select and well-trained individual or crew to ensure that no striga or other objectionable plants remain in the field.

10. Making Trial Hybrids

A small amount of ATX 623 should be planted in fields of known local varieties. The seed produced should then be planted for grow out. These hybrids then can be used to help identify undesirable outcrosses in Hageen Durra-1 production. Sources of contaminating pollen can be located and these sources can then be avoided the following year. There is also a slight chance that a suitable locally adapted hybrid or a line might be produced from this cross. This exercise, however, should be viewed only as an excellent learning tool to use in developing quality hybrid seed production.

C. Use of Pesticides

The application of systemic insecticides at planting, in addition to a good insecticide seed treatment, should be used to control shootfly, aphids, thrips, stem borer, and rootworms. Trials should be established, using systemics to determine which products are most beneficial and practical for each production area. Chemicals to control outbreaks of insects should be used as needed. Label instructions should be followed and used at the lowest rate in the recommended range.

Repellents to keep birds away from freshly planted seed are available and should be used where this is a problem. Repellents to keep birds away from maturing crops are not known by this adviser; however, a search is being undertaken to determine if such products exist. Some experimental work with reflective tape and corrugated gift package ribbon strung above seed rows has proved successful for deterring some bird species.

Killing large numbers of birds is a method commonly used in Sudan to control the bird population. This however, disrupts the balance of nature, as birds also eat insects. Consequently, such measures are not readily acceptable but may be necessary in some situations to produce a seed crop. Growers, however, should continually seek alternative methods of bird control.

All foundation seed stocks should be treated with Captan, a good general purpose fungicide for control of seed borne diseases. Also available and strongly recommended is a new product from Ciba-Geigy, called Apron, which is a systemic fungicide seed treatment. Apron gives excellent control of Pythium seedling disease complex, sorghum downy mildew, and crazy top downy mildew. This new product promises control of other disease problems although it has only been recommended for the diseases mentioned.

A seedling disease epidemic affected all sorghum planted about July 5 to 25 of this year in an approximate 80 kilometer radius area around Damazin. Thousands of feddans were affected with loss of 10 to 80 percent. It is possible that Apron would have controlled this seedling disease.

Apron should be used on all sorghum stock seed and should be made available on hybrid seed for large-scale farm trials in 1986. Apron should also be applied to all sorghum seed planted in any of the sorghum type trials, as too much time and effort is spent on these trials to risk loss from seedling disease. Apron is inexpensive and is recommended for use on many other crops for control of various diseases.

D. Striga Control

Integrated control, using as many methods as possible, as outlined by Dr. Bedawi of the University of Khartoum is recommended.

Since seed produced in Sudan cannot be exported to many countries due to a fear of striga introduction, the developing seed industry in Sudan must make a strong effort to control this weed. Such control is essential to making Sudan grain production profitable in many areas where this pest is prevalent. Hybrid sorghum seed or improved varieties of sorghum seed that were produced in areas where striga was allowed to mature seed should not be sold.

In sorghum trials which contain striga, the percent striga should be a part of the data collected from each treatment, since many cultural practices appear to aid in the control of striga.

E. Use of Fertilizer

Recommended rates of N and P, based on soil test and trial results, not only increase yields, but there is some evidence that N is a good aid in striga control. In split applications of N, the first application should be made prior to or at the time of planting; the second application should be made prior to the boot stage.

Each grower should make trial applications of N and P to determine rates that are most compatible with other cultural practices used and that are most profitable. Application should occur at least 5.8 centimeters to the side and 5.8 centimeters below the seed when planted and within reach of the root of established plantings.

F. Harvesting Seed

Male rows should be harvested first. If border rows of male were not planted, a 4 to 6 meter border of female around the field should be harvested and used as grain, not as seed. Stubble of male rows should be harvested before harvesting the female rows.

Harvesting should be closely supervised by trained personnel to ensure no added mixtures of other seed, sorghum, or weed seeds occur. Moisture content should be monitored and held below 13 percent.

At harvest, each field or portion of fields should be identified by a lot number which should remain with the seed throughout processing or until marketed. Quantity of seed in each lot should be as small as practical. Downwind sides of fields and portions of fields with expected problems should be kept in separate lots.

The seed crop may be defoliated with a suitable and approved chlorate compound provided the sorghum is physiologically mature (indicated by good coloration), if newly emerged striga exists without seed, if other late emerging undesirable plants have not yet made seed, or if other reasons exist which make early harvest desirable. Stalks from chlorate treatment can still be fed without danger, and grain from the male plants and screenings from the seed can still be used as a food. Palatability is actually improved by the chlorate. Caution should be exercised to ensure that the product plants used are approved in Sudan and label instructions must be followed.

G. Storing Seed

At harvest, all seed should be treated with a new product--Reldan 4E from Gustafson. The cost in the United States of this product is $160 per gallon, or 1.6 cents per bushel to treat sorghum seed. It gives one year's protection from all storage pests, yet is safe for human consumption directly after treatment. This could also be interesting to buyers of grain in Sudan or farmers who store grain for resale or for their own use. Regular inspection and fumigation with Phostoxin or other approved chemicals should be practiced at all times when seed is in storage.

Controlled temperature and humidity are recommended for all stored breeder and foundation seed stocks and may be necessary to maintain good germination for carryover stocks of hybrid seed.

H. Processing Seed

Seed should be cleaned to at least 98 percent purity. Cleaning and treating of seed should be closely monitored by trained personnel. Seed samples should be collected regularly

by lot or sub-lot, and all bags should be marked according to their origin. Germination and other quality control test samples should be forwarded to laboratories regularly for analyses.

Packaging should be in much smaller bags than the "bag" or "sack" commonly used in Sudan. The high price of hybrid seed and the size of many farms indicate that packages as small as 5 kilograms to a maximum of 25 kilograms are more appropriate.

IV. CERTIFIED HYBRID SORGHUM STANDARDS AND INTERNATIONAL ACCEPTANCE

Using all the best possible conditions of hybrid sorghum seed production, undesirable sorghum pollen can at times remain viable while traveling great distances.

A. Certification Problems

The only way to assure market quality of hybrid sorghum seed is to plant some of the seed in the off-season prior to marketing to determine the degree of outcrossing. If seed with a high percentage of off-types is put on the market, the "hybrid weed" problem could become serious early in the establishment of the industry. The "hybrid weed" problem could seriously affect the hybrid sorghum program in its infancy. Quality in regard to off-types and freedom of striga and other objectionable weeds is essential if the hybrid sorghum seed program is to expand in Sudan and if hybrid sorghum seed produced in Sudan is to be accepted outside the country.

B. Certification Requirements to Permit International Acceptance

1. Striga

Striga should be listed in certification standards as an objectionable weed.

2. Isolation

The isolation distance, as established for certification, from grass-type sorghum and sorghums of a greatly different height and maturity is inadequate as a "guide" to produce hybrid seed of a quality that would be acceptable outside of Sudan.

The isolation distance of 400 meters for male sterile certified seed is inadequate. At least 3.2 kilometers from any sorghum is required to produce quality sterile stock seed.

3. Purity

Varietal purity grow-out test standards are already liberal and should not be relaxed. Seed produced will have to exceed these standards to be accepted in most areas outside of Sudan.

All hybrid sorghum seed produced or imported into Sudan should be grown out or should be accompanied by a grow-out test, whether the seed is to be certified or not certified.

V. RECOMMENDATIONS

A. Recommendations for Monitoring Hybrid Sorghum Seed Production

Recommendations are presented based on current sorghum seed production technologies and observations from visits during the adviser's three month tour of duty in Sudan. See the Appendix for observations.

With the hybrid sorghum seed program being an important part of USAID programs, the services of an experienced hybrid sorghum seedsman should be maintained for monitoring hybrid sorghum seed activities. Duties, among others, should include the following:

1. Keep accurate records of seed being produced with regular updates of potential quality and quantity.

2. Regularly survey crop conditions and planting intentions to identify seed needs for timely and orderly action.

3. Encourage and assist private seed growers with cultural, production, processing, and marketing requirements.

4. Assist NSA and others with the production of quality foundation seed certification.

5. Assist NSA to correct certification problems and maintain or upgrade standards.

6. Locate sites more suited for hybrid seed production than those currently used.

7 Assist USAID officials with contracts involving seed, where terms and conditions of the trade are unique to the seed industry.

8. Encourage and assist in the formation and establishment of new private seed enterprises.

9. Coordinate or monitor the activities of Intsormil, IITA, ARC, other AID institutions, and public institutions related to hybrid sorghum seed development and use in Sudan.

10. Solicit the support for hybrid seed development in Sudan from the Texas Seed Association, Southern Seedsmen, and American Seed Trade Association.

11. Solicit the support of American universities and other organizations with strong programs to develop hybrid sorghum.

12. Assist the GoS with drafting and implementing meaningful and workable seed laws.

13. Assist the Agricultural Bank of Sudan and other lending institutions in establishing systems to make capital available for developing and expanding private enterprise to purchase parent seed, hire labor, and pay contract growers as well as to transport, process, store, market, and carryover stocks of unsold hybrid seed.

14. Assist in establishing banking programs for traditional farmers to obtain money for the purchase of the higher priced hybrid seed.

15. Assist USAID and GoS in establishing revolving funds for seed.

16. To contact and encourage visits and investigations of seed opportunities in Sudan by the private sector of the United States seed industry.

17. Advise USAID officials on the reliability and potential of hybrid sorghum seed production both in Sudan and in the United States.

18. Assist USAID development programs for distribution of USAID purchased seed which will not interrupt or compete with the private sector.

19. Assist with organizing a Sudan Seed Trade Association to bring together all parties from private and public sectors who have an interest in research, production, quality control, processing, and marketing seed. Parties from both Sudan and abroad should be included.

20. Assist GoS extension with the promotion of hybrid sorghum seed.

21. Collect and distribute information of particular importance to seed growers; i.e., improved chemicals, machinery, method of production, processing, marketing, and new publicly released parent lines.

22. Assist NSA and ARC to establish standard seed trials of commercially available hybrids.

23. Encourage and assist ARC to include all released parent lines in trials of plant population, planting rate trials, fertilizer trials, herbicide trials, etc.

24. Assist USAID in placing bid notices with seed trade organizations which will reach all interested parties.

25. Encourage and assist NSA and ARC to include private sector seedsmen on the Release Committee for public developed parents.

26. Assist NSA in securing high quality hybrid sorghum seed samples for quality comparisons by Sudan producers.

27. Assist NSA and seed producers with grow-out readings and training to read grow-outs.

B. Recommendation on Role of NSA and Their Relationship with Private Seed Producers

1. Seed produced by NSA should be limited to the seed needs of GoS-controlled schemes. Seed produced in excess of the requirements of these schemes should be sold to private seedsmen by bid for marketing.

2. NSA should maintain supplies of foundation seed stocks, but should not have a monopoly upon seed stock production or marketing.

3. NSA should encourage and assist private growers in any way possible.

4. NSA should assist private seedsmen with importing improved and higher quality stock seed, hybrids, and varieties of sorghum and other crops. Any improvement in seed supplies should be recognized as a step forward for Sudan.

5. NSA should be responsible for implementing and enforcing seed laws, including certification and quality control measures.

6. NSA should advise and assist the ARC in establishing standardized trials of commercially available hybrids from abroad. These should be planted in all major areas of sorghum production. Should a need arise to import seed, acceptable hybrids would then be known.

Contributors of hybrid seed samples who feel that their hybrids performed well enough in these trials to compete in the Sudan market should be encouraged and assisted by NSA to import enough hybrid seed for large-scale farm trials. They should also be encouraged and assisted by NSA to license, franchise, or conduct joint ventures with a Sudanese enterprise to import seed stock for production and to produce and market the hybrid(s) in Sudan.

Since Texas is the world leader in hybrid sorghum seed production, the NSA should benefit from cooperation of TSTA, TAMS, and Texas Technological University to establish standardized trials of commercially available hybrids.

7. NSA should vigorously support extension efforts to promote the use of quality hybrid sorghum seed.

8. To encourage seed development, NSA should emphasize, and work towards quality seed and private sector involvement.

9. NSA staff should visit the United States private sector seed industry and the public institutions contributing to sorghum development.

C. Recommendations For Strengthening Sudan's Private Sector Seed Industry

1. USAID should encourage the establishment of seed laws which require only quality seed to be sold. This is necessary to prevent production of poor quality seed in the industry.

2. USAID should assist in the establishment of seed laws which permit the timely introduction of improved seed and seed stocks. The private industry cannot be developed with every party producing and selling a generic hybrid, which is the case at this time.

3. USAID, other AID organizations, and GoS entities should develop programs for distributing seed purchased or produced by public and AID organizations through the private sector market. This would complement the private sector rather than becoming competitive with it.

4. USAID should monitor, assist, and advise the GoS on seed laws to establish laws which do not unduly restrain the private seedsmen in conducting business.

5. Private seedsmen should join an association which includes all parties with an interest in exchanging ideas and information.

6. ARC should be encouraged to release breeder seed of EEH1 and EEH2 to private seedsmen for increase of parents and hybrid production. Other suitable lines should be released as developed, allowing the private sector to determine the place in the market. Seed production costs will prohibit unsuitable hybrids from being produced by seedsmen. The expertise needed to produce hybrids with difficult problems of production is a challenge to seedsmen. Many times the hybrid seed which is difficult to produce is the best commercial grain for an area. If seed stocks are available, the private sector marketplace should determine if the hybrid should be produced. Private companies should also be allowed freedom to maintain private lines and produce private hybrids.

7. If standardized trials of commercially available hybrids are not established in Sudan, private sector seedsmen should solicit samples of commercially available hybrids for their own trials.

8. Sudan private sector seedsmen should visit the United States hybrid sorghum seed production areas, preferably in September.

9. Sudan private sector seedsmen should invite United States hybrid sorghum seedsmen to Sudan for discussion and investigation of possible license, franchise, or joint venture.

D. Other Project Recommendations

The hybrid sorghum seed production program serves the general objective of the BNIADP which states "Increased production and income of the traditional farmers in the rainfed area." The following recommendations to the BNIADP seed program are presented to assist farmers with sorghum production. They are presented in addition to, and not place of, the recommendations given for producers of hybrid seed throughout Sudan.

Also included are other recommendations not directly related to seed production, but which do relate to the general success of the BNIADP. These related recommendations are based solely on observations of BNIADP activity and are not based on findings.

1. The following additional data should be collected from all BNIADP sorghum trials at all locations and in seed fields.

   - Accurate bloom data of initial bloom, 50 percent bloom, and final bloom of all treatments and seed parents.

   - Percent of striga infestation from all treatments and all trials.

- Accurate population data from all treatments, all trials, and both parents in seed fields. Mark areas in seed fields where populations are counted and take bloom data from these areas.

- Establish inter-row cultivation trials in seed production fields. In addition to data normally collected, measure the effect on following crop.

2. The BNIADP should assist the seven cooperatives in the project area to organize and establish a private cooperative seed company with flexibility to allow for additional membership. Assistance to cooperatives should be as follows:

   - Arrange a "forward contract" price to produce the newly formed company's seed needs.

   - Assist the Cooperative Seed Company to establish a marketing system to service the large mechanized farm in the Damazin area.

   - Provide technical advice to the cooperative on cultural practices to obtain maximum performance of hybrid seed.

   - Produce all other seed crops needed by the Cooperative Seed Company on a forward contract basis.

   - Assist through extension, including the women's extension, the promotion of benefits to be derived through planting improved seed.

   - Assist the cooperative in determining the seed needs of the project area and of the area around Damazin which the coooperative can service.

- Assist the cooperative in booking seed for 1987 delivery to be produced in 1986 with some seed going to the large mechanized farms.

- Assist the Cooperative Seed Company in conducting field days and tours of BNIADP seed fields and research plots to promote hybrid sorghum and other improved seed.

- Assist the Cooperative Seed Company to develop business affiliations with other Sudan seedsmen to facilitate movement of excess supplies to seed deficient areas.

- Assist the cooperative in an investigation of possible joint ventures with established seed companies in Sudan or abroad.

- Make all arrangements for the forward contract price to the cooperative. Include all production, harvesting, transport, processing, supervision, storage, seed treatment, bags, government fees, a return to land use, and a profit for BNIADP.

- Assist the cooperative to establish a good working relationship with government agencies, research organizations, the AID organization, and all other groups interested in seed development in Sudan.

- Assist the Cooperative Seed Company in obtaining supplies of improved seed not produced by BNIADP.

- Make clear to the cooperative members that they are free to produce their own seed, and encourage them to do so when they are capable of it. Inform members that they are free to purchase seed from other sources without BNIADP support, assistance, or restraint.

3. BNIADP should locate a suitable site for hybrid sorghum seed production which can be irrigated.

4. BNIADP should establish a soil conservation section or develop a joint program with GoS soil conservation.

5. BNIADP should develop a program for constructive work during the rainy season for women's extension and other section personnel not active at the Damazin headquarters.

6. BNIADP should strengthen the Livestock and Range Management Section.

7. BNIADP should involve all sections in the promotion and development of the hybrid seed program.

8. Make immediate arrangements for all input needs for harvesting, processing, and marketing of 1985 seed production.

9. Discuss with USAID and GoS the need for a Uni-Mogg or similar transport vehicle for seed supplies and personnel during the rainy season.

10. BNIADP should invite the entire agricultural staff of USAID/Khartoum and GoS authorities to visit the project area and the Damazin offices. The favorable impact of the project would be observed and the potential for expanding the project area should be analyzed.

VI. CONSTRAINTS IN REALIZING OBJECTIVES

The extremely short two-week notice of this assignment did not allow for a search for background material on hybrid sorghum seed production in Sudan before the adviser's arrival.

A search for background material after arrival in Sudan resulted in finding that some material either did not exist or could not be found. The material found was only sketchy and most of the background information was gained from conversation with people who had some involvement or observation of the 1984 Hageen Durra-1 seed production. Most of these oral reports were contradictory, which limited the adviser's knowledge of Hageen Durra-1 seed production in Sudan.

The beginning of the assignment was too late in the planting season for recommendations on site selection and planting to be of much benefit for the 1985 production.

The inability to make timely trips due to poor roads, broken boats, the rampaging Blue Nile River, and the limited number of boarding passes on Sudan Air has restricted the number of visits to private growers and NSA. Much time was lost in waiting for transport to production areas.

Poor lighting or, in many instances, no lighting resulted in having to perform much homework during the daylight hours. This limited outside activities and assistance in the production fields where it was most needed.

Poor phone, telex, and mail service has resulted in not getting technical material from the United States on many chemicals planned for inclusion in this report. When received, this material will be made available to USAID, BNIADP, and others as requested. Work was inhibited by the Sudan Id and New Year's Holiday.

VII. CONCLUSIONS

Sudan hybrid sorghum seed producers are faced with some problems, the most important being the amount of wild sorghum in Sudan; nevertheless, quality seed of Hageen Durra-1 can be produced in Sudan if production is properly managed. Many individuals in Sudan now have some experience in hybrid seed production and a good understanding of the principles in quality production.

If recommendations presented in this report are followed, quality hybrid sorghum can be produced and marketed in a competitive manner with minimal restraint and competition from government institutions. Government programs should assist the developing industry with meaningful and workable seed laws and quality control measures. The BNIADP will contribute favorably to the developing private sector seed industry. With free competition, the profit motive, and quality seed production, the Sudan industry will evolve. It will produce and market quality seed above the present standards, and Sudan-produced seed will be accpeted by the international community.

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APPENDIX

APPENDIX

A. BNIADP Research Farm at Damazin

Numerous trips to the BNIADP research farm have allowed the adviser opportunity to witness the death loss of sorghum due to severe seedling disease diagnosed as Seedling Leaf Blight (Helminthosporium species). There appears to be a complex of other seedling diseases also present. The disease problem seems to be affecting only certain planting dates and was triggered by excessive cold rains at time of emergence.

All other trials on the farm are well planned and cared for. They look good, but are in need of rain which has been limited to the Damazin area.

B. BNIADP Seed Farm and Project Area at Abu Gumai

A trip was made by the adviser to the project area September 4 accompanied by Dan Callery and Ken Ingvalson of Experience, Incorporated. Also on the trip were Mohamed Abbas, Babekir Salih, Yousif Jaffar, and Mohamed Saeed, from the BNIADP staff.

The influence of the project was observed en route. The approach to the area revealed more and more plantings of the improved varieties of sorghum--Gadam El Hamman and Dabar. Entering the project area was like entering a different country. Crops were all planted to improved varieties, fields were free of weeds and with proper plant spacing, fields were neatly laid out, and plant color and growth were good. It is obvious that this is a government project that is showing good results.

The tour covered the project cooperatives of Abu Gumai, Din Din, Esseil, and Banat. The area observed included 9,000 feddans in 25-feddan blocks of individual farmers' cropping. Crops were mainly Gadam El Hamman Sorghum and Zira 7 Sesame. It appeared that good yields could be expected with adequate rain.

The BNIADP seed farms had 100 feddans of Zira 7 sesame which looked good. Eighty feddans of Gaddam El Hamman with some seedling disease damage were observed. This appears to be recovering and shows promise of a good crop.

Hageen Durra-1 seed production suffered severe death loss from seedling disease. Only 23 feddans remain of the 57 originally planted. These 23 feddans were in the three to four leaf stage and were suffering from seedling disease. Many plants had died but the remaining plants showed signs of recovery.

An error was made in site selection, land preparation, and planting of the Hageen Durra-1 production on an excessive slope. This error is acknowledged by the BNIADP staff. Observations were: planting rates were correct, with each parent at 3 kg. per feddan, no split planting, a row pattern of 2 and 4, no fertilizer, and a row width of 65 cm. Plant population was poor due to seedling disease. Even with good nick and adequate rains projected, yield will be low due to population. No objectionable plants were observed in or around the field. Quality, if properly rogued, should be good.

The staff seemed qualified and knowledgeable in Hybrid Seed production. Barring uncontrollable problems, a good hybrid seed crop should be produced by BNIADP next year.

Sorghum in the Abu Gumai verification farm trials and in many on-farm trials in the project area are severely damaged by seedling disease.

C. Jaroof Area
(Recessional Land Near Roseries Reservoir)

Accompanied by Osman Yousif as interpreter and Experience, Incorporated adviser Duane Eriksmoen, a visit was made to a traditional farmer to learn of his difficulty in getting enough money to purchase improved seed. Observations were made of native wild Sudan Grass and Striga.

D. Damazin and Roseries

Traveling around the Damazin and Roseries area provided an opportunity to observe traditional land preparation, fence building, planting, and weeding. Observations were also made of the tall and late maturing varieties of sorghum which are common to Sudan.

E. Abu Dum

Accompanied by Experience, Incorporated adviser Duane Eriksmoen, Dan Callery, and Osman Yousif, a visit was made to the Damazin Agricultural and Animal Production Farm (Fisal Farm), at Abu Dum July 5-7. Mr. Hamid Mohed Mahmoud, Executive Manager of the farm, served as host and guide.

The farm is rainfed and contains a total of 500,000 feddans. The goal for 1989 is to have 310,000 feddans cultivated and to plant 105,000 feddans of sorghum. Plans are to use the balance for soybeans, safflower, sunflower, sesame, and cotton.

The present area contains 57,000 feddans of sorghum planted with 8 tons of Pioneer W823A, 8 tons of Funk G-550, 1 ton of Hageen Durra-1, and the balance planted to many different local varieties. No fertilizer has been used. All land preparation and planting has been done with a widelevel disk drill. All the sorghum that was observed was suffering severe death loss from seedling disease and appeared to need replanting.

Past sorghum yields were reported to average 1,000 pounds per feddan. The soil, climate, and average rainfall indicate the potential for a much higher yield. The use of the widelevel disc drill and local varieties of seed are the most limiting factors to grain production on the farm.

Other crops planted are 10,000 feddans of cotton and 3,000 feddans of sesame.

Mr. Hamid indicates a strong interest in Hybrid sorghum seed and a willingness to cooperate with BNIADP in seed matters.

F. Abu Naama - Arkel International Seed Farm

Robert Martin, Arkel International Seed Project Leader, Ian Horton, Arkel Seed Site Manager, and the Experience, Incorporated Adviser visited the Arkel Seed Farm at Abu Naama from August 20-22. Observations were made of 500 feddans of Hageen Durra-1 seed production hand planted around July 15. Planting was in hills with two to three plants per hill. Hills were 30 centimeters apart in 60 centimeter rows. No split planting was done, the row pattern was 2 and 6, the crop was about knee high, and fields were free of weeds. The isolation problems appeared to be managable and work on isolation improvement was in progress. Some fertilizer had been applied and additional use of fertilizer planned. The plant color was good with a population of male and female being about equal. Yields should be good. Quality, if properly rogued and isolation maintained, should be good. Prospect for nick appeared probable. Another 150 feddans of Hageen Durra-1 which were machine planted about August 13 was not well established and some replanting was in progress. All staff appear to have a good understanding of hybrid seed production and are working for a quality crop.

G. Abu Naama ARC Station

Dr. Ibrahim Noureldin, sorghum breeder, gave Mr. Martin and the adviser a tour of the station on August 21. Of particular interest was the Sudan National Hybrid Trials which contain two hybrids of seed produced in Texas. All sorghum trials at the station looked good.

H. Sennar

On August 22, accompanied by Mr. Robert Martin and Mr. Ibrahim Osman Salih, the Arkel technologist, and the Experience, Incorporated Adviser visited a Hageen Durra-1 seed production field of the Plant Propagation Administration--NSA, at Sennar. The 100 feddans of seed production observed were machine planted July 15. Original stands appeared to have been excellent. Death loss attributed to Sorgoprim had destroyed over half of the original stand. Some evidence of seedling disease exists in the field. Gaps had been replanted. The resulting population was in the 2-3 leaf to pre-boot stage. Prospects for a good yield and quality appeared to be slim.

While at Sennar, a meeting was held with Dr. S.K. Banerjee, FAO Seed Technologist, and Dr. Ahmed Abdel Aziz, head of PPA Seed Production Division.

I. Barakat

On September 15, the adviser was taken by Dr. George Ghobriel, Senior Agonomist, USAID/Khartoum, to Barakat to see the Hageen Durra-1 seed production of the Sudan Gezira Board.

Mr. Waagil Samoul, Director of Sudan Gezira Board Seed Production and Mr. Omer Fadeil, NSA leader for Hybrid Sorghum Seed Project accompanied on the visit to the seed fields. Three

fields were visted. All fields were free of weeds and relatively free of wild sorghum. The plant color was good. Row pattern was 2 and 4, which was machine planted with the gaps hand planted in field No. 3. No split planting was done. In field No. 1, the female was beginning to bloom and early planted male border rows blooming. Male rows were 203 days behind female in blooming. Female population was excellent. The male population was much less than the female. In Field No. 2, there were no male border rows. The female planting was an excellent stand and in bloom for about 5 days. The male stand was very poor and expected to bloom in a couple of days.

Field No. 3 had suffered damage. This was reported to be from Sorgoprim. The male and female stands were very poor. The original planting was hand planted and gaps had been hand planted at all stages of development. The prospects for quantity and quality seed were very poor.

If adequate isolation is maintained and fields 1 and 2 are properly rogued, they should produce a much better seed crop than last year. Mr. Omer Fadeil appears knowledgeable in hybrid production and is also quality minded. Under his direction, production of Hageen Durra-1 seed by NSA should continue to improve.

J. Dongola - Trip No. 1

Mr. Mustafa Mahmoud, Tenneco Farm Manager, was host and guide to the tour of Tenneco Farm and Dongola on August 16-19. Tenneco Farm is in the desert five miles west of the village of Binna on the Nile. The farm is irrigated by four drilled wells. Tenneco had five feddans of Hageen Durra-1 seed production hand planted on pre-watered land. This was planted about July 15 in hills with several plants per hill. The hills were spaced about

0.3 meter apart on ridges 0.6 meter apart. No irrigation had been made since pre-watering, and plants were severely moisture stressed.

Fifteen feddans had been machine planted, watered, and a stand established. Areas approximately one feddan in size contained wild sorghum which merged with the seed production. A crew was removing the wild sorghum. Stands of both male and female were excellent. The row pattern was 4-8. There was no split planting, but the hand planted five feddans on the downwind side should provide early pollen. Plant color of all planting was good. Fertilizer application was planned.

Surrounding isolation appear excellent. If the wild sorghum is properly controlled and the roguing and irrigation are timely and proper, a good quantity and quality of seed should be produced.

Another five feddans has been planted to Hageen Durra-1 seed production and was being watered. An additional 20 feddans of production is planned.

Mustafa and the adviser visited several small farms using hand-dug wells as a source for irrigation. These farmers were presented some HD-1 Hybrid Seed for trial planting. Discussions were held on proper planting and spacing for the hybrid and the expected benefits.

K. Dongola-Trip No. 2

Steve Kontos, of Tenneco; Mr. Ahmed Rubo, of the Ministry of Finance; Dr. Abu Elgasim, the Director General of NSA; Dr. Ahmad Abdel Aziz, the head of Seed Production of PPA; Abdulah El Haleem, Head of PPA Station at Dongola; Mustafa Mahmound, of Tenneco; and the adviser toured the seed production area of Tenneco on September 10.

Twenty feddans of Hageen Durra-1 seed production were in pre-boot stage. Fifteen feddans were in 2 to 3 leaf stage and another 15 feddans planned for planting. Fertilizer had not been applied. Some areas of the early production were moisture stressed. The removal of wild sorghum had not been properly supervised and was an increasing problem, due to difficulty in finding it in the taller sorghum.

Wild sorghum was blooming and some females were due to bloom in a few days. Chance of nick appeared good in areas not stressed. Male and female populations were equal.

Wild sorghum now appears to be on the entire farm. It is unlikely that quality seed will be produced on the farm this year or any time in the near future.

Tenneco could develop nearby land, using existing wells for irrigation of hybrid seed.

Mustafa and the adviser visited the farms that had planted with Hageen Durra-1 seed which had been furnished by Tenneco for demonstrations. It had been planted in the traditional manner with five to ten plants in hills. Benefits of the hybrid are not likely to be realized without improvement in cultural practices.

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