

Final Report-Part II
Tropical and Subtropical Fruit
Improvement Project



Yemen Arab Republic
Contract Number 279-0024



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Acknowledgments

The Tuskegee/Yemen Tropical and Subtropical Fruit Improvement Project was a success of major proportion. This observation recognizes the fact that neither Tuskegee's goals nor its aspirations were achieved in all cases. In spite of this, the successes were admirable to say the least.

Tuskegee's successes were the product of input, cooperation and support by a multiplicity of individuals, teams and agencies. We are especially pleased with the receptivity experienced in meeting, living and working with the peoples of Yemen.

The Ministry of Agriculture provided indispensable support to the efforts of Tuskegee Institute. For all of this, Tuskegee is most grateful.

It goes without saying that the involvement of Tuskegee Institute in the Yemen Horticulture Project was due in large measure to the support provided from the United States Agency for International Development (USAID) at home and abroad. A special vote of thanks and appreciation is extended to the AID Mission in the Yemen Arab Republic for the advisory, administrative and logistical support provided to Tuskegee in connection with this project.

Finally, Tuskegee Institute is most grateful to project personnel including those on short-term and long-term professional assignments and to the many Yemeni Nationals who rendered invaluable services in the field operations.

In our opinion, the Horticultural Improvement Project was a mutually rewarding experience for the Agency for International Development, for the Yemen Arab Republic and for Tuskegee Institute. For all of this we are most grateful.

B. D. Mayberry
Project Director

Executive Summary

In February of 1977, Tuskegee Institute responded to a request by USAID for a proposal to Conduct an Adaptive Research and Development Program for Selected Horticultural Crops, in Yemen (based on a project paper and other developments which had been under discussion for two to three years.) This proposal led to a contract which was signed and made operative in May of 1977.

Description of Services

In cooperation with the Yemen Arab Republic Government, while working in collaboration with a horticulture team provided under a separate contract and with other donors, all under the project management of the USAID food and agriculture officer, Tuskegee Institute proposed to plan and direct the following:

- Screen high producing varieties of tree fruit vine and nut crops and select plant material of potential importance for Yemen.
- Study common horticulture production practices and identify improved practices of potential benefit to increased yield for the selected fruit crops.
- Plan and manage adaptive research of varieties and cultural practices at government research stations and on farmers plots.
- Undertake selected economic and sociological research related to horticultural production and use.

- Assist in the planning of institutional improvements and staff training for the horticulture program of YARG.
- Assist in dissemination of proven high producing varieties and cultural practices identified in the project.
- Train counterpart Yemeni staff to undertake the program features above.
- Assist in preparation of a list and specifications of plant materials, production supplies and other commodities necessary to implement the project.
- Provide professional and technical cooperation for the staff horticulturalist to be provided for the project under a separate contract.

Within three (3) weeks of the signing of the contract, the Tuskegee Institute project director and Dr. B. T. Whatley went to Yemen and developed the long-term work program.

Within 2 months of the signing of the contract two long-term professional horticulturists were identified. After receiving preliminary approval by AID/Washington, they were placed in orientation in Washington in preparation for departure to Yemen. In the meantime, they were rejected by the Mission and/or the Ministry for reasons not previously in the contract (age, language, degree levels, etc.).

At this point, the personnel requirements were changed to include age limits (30 to 40 years) Arabic language competency and the Ph.D. Degree in the specialty. This caused serious difficulty and delay in recruiting professionals with acceptable qualifications. Ultimately acceptable professionals were recruited and sent to Yemen.

By the time of the arrival of the long-term staff the major focus of the project was changed from research experimental and demonstration to the production and acquisition of plant materials for distribution to farmers.

Although Tuskegee Institute was not involved in the decision to change the focus of the project, we made a strong effort to comply. This effort was seriously hampered by the failure and/or delay in the in-country support and back-up which were spelled out clearly in the original contract. Some of the factors in this regard included land acquisition, facilities (housing, utilities, irrigation) and access roads to the remote station at Jarouba. Other difficulties were caused by a reduction and in some cases, a discontinuation of logistical and administrative support by the Mission.

In spite of the difficulties, Tuskegee was successful in establishing very impressive plantings on two government experiment stations.

The Bir Al Shaif Station in Sanaa was planted as planned in the program of work which was developed in the summer of 1977. The trees were progressing admirably; however, the station was in the path of urban development and thus essentially demolished by the Yemen government. Near the end of the project, a new site for the station was identified, no time was left however, for development.

During the last two years of the project some very substantial gains were made at the Jarouba station. This included the production of thousands of seedlings for budding and grafting purposes and the establishing of field plants of citrus, papaya and banana crops.

In an effort to comply with the change in focus of the project, Tuskegee Institute devoted the later years to the purchase of seeds for root stock production for budding and grafting and to importing budded and grafted trees. This process resulted in the production of 70,000 citrus seedlings and importing 7,565 trees for distribution to farmers. The original contract called for a socio-economic study of the impact of the proposed horticultural development. Because in-country de-emphasizing this was not completed. Tuskegee had planned to provide training for a substantial number of Yemeni nationals in applied horticulture. Since the candidates were not identified, the training was not provided.

Finally, the Yemen horticultural project was a rewarding experience for Tuskegee Institute. We will welcome the opportunity to return to Yemen on another assignment.

The Yemen Arab Republic

The Yemen Arab Republic is located on the southern edge of the Arabian Peninsula. It is bordered in the north by Saudi Arabia; in the south and southwest by People's Democratic Republic of Southern Yemen; in the west by the Red Sea; and in the east by the Great Arabian Desert.

The diversity of the country's altitude, landscape and climate is enormous. The population has recently been estimated at 6.4 million of which more than 80% is directly engaged in agriculture. In 1974 horticulture products accounted for 10% of all food imports.

The major cities are Sanaa (pop. 134,000), Taiz (pop. 78,000), and Hodeidah (pop. 80,000). The Yemen Arab Republic covers an area approximately 117,800 square miles which is about the size of the state of Arizona (113,000 square miles) and is divided into four geographic zones:

1. The Tihama (sea level to 650 feet) where Hodeidah is the main city, includes the coastal plains about 20-40 miles wide and about 1000 miles long bordering on the Red Sea. This is the tropical area of the country which receives from 3-8 inches of rainfall annually.
2. The Southern Uplands where Taiz is the main city and consist of the slopes of the mountains parallel to the coast behind the Tihama. This is the most intensive agricultural area in the country, which is due to the amount of rainfall in this zone -- about 30 inches annually. The elevation of this region ranges from 650 to 8000 feet above sea level. This is the subtropical zone of the country.
3. The Central Uplands with elevations from 4000 feet includes the capital city of Sanaa at 7,300 feet. Agriculture is intensely grapes and gardens with a variety of vegetables. The temperature is mild and rainfall is low. Irrigation is required,

4. The Eastern Region is a semi-desert plateau. The natural vegetation is scanty, mainly composed of acacia spp., salvadora persia and aristida spp. This region slopes toward the Rob Al Khale desert.

The first three zones mentioned above are of major importance for agricultural production and differ considerably in altitude, rainfall, and temperature from the rest of the country. The USAID Mission/Yemen and AID/W developed plans for Tuskegee Institute to work in the Tihama zone at Wadi-Rema and the Central Upland zone at Sanaa/Bir Al-Shaif.

Tuskegee Institute

Tuskegee Institute -- a multidiscipline, co-education, historically black university -- offers a unique, marvelous and exciting educational experience in the Deep South. From its humble beginning in 1881, as an arts and crafts teacher training trade school, there evolved a major collegiate and graduate center of excellence that is fully accredited by the Southern Association of Colleges and Schools. Professional programs in hospital dietetics, nursing, engineering, chemistry and veterinary medicine are also accredited by national accrediting agencies. Equally impressive programs are conducted in agriculture, architecture, arts and sciences and technology, human nutrition, industrial technology, teacher education and human resources development.

Tuskegee Institute's commitment to and involvement in international development began before the turn of the century when, in response to an invitation by the colonial committee of Germany, a task force was sent to West Africa to provide technical assistance in cotton production. International development continued to be a major focus of the Tuskegee program.

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I. Rationale (Introduction)

Horticultural crops of many kinds appear well adapted to certain areas of the YAR though these areas are limited. These areas are those where there is adequate rainfall, where irrigation is feasible or where available rainfall, though inadequate over a large area, can be concentrated and stored as in the numerous terraces so prevalent in the mountainous spine of the YAR. (These terraces, some of which had produced sorghum and millet but now are going out of production, may well be adapted to higher unit value crops such as grapes, apricots and nuts which have the potential for much higher labor return). Irrigation potential is greatest in the Tihama and numerous small wadis, while the major significant area of adequate rainfall is in the Taiz/Ibb area.

While water, and to a lesser extent soil, will be constraints to increased horticultural production, it does appear that adapted introduced varieties and a set of improved cultural practices could greatly increase yield. For example, Dr. Taye Dezumeh, June 1974 report, Prospects for Horticultural Development in YAR (available upon request from NE/TECH/AGR) indicates that a wide range of horticultural crops can grow successfully in Yemen and that adapted introduced varieties combined with improved cultural practices would greatly increase yield and quality. This same observation is made by other agriculturists with horticultural experience. Further, while no adequate research data exist to prove the above assumption, the limited adaptive trials conducted by the Germans on a few vegetables and the vegetable work at Wadi Zabeed indicate excellent potential from a combination of introduced varieties and improved cultural practices.

On the basis of the background expressed above, Tuskegee Institute contracted with AID/W to undertake an adaptive research and development program for selected horticultural crops in the Yemen Arab Republic.

II. Objectives

During the contract negotiation period a comprehensive set of specific objectives was developed based on the purposes and background of this project. Incidentally, this project was revised nine (9) times during the life of the project. In the process, the objectives were revised accordingly. These revisions are discussed more fully later in this report.

The original specific objectives as stated in the original contract included the following:

- A. Screen high producing varieties of tree fruit, vine and nut crops and select material of potential importance for Yemen.
- B. Study common horticulture production practices and identify improved practices of potential benefit to increase yield for the selected crops.
- C. Plan and manage adaptive research of varieties and cultural practices at government research stations and on farmers plots.
- D. Undertake selected economic sociological research related to horticultural production and use.
- E. Assist in the planning of institutional improvements and staff training for the horticulture program of the Yemen Arab Republic Government.
- F. Assist in dissemination of proven high producing varieties and cultural practices identified in the project.
- G. Train counterpart Yemeni staff to undertake the program features above.

- H. Assist in preparation of list and specifications of plant materials, production supplies and other commodities necessary to implement the project.
- I. Provide professional and technical cooperation for the staff horticulturalist to be provided for the project under a separate contract.

III. Program of Work

In an effort to achieve the objectives as originally planned, Tuskegee's early action included a trip to Yemen to make a preliminary study designed to facilitate the development of a detailed plan of work. In that first trip, we looked broadly at the socio-economic, cultural, environmental and agricultural factors that would affect the implementation of the project. Subsequently, a rather detailed plan of work was developed with a major focus on research.

A. Crops Planned for Study in the Government Experiment Stations

Tuskegee Institute restricted its efforts to a relative few crops as suggested in the project paper, Yemen - Tropical and Subtropical Fruit Improvement. The following are crops which were proposed for the respective zones in order of priority:

Sanaa - Bir Al-Shaif Experiment Station

- Grapes
- Apricots

The following crops should be established for observation only:

- Walnuts - English
- Sweet Potato
- Tomato

The Jarouba Experiment Station

- Sweet Oranges
- Limes

-- Banana

-- Papaya

The following crops should be established for observation only:

-- Dates

-- Sweet Potato

Because initially this was conceived as a research project, specific research planned for several of the crops destined for study includes citrus, banana, lemon, lime, papaya, mango, grapes and apricots.

1. Citrus

Sweet oranges and limes will have first priority at Wadi-Rema. These studies should involve rootstock cultivars, mulching, major and minor element nutrition and plant protection. Certified scionwood of the 'Washington Navel' and 'Valencia' should be obtained from the Willits and Newcomb nurseries in California. Certified rootstock of 'Cleopatra Mandarin' and 'Carrizo citrange' from Florida or California. The use of sour or seville orange for rootstock should be avoided because of its susceptibility to the virus disease called tristeza or "quick-decline." The budding should be 15 inches above the ground level in order to avoid infestation of the scions. Other reasons for budding on resistant rootstock are to obtain tolerance to lime, salt, chlorides, nematodes and other soil borne pathogens. 'Cleopatra Mandarin' is more salt tolerant than 'sour orange.' It has fair resistance to high lime and will tolerate chlorine. Selections of 'trifoliolate' and 'carrizo citrange' have been found to be resistant to nematodes. 'Sour orange', 'rough lemon', and 'cleopatra' resist drought better than other stocks.

(a) Plant Spacing:

In general, a spacing of 8 x 8 meters is best, but where all hand labor is used 6 x 6 meters may be used.

(b) Pruning:

Severe pruning will prevent flowering, encourage sucker growth and in the tropics there is the further possibility of spreading *Diplodia Natalensis*, gummosis. Therefore, pruning should be used only for convenience in harvesting, spraying, or to remove broken, dead and crossover branches.

(c) Mulching:

Mulching in the Wadi-Rema will accomplish the following: reduce soil temperature, conserve soil moisture, and control weeds. The best root development occurs at soil temperature of 80° to 90°F. There is a poor development below 60°F and the roots die at 105°F. It is recommended that a leguminous green manure crop be maintained in the citrus planting and that mulching material for individual trees be obtained therefrom. The green manure crop should be planted in a 5-meter strip between rows 1.5 meters from the plants on all sides.

(d) Plant Protection:

The objective of the plant protection program will be control of termites, black fly, leaf minor, scale insects and aphids.

(e) Potting of Rootstocks:

Immediately upon arrival of the rootstocks, they should be potted in 3-gallon, plastic bags with two to three holes in the bottom for drainage. A potting soil consisting of one part top soil, one part sand, and two parts dried-chopped alfalfa, by volume. Give this mixture a good dusting with insecticide or fumigate with methylbromide.

(f) Budding:

Since the scionwood will be brought into the country it will be important that the rootstock is growing vigorously and everything set for its arrival. The propagation technique recommended for citrus is "T-Budding".

(g) The Impact of the Citrus Study;

- 1) Increase crop diversification
- 2) Increase net farm income
- 3) Improve nutritional levels
- 4) Reduce imports of citrus

Limited amounts of citrus are cultivated in the Tihama region. Large amounts of sweet oranges are imported, since local production is not adequate. Proper care of existing citrus plantings can improve the number and size of fruit trees. Commercial fertilizers are rarely applied. Deficiencies of nitrogen and minor elements are common.

2. Banana

The banana is one of the most important fruit crops grown in the Yemen Arab Republic. The Tihama and the Southern Uplands zones are the major areas of production. Bananas are well adapted to Yemen. Excessive numbers of suckers are allowed to grow per mat.

Banana Cultivars to be included in the Study:

(a) 'Cavendish-Dwarf'

Planting material may be obtained from the Wadi Sorded in Yemen. This material should be free of the banana fruit spotting disease. Cavendish is well flavored, small fruit and resistant to fusarium spp.

(b) 'Grös Michel'

Planting material should be obtained from the United Fruit Company. This cultivar is adapted to shipping but is susceptible to fusarium oxysporum.

(c) 'Poyo'

This is an important cultivar and plant material should be brought in from Somalia. It is more robust than 'Dwarf Cavendish' but have similar organoleptic characteristics.

(d) Plant Spacing

- 'Dwarf Cavendish' 4 x 4 meters
- 'Poyo'. 4 x 4 meters
- Gros Michel 5 x 5 meters

(e) Suckers Per Mat

-- Dwarf Cavendish ,	3
-- Poyo	4
-- Gros Michel	5

The number of suckers that are allowed to grow per mat is necessary to obtain continuous marketable fruit, and to provide propagating materials.

(f) Flowering

Blossoming occurs 9 to 10 months after transplanting and the first harvest 90 to 150 days later.

(g) Fertilizers Application

Fertilizer application should be based on soil testing and plant analysis of samples taken within the plot.

(h) Plant Protection and Minor Elements

The plant protection program must control the following pest and physiological diseases; bacterial wilt, anthracnose, cigar end disease, fruit spotting disease, nematodes, aphids, thrips and other plant bugs. Two grams of the following should be added to each 50 gallons of spray material: boron, copper, iron, manganese and zinc. About 50 grams of mocap should be mixed with the soil at planting time.

3. Lemon

Lemons are grown much like oranges except that sometime more pruning is required; however, pruning is confined to interfering branches and dead or damaged wood. Lemons seem to adapt better to soil alkalinity than oranges.

(a) Lemon Cultivars

- 1) Meyer
- 2) Eureka

(b) All other cultural factors are the same as oranges.

4. Lime

(a) Lime cultivars to be imported:

- 1) Key Lime
- 2) Mexican Lime
- 3) West Indian Lime

All cultural practices are the same as those for oranges and lemons.

5. Papaya

The papaya is well adapted both in the Tihama and Taiz areas. The fruit is an excellent source for vitamin C and contains some vitamin A and B. Papaya may be cooked when green like summer squash or used as preserves, sauces or in pies. It is most commonly eaten as ripe fresh fruit. The papaya plant produces the enzyme "Papain" in both the leaves and fruit which is the active ingredient in meat-tenderizers. This fruit has great potential for export as soon as the local demand is met.

(a) Papaya cultivars -- all hermaphroditic

- 1) Solo
- 2) Bluestem
- 3) Graham

Local solo seed may be obtained from UNDP/FAO Taiz. Bluestem and Graham should be obtained from Hawaii. Seed brought into Yemen should be treated and certified as being true to cultivar name. These cultivars will usually fruit 100% because 2/3 of the plants are hermaphroditic and 1/3 female plants.

(b) Plant Spacing

The papaya plants should be spaced 3 x 3 meters.

(c) Maintaining true to type cultivars

None of the hermaphroditic papaya cultivars are stable and should be maintained by siblings or suckers.

(d) Flowering

The plants will flower the first year and some ripe fruit may be expected 9 to 10 months after transplanting in the field.

(e) Planting Renewal

The planting should be renewed every 18 to 24 months and rotated with other crops.

(f) Fertilization

The application of fertilizer should be based on the soil and plant analyses, however papayas respond well to high nitrogen fertilization, therefore two side-dressings with ammonia nitrate is recommended each year.

(g) Plant Protection and Minor Elements

The plant protection program should protect against the following pests: the green peach aphid and nematodes appear to be the major pests. All spray should contain both insecticide and fungicide to which is added one gram of boron, copper, iron, manganese and zinc per 50 gallons of spray materials.

(h) Handling of Seedlings

The seed should be sown in flats immediately upon arrival -- germination will take 3 to 4 weeks. At the two leaf stage, they should be transplanted in plastic bags using the soil mixture recommended for citrus rootstocks. When the plants reach a height of 6 to 8 inches they should be set in the field.

6. Mango

The mango is probably the most widely used tropical fruit other than bananas and citrus. It is especially adapted to areas with a definite dry and wet season. It is Asiatic in origin and definitely tropical.

(a) Procedure

- 1) About 2 to 3 thousand local mango fruits should be obtained.... the seed removed and planted immediately in specially prepared seed beds, with the point upward so that straight stems and tap roots will be produced. Mango seeds are very perishable.

2) Seedling should be transplanted to plastic bags when about 6 inches tall. When the stock reaches the stage of turning from green to brown or bronze -- or when about pencil size or larger they should be budded or grafted. The most successful type appears to be veneer graft, a type of side graft.

(b) Plant Spacing

The plants should be set 30 x 30 feet.

(c) Pest Control

Anthrachnose may be a problem, especially at flowering and fruit setting time. One point five (1.5) pounds of captan per 50 gallons of water has given excellent control. Scale insects may be a problem at Wadi Rema, but usually the worst pest is the fruit fly. Scion should be obtained from Florida and Puerto Rico -- the two leading cultivars from each location.

7. Grapes

More than seven thousand hectares (17,290 acres) are devoted to grape production. Over 70% of the total production is produced in the Northern Uplands (Sanaa Governorate). Four major types of grapes are grown and over forty sub-cultivars are reported cultivated. Taxonomic and horticultural descriptions of the four major types should be made. The harvest period for grapes seems to be during July and August, and perhaps going into September. The Yemen Arab Republic in general, is

self-sufficient in this fruit and the potential for exporting grapes to neighboring countries is good.

Tuskegee Institute will have the opportunity for making significant contributions to grape culture in YAR. Grapes are presently being produced under the following conditions:

- (a) Vitis Vernifera grapes are grown on its own roots. No rootstock is being used. The soil pH ranges from 8.0 to 8.5. The grapes are trained on rather low arbors-type trellis. The Yemeni grape grower applies a refined soil material, which he dusts on the leaves and fruits of the grape plant to prevent various diseases and to stimulate growth. A sample of the soil which is used for dusting was returned to the U.S. for a complete analysis. The presence of such elements as: sulfur, copper and iron will be of great horticultural interest.

(b) Grape Cultivars to be Studied

- 1) YAR - Type 1 Red
- 2) YAR - Type 2 Black
- 3) YAR - Type 3 White
- 4) YAR - Type 4
- 5) Lake Emeral
- 6) Blue Lake

Lake Emeral and Blue Lake are bunch grapes; both cultivars were developed at the University of Florida, Leesburg Experiment Station and have done well in tropical areas.

(c) Cultural Practices to be Introduced

- 1) The vertical one-wire and the Geneva Double Curtain trellis systems.
- 2) The three bud -- fruiting spur pruning system.
- 3) Chemical pest control.
- 4) Major and minor fertilizer elements application.
- 5) Wide and narrow row spacing.
- 6) Mulching.
- 7) Propagation-production of plant material for the Tuskegee Institute Project and for distribution to YAR grape growers.

All of the above cultural practices will be compared with the local cultural practices.

An alfafa sod or green manure crop should be grown between rows of the grape plantings. This crop will in addition to providing nitrogen and improving the soil structure -- provide the mulching materials. A two-foot strip on both sides of the plants should not be seeded to alfafa.

(d) Grape Rootstocks

Even though grapes are presently being produced on their own roots; a study should be conducted to evaluate: Dog Ridge Champanel, and LaPryor -- these are good stocks for root rot resistance. Dog Ridge, Salt Creek and 1613 are resistant to some nematodes. Rootstocks are useful in avoiding soilborne diseases and nematodes.

8. Apricots

The Yemen Arab Republic Government has established at Bir Al-Shaif, Sanaa, several hundred apricot plants. These plants should be evaluated for desirable horticultural characteristics for use as rootstock.

Two to three hundred hours of temperature between 40^o and 45^oF are needed for breaking the rest period of local apricots. Cultivars with low chilling requirements should be tested in YAR at Sanaa.

(a) Cultivars to be Tested

- 1) Earli-Gold
- 2) Reeves
- 3) Trevatt
- 4) Royal
- 5) Newcastle

(b) Plant Spacing

The plants should be spaced 15 x 15 feet and replicated 4 times. As many local types as possible should be included in the planting.

(c) Plant Protection

Plant protection will be those recommended for peach and plums. Efforts should be made to have the horticulturist/ counterpart to identify the apricot cultivars which are established at Bir Al Shaif and make them a part of the planting suggested for importing into the YAR. There are a number of other crops which have a chilling requirement much lower than apricots that may also be better adapted to the region.

9. Sweet Potatoes for Observation

Sweet potatoes were observed being offered for sale only at Hodeidah in the Tihama Region, which had red skin and white flesh.

Sweet potatoes are recommended for both the Wadi Rema and the Bir Al-Shaif stations. At Wadi Rema plants should be made each month of the year for a two-year period in order to determine the best planting time. At Bir Al-Shaif plantings should be made each month during the Spring and Summer and up to 100 days prior to the expected date of frost in the Fall.

The cultivars recommended are:

- 'Carver'
- 'Rojo Blanco'
- 'Jewel'

Planting material for this crop will be shipped from Tuskegee Institute.

B. Yemen Soil Analysis

In view of the research nature of the horticultural project, it was considered critical to analyze the soils of the two major government experiment stations. The result of this analysis is recorded in the table below.

An Analysis of Yemen Soils

Sample #	pH	lbs/A								
		P	K	Mg	Ca	Mn	Zn	Cu	Fe	Na
1	8.2	M	EH	H	9990 f	175	3.0	5.1	59	698
		80	420	2000						
2	8.4	L	VH	H	9990 f	113	2.4	4.5	67	706
		70	300	2000						
3	8.3	M	VH	H	9990 f	84	6.2	4.9	64	658
		80	380	2000						
4	8.3	L	VH	H	9990 f	114	3.4	4.1	68	433
		60	340	2000						
5	8.4	H	EH	H	9990 f	149	4.2	4.5	62	622
		110	420	2000						
					High	High	High	High	High	High

RECOMMENDATIONS

		N	P ₂ O ₅	K ₂ O			N	P ₂ O ₅	K ₂ O	
GRAPES	Low P	*	60	0	(120)-Comment No. (117) CIRC. 176	PECANS	Low P	*	60	0
	Med P	*	30	0			Med P	*	30	0
	High P	*	0	0			High P	*	0	0
SWEET POTATO	Low P		80	120	0	PLUMS	Low P	*	60	0
	Med P		80	80	0		Med P	*	30	0
	High P		80	0	0		High P	*	0	0

All samples are High in K, Mg, Ca, Mn, Zn, Cu, Fe, and Na. The only fertilizers that we would recommend are P as indicated above and N based on the crop to be grown.

Specific recommendations for various crops can be determined from Circular 176, which is attached.

C. Revised Description of Services

The Horticultural Improvement Project was amended nine (9) times. With each amendment came a revised program of work. In the process the major focus was shifted from basic research to applied research, demonstration and extension. The revised description of services as recorded in the seventh (7th) amendment is included here.

In carrying out the contract services the Contractor will be responsible for developing a collaborative relationship with the Government of Yemen Arab Republic (YARG) so that the YARG may use the Contractor as a source of expertise on horticulture in Yemen. The following tasks and services will be carried out by the Contractor prior to the completion date of this contract:

1. Prepare a workplan to cover Contractor activities to be performed during the balance of the term of the contract. The workplan is to be jointly agreed upon by YARG and AID, and may be amended from time to time by mutual agreement of the Contractor, Mission Director and the YARG.
2. Research
 - a) Screen high producing varieties of tree fruit, vine and nut crops and selected material of potential for Yemen.
 - b) Study common horticulture production practices and identify improved practices of potential benefit to increased yield for the selected crops.
 - c) Plan and manage adaptive research of varieties and culture practices at government research stations and on farmers plots.
 - d) Undertake selected economic sociological research related to horticultural production and use.

- e) Establish a minimum of ten species and thirty varieties of horticultural crops at each of the two research stations; Bir Al-Shaif and Jarouba.
- f) To the extent possible identify the three most promising varieties of fruit trees at each of the two research stations.
- g) Determine the best cultural practices for fruit production under subtropical and tropical conditions (e.g. tillage practices, water management, spacing, intercropping, ground cover and pruning.
- h) Assist the YARG in establishing a system to coordinate horticultural research with foreign assistance agencies.

3. Extension Training

- a) Undertake multiplication of seedlings of recommended varieties at each of the two research stations for distribution to producers.
- b) Train a minimum of ten Ministry of Agriculture personnel in seedling production techniques.
- c) Establish a minimum of two sites in each region to demonstrate recommended varieties and proper cultural practices.
- d) Two senior Tuskegee technicians will work on extension activities at demonstration plots and with fruit growers, a minimum of two days per week.
- e) Provide approximately six months of horticulture training in the U.S. for four Ministry of Agriculture Officials.

4. Other

- a) Submit to the YARG a detailed set of guidelines on regulations importation and in-country production of plant material, especially with regard to phytosanitary conditions, insect and disease control.

- b) The Contractor will procure seedlings, budwood, cuttings, seeds and any other plant material for research, outreach demonstrations and distribution as required but not to exceed twenty thousand dollars of the fifty thousand dollars in the contract, (including cost of plant material and transportation) without the written approval of the Mission Director or his authorized designee.
- c) The Contractor will assist the YARG as necessary to order and purchase seedlings and other plant material from the United States if the materials are available and if YARG provides, in advance, to the Contractor the necessary funding for purchase and transportation of the desired plant material.
- d) The Contractor will establish a seedling propagation nursery in conjunction with the two research stations at Bir Al-Shaif and Jarouba.
- e) Contractor will provide seedlings as necessary (up to contract funding limitation) for establishment by the YARG of "mother-tree" nurseries. The Contractor will provide technical assistance to the YARG nurseries and fruit tree plantings as requested by YARG.

D. Acquisition of Plant Materials

One major contractual obligation was to secure plants and/or seeds for shipment into Yemen for the Horticultural Project. Initially, these introductions were to serve as the basis for adaptive research including thoroughly testing before being distributed to Yemeni growers. On the basis of the change in focus -- thousands of plants and seeds were secured for the purpose of immediate and/or ultimate distribution to growers and to government experiment stations. These shipments were made over most of the project period.

Most of the seeds which were shipped to Yemen were to produce rootstocks for later budding or grafting prior to distribution. A summary of the plant and seed collections are included in Tables 2 and 3.

Table 2

FRUIT TREES PURCHASED FOR SHIPMENT TO YEMEN

11/23/77	University of California Davis, California	700 Cuttings	Grape Fruit Trees
12/8/78	Pacific Coast Nursery Portland, Oregon	200 Rootstock	Apple
12/12/78	University of California Davis, California	700 trees	Grape, Plum, Almond, Peach, Apricot, Apple
12/12/78	Milburn & Tweed Fresno, California	155 trees	Fig, Pomegranite
12/12/78	Dave Wilson Nursery Selma, California	250 trees	Apricot, Nectarine, Almond, Fig
12/12/78	Transvine Exeter, California	60 trees	Olive
1/3/79	Haley's Nursery Smithville, Tennessee	100 trees	Peaches
1/12/79	Simpson's Nursery Monticello, Florida	540 trees	Apple, Pear, Peach, Plum, Nectarine, Pecan
1/19/79	Coral Reef Nurseries Goulds, Florida	600 trees	Mango, Avocado, Banana, Lime, Guava, Passion
1/26/79	Grand Island Citrus Eustis, Florida	850 trees	Orange, Grapefruit, Lemon, Mandarin
12/21/79	Willits & Newcomb Arvin, California	650 trees	Grapefruit, Tangarine, Orange, Lime, Lemon Apple, Apricot, Peach
2/13/80	Willits & Newcomb Arvin, California	400 budwood	Grapefruit, Orange, Lime, Mandarine, Tangarine
1/27/81	Willits & Newcomb Arvin, California	3300 trees	Navel Orange, Mandarine, Grapefruit, Lemon

Table 3
SEED PURCHASED FOR SHIPMENT TO YEMEN

12/12/78	University of California Davis, California	2000	Nemaguard Seed
12/12/78	Dave Wilson's Nursery Selma, California	2000	Nemaguard Seed
1/18/79	Holm & Larson Winter Haven, Florida	2 qt	Rough Lemon
		2 qt	Carrizo Citrange
		2 qt	Cleopatra Mandarin
		1 qt	Sour Orange
		1 qt	Volkamericana
2/13/80	Willits & Newcomb Arvin, California	1 qt	Volkamericana
		5 qt	Cleopatra Mandarin
		5 qt	Troyer Citrange
		5 qt	Carrizo Citrange
4/18/80	Holm & Larsen Winter Haven, Florida	1½ qt	Lime (Palestine)
		2 qt	Lime Rangpur
4/18/80	Willits & Newcomb Arvin, California	3 qt	Pineapple/Sweet Orange
		3 qt	CRC Grapefruit
		200	Dancy Mandarin
10/21/80	Willits & Newcomb Arvin, California	2 qt	Sour Orange
		1 qt	Lime

Searching for Certified Citrus Budwood

The very fact that we had some 70,000 plus citrus seedlings growing, and that not too far in the distant future they would all have to be budded was of great concern. The conclusion was reached that the first priority was to select disease free buds. It was known that certain areas in the world were more adapted to commercial citrus production than others, and that some of these would surely have better plant protection programs against insects and diseases. The first thought, of course, was the certification programs of the United States, but then budwood had already been

shipped from the Willits and Newcomb Nursery in California at a cost of twenty-five (\$.25) cents per bud, not including freight charges. Since we were initially looking at 100,000 citrus buds, the cost factor represented \$25,000.00 plus freight. This figure seemed high, so the Chief of Party sought the literature and advice of others regarding the obtaining of budwood elsewhere.

We were aware of the fact that Italy, Spain and Morocco and other Mediterranean countries are commercial producers of citrus, and that they were all closer to Yemen than California. However, it could not be ascertained whether any of those countries had a certification program. After consultation with members of the Ministry of Agriculture and the USAID/Sanaa agricultural officer it was decided that the Chief of Party and a member of the Ministry would go in search of the needed budwood.

Mohammed Sharaf Addin, the horticultural representative of the Ministry of Agriculture and co-manager of CID, had been sent to Rome for a F.A.O. conference, and the Chief of Party planned to meet him after his meetings so that they could seek the best sources for budwood. Upon arrival in Rome, Mr. Merkley made some personal contacts at the Food and Agriculture Organization complex and received references in Valencia, Spain which were extremely valuable. It was decided that they would go directly to Valencia rather than stay any longer in Italy and look for budwood there.

Their flight into Valencia took them over great groves of citrus which made them feel that they might be at the right place. They learned upon arrival that they would have to travel to Moncada, about 10 kilometers

from Valencia, where the Regional Agricultural Investigations Laboratory was located. When they reached the facility they met Dr. Luis Navarro who is a well-trained plant virologist. He explained the on-going research, and was extremely helpful in programming Mr. Merkley's and Mr. Addin's agenda while in the Valencia area.

The next day they were picked up at the hotel by Senor Ricarb and Senor Hill who then drove them to Alcoceber where foundation virus-free citrus nursery stock was being grown. There isolation policy provided that no other citrus could be grown within a five-kilometer radius of this nursery. Their activity was fairly new, but production was good.

It was learned that a group of nine (9) nurserymen had formed an association to sell only virus-free plants, so they were then taken to Viveras, Valencia to meet one of the Ministers of Agriculture and other association members. There they observed the preparation of plants readied for sale, their modern refrigerated cool rooms where seed and budwood was stored. They also toured the greenhouses and fields, and noted how well kept they were. Facilities and plantings were observed at Viveras Mas De Fabra and Viveral La Plana where they found each of the nurseries as well managed and clean as the others.

Later, a meeting was held with the business group of the association and with Dr. Luis Navarro translating, the varieties chosen are shown in Table 4.

Table 4

Kind	Cultivars	
1. Grapefruit	Marsh Seedless	5,000
2. Lemon	Eureka Frost	3,000
	Lisbon Frost	3,000
3. Mandarin	Clementine	15,000
	Kara	10,000
4. Orange	Navelincia	7,000
	Salustiana	7,000
	Valencia	30,000
	Washington Navel	20,000
Total		100,000

Prices and time of shipment were then discussed, and a price of \$0.20 per bud was set plus shipping costs. The manner of ordering and payment was discussed. The consensus of opinion was that the order be placed three to four months in advance, and that a check pro forma, be placed in a bank of their choice to complete the contract. With agreement on these points the meeting was adjourned.

Inasmuch as arrangements had been made earlier to meet with agricultural representatives of USAID/Rabot, Morocco, and after discussing the matter thoroughly it was decided to proceed on to Morocco to view the citrus situation there and determine whether or not citrus budwood could be purchased at a lesser cost.

After arriving at the AID Mission in Rabot Mr. Merkley learned that Dr. Aly Lasheen, Chief of Party for the Minnesota Team, had come to Rabot on a monthly visit from Agadir and that he would be able to meet the group from Yemen. As the project in Yemen was discussed and our need for disease-free budwood was stressed, he told them that there was no certification program in Morocco, and that all the budwood had diseases. With this in mind it was known that there was no use to look further in that country.

Mr. Merkley returned to Sanaa -- knowing that "disease-free" budwood could be obtained in Spain -- that we could save money on the buds themselves, and that freight costs would be much less because we could purchase them closer to "home".

Because the Tuskegee contract was soon to end no further effort was made to procure budwood from Spain. It is hopeful, however that this information will be valuable to YAR and to others who will be participating in the continuation of the Yemen Horticultural Improvement Project.

IV. In-Country Professional Staffing

Recruitment and/or the assignment of professional staff for the Horticultural Improvement Project proved to be the single most difficult problem in the initial period. The magnitude of this problem decreased as the project progressed such that in the end the project was fully staffed with professionals who performed admirably under the most difficult circumstances.

Professional personnel who served the project are listed in the tables which follow.

Table 5

Short-term Professional Personnel

<u>Name</u>	<u>Assignment</u>	<u>Duration</u>
Sayed A. Badr	Horticulturist	17 days
Fouad M. Basiouny	Horticulturist	9 days
P. K. Biswas	Horticulturist	5 days
C. D. Covey	Agricultural Economist	34 days
Dean Davis*	Horticulturist	N/A
C. O. Foerster, Jr.*	Horticulturist	N/A
Hesham A. Gawad	Horticulturist	15 days
Mohamed A. Ismail	Research Scientist	23 days
L. W. Jones	Sociologist	15 days
M. E. Sarhan	Agricultural Economist	17 days
Eugene A. Mielke	Horticulturist	2 days
Lowell True	Horticulturist	1 day
B. T. Whatley	Horticulturist	15 days

*Cleared for long-term employment but rejected by the Ministry of Agriculture in Yemen as being too old.

TABLE 6

Long-term Professional and Technical Personnel

Name	Assignment	Duration
Lee, Jeffrey Randall	Field Technician	11/77 - 11/79
Badr, Sayed	Chief of Party	6/78 - 9/79
Basiouny, Fouad M.	Horticulturist	7/78 - 9/79
Issa, Jami	Tropical Horticulturist	7/79 - 9/81
Merkley, Don	Chief of Party	9/79 - 9/81
Checole, Sinedu A.	Secretary	12/79 - 3/81
Mutwali, Abdulaziz M.	Field Technician	3/80 - 9/81
Mayser, A. Ahmad	Field Technician	3/80 - 9/81
Jaifer, Khadija A..	Secretary	3/81 - 7/81

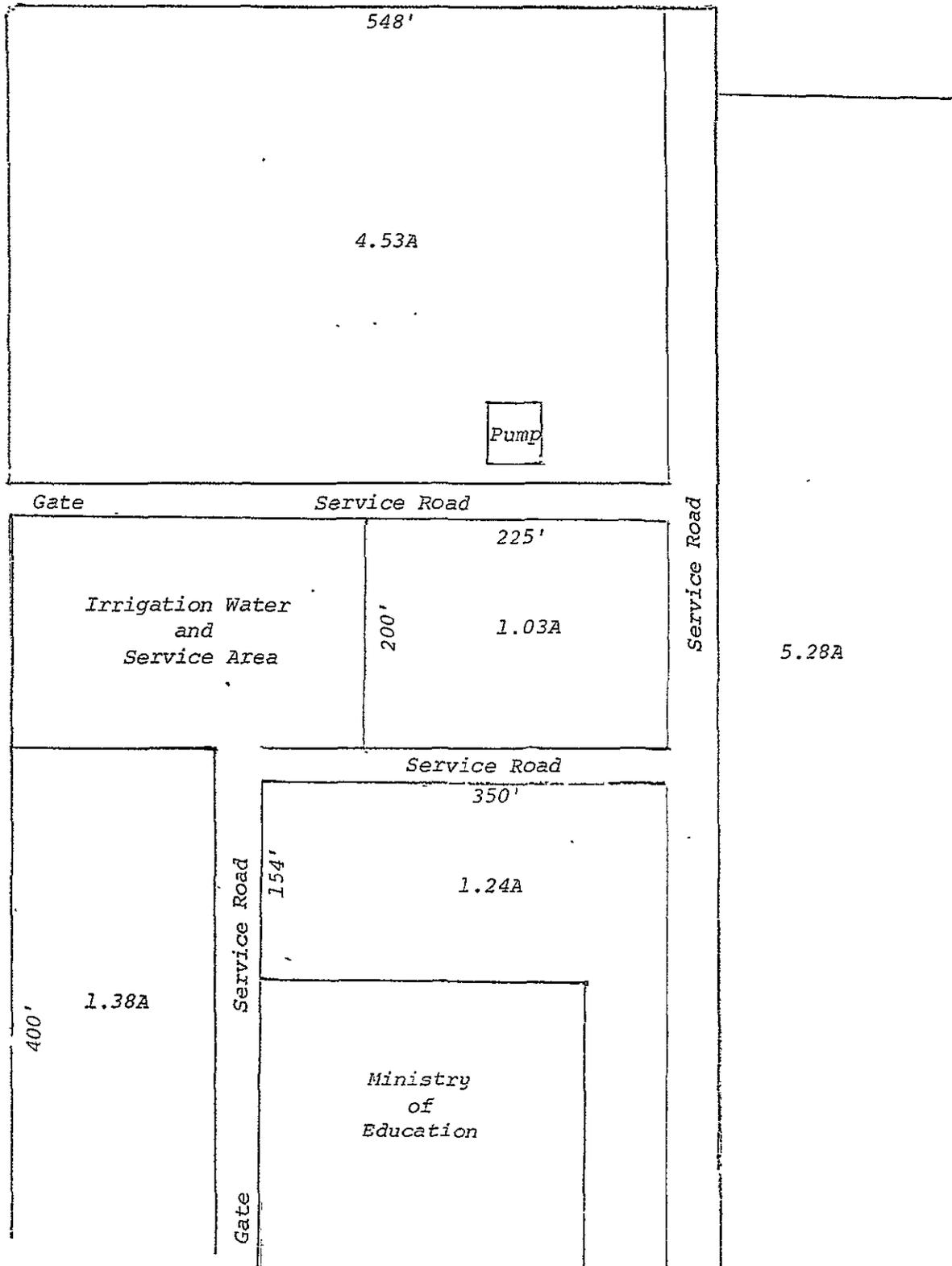
V. Government Experiment Stations

The government of the Yemen Arab Republic had established experiment stations in Sanaa, Jarouba, and Taizz, prior to the arrival of the Tuskegee team. These were in varying stages of development. Tuskegee Institute was assigned the responsibility of further development of the Bir Al Shaif station at Sanaa and the tropical station at Jarouba.

Developments at the government stations are briefly discussed in the sections which follow.

A. Bir Al Shaif - When we arrived in Sanaa, we assumed full responsibility for the development of this station. Its location and the environment made it well suited for temperate zone horticultural crops. It consisted of 15.4 acres which was considered small. However, its size was sufficient for the initial experimental and demonstration work as initially planned. Tuskegee's initial step was to develop a complete experimental or field plot design and planting plans as discussed under the program of work.

The field plot lay-out for the Bir Al Shaif Station is illustrated below.



Plantings were made in accordance with the original planting plan. These plants were growing such that there was every indication that the original objective would be achieved.

Unfortunately, Bir Al Shaif was located within the city limits of Sanaa. During the project period, urban development expanded through the station destroying hundreds of trees which had been imported and were growing excellently. Urban developments including government buildings and streets took more than one-half of the original land area.

In spite of the developments Tuskegee continued to use the land that remained for the production of plants from cuttings for distribution to stations and farmers. About 35,000 cuttings were planted in the final year.

Out of 35,000 plants, 29,750 will be available for sale and distributed during January, February, and March of 1982. The plants represented in these cuttings were of local varieties and included figs, grapes, pomegranates and walnuts.

We were disappointed to learn that the apples and apricots imported from the Willits and Newcomb Nursery, Arvin, California, did not meet the low chilling requirement necessary for them to break bud dormancy in the Spring and leaf out during the early months of 1981. The tremendous growth during 1980 precluded conditions indicating that the Yellow Bellflower and Valnora apples and the apricots would do very well in the upper highlands of Yemen; however, there was simply not enough accumulative chilling hours needed for these varieties.

Later we learned that apple varieties such as Anona, which is growing on the station, and Winter Banana are two needing less chilling, so,

should produce under Yemen upland valley environment.

The general care and upkeep of the station diminished during a period due to the fact that the laborers knew that the emphasis would be placed on the new area at Al Irra. Nothing had been done to clean up the rubble of stone left from the wall-building and, in fact, the last of the wall had not been completed but the workmen were striving to finish the job.

Despite the fact that the wall and fence had not been completed, there were two places where vehicle accidents had torn the wall down and these were not fixed until the first part of September. In one of these accidents, two men were killed and four were seriously injured.

As a team, we hope that Bir Al Shaif would retain the remainder of its entity as a place to grow cuttings and produce scions and budwood from the parent trees still growing there. However, urbanization we fear, will ultimately encroach until there is no land left for nursery purposes.

B. Al Irra - Although the new site selection was reported in the six months report dated November 1, 1980 to April 30, 1981, page 3, it should be noted that this area was turned over to the CID team and will ultimately be developed as the "demonstration" farm.

The Ministry of Agriculture has clearly stated that this entity will be for horticulture only, and that other crops and their development will be placed elsewhere.

The original procurement of the Al Irra property was a piece of land whose boundaries were haphazardly defined and present efforts are to purchase or trade sufficient area to "square" it up. There is not a good road

onto the property, but suffice it to say, it is much better than the "tract" to Jarouba.

C. Al Jarouba Station - Upon arrival in Yemen, the Jarouba Station was simply an idea with no developments of note. The land was made available by the government. The place is quite remote with no road, then or now. This will remain a seriously limiting factor until a road is a reality. The development of the station is further limited by the lack of buildings and utilities. In spite of these difficulties, some very significant progress was made.

Large plantings of citrus, banana and papaya are in the fruiting stages of development. As this project ended, citrus seedlings were growing well, and will be ready to "line-out" during September - October, 1981. The average height of the seedlings at the end of August was 50 cm (19.68 inches).

The land was being prepared and rows marked for the lining-out process. A seedling count indicated that there were 70,000 to 75,000 plants to be placed in the field. Initially, $1\frac{1}{2}$ hectares of land will be needed to receive the seedlings.

Our summary statement regarding this station is that we leave the plantings in excellent condition. There are certain situations and conditions which we wished could have been changed, but since we made the effort and in a sense failed, we still feel good about our accomplishments.

The most outstanding deterrent to the over-all program is the fact that in all these months there is still no road into the station. This in itself will alter all future progress and development until such a facility is built.

Perhaps the lack of shelter belts and fences to keep out the animals were factors which would affect the station as a demonstration farm. Insect problems cause concern and only automated equipment can overcome this situation. The termite damage is minimal to fruit trees but will always exact their toll on wood and wooden structures unless chemically controlled. Grasshopper injury to citrus and other plants is not unmanageable, but, larger and mechanized equipment must be employed to control these pests.

VI. Socio-Economic Developments

The Tuskegee contract included a provision that Tuskegee Institute would undertake selected economic and sociological research related to horticultural production and use. Tuskegee placed very high priority on this provision and made a special effort to comply with it to the fullest extent.

During October of 1977, Dr. C. D. Covey initiated this study in Yemen and compiled a very significant document designed to facilitate the study. In May of 1979 Dr. Covey and Dr. M. E. Sarhan returned to Yemen to followup on the initial visit and to begin implementation. This later visit resulted in a second invaluable document related to the study. Both of these documents have been widely distributed and for this reason are not made available here.

By the time of the second visit to Yemen by the economist, there appeared to be a reduction of interest in the socio-economic aspect of the project by both the Mission and the Ministry. Subsequently no visits or followup activities took place after 1979.

Because this component is so essential for the development of Yemen agriculture, in the years ahead, and because our professionals in this area had done such a commendable job in the first two visits, their recommendations in the 1979 report is included here for the benefit of the Yemen government and for those who will continue to work for agricultural development in the Yemen Arab Republic.

Summary and Conclusions

Summary of the Present Situation - Production and Marketing-- The physical aspects of the project, i.e., getting plant material introduced and growing in both Bir Al Shaif and AlJarouba, seems to be finally showing some progress. Once this plant material is established, different technology can be applied and results measured. Fruit trees and vines require relatively long periods to reach full production and hence the critical ingredient in the project is patience.

Given the progress being made on the physical side, it does not appear to be too early to pursue the socio-economic phase of the project. In fact, the project schematic shown in the Project Paper calls for a Farm Gate study in the second year of the project. If contract time is measured from the time the two senior horticulturalists arrived in YAR, the current attempt to initiate the Farm Gate studies is on schedule. While this proposal was a stop-gap measure, if given a chance it hopefully would have provided the data for constructing the initial or "benchmark" budgets and would have been a start on the Farm Gate study portrayed in the project schematic.

The lack of appreciation of other socio-economic aspects of this project, i.e., the needed infrastructure to provide market channels for

increased fruit production (credit, transportation, grading, packaging, market information, etc.) and the factor markets and distribution system to supply inputs to farmers who adopt recommended technology, seems to reflect the philosophy that once added production is achieved the supportive structure will materialize as though by magic. Countless USAID studies have proven this strategy to be unworkable. (See Covey report)

Recommendation

As stated earlier the proposal to train project horticulturalists and Yemen counterparts in budget analysis techniques was a temporary expedient predicated on what appears to the authors as a major deficiency in the project design and staffing. It appears, however, that all the USAID agricultural projects in YAR suffer from the same design and staffing deficiencies.

The Project Paper on which the contract was negotiated between USAID and Tuskegee Institute calls for a substantial analysis of the socio-economic internalities and externalities associated with the improvement of fruit crops in YAR. Despite this obligation the manner in which these socio-economic responsibilities were to be discharged received little consideration in the project proposal.

The farm economics obligations are essentially contained in the following paragraph from the Project Paper:

"The study of the farm economics for horticulture production is shown in the project schematic as two Farm Gate studies. The first study is to be undertaken early in the project and using partial budget analysis will study the economics of current tree crop production practices. The second Farm Gate study is scheduled for the 4th year in order to analyze the production economics for practices and crops of promising potential as identified in Track one of the project."

Further economic obligations of the Project Paper concern the analysis of the marketing constraints of horticultural products. The Project Paper outlines these studies as follows:

"The marketing constraints on horticulture production will be the subject of a study proposed for the third year of the project. The constraints on conventional practice and possible constraints on new practice will be studied. This first study may identify sufficient questions to warrant further studies and provision has been made in the project budget to support such further work if found to be valuable."

The authors of this report are strongly convinced that the economic research aspects of the project would be more adequately conducted by an agricultural economist assigned to the project full-time in Yemen than by TDY consultants. We disagree with the statement in the Project Paper that assumes that this work can be accomplished by "various TDY staff and/or consultants of the major contractor--."

Further studies outlined in the Project Paper emphasize the socio-economic aspects of horticultural crop production, i.e., the role of women in farm decision-making resulting from male migration and cultural constraints to horticultural crop production. These are studies which should be ongoing under the direction of either a full-time research sociologist or cultural anthropologist as part of the permanent Yemen team.

In summary our recommendations listed in the order of the authors' recommended priorities are:

1. Tuskegee Institute and USAID should renegotiate the Yemen Tropical and Subtropical Fruit Improvement Project to include, among others:
 - a. The services of a competent agricultural economist and a competent sociologist/anthropologist as members of the permanent staff in YAR.

- b. In view of the lack of language competence at the USAID Mission in Sanaa and the lack of counterparts, require the agricultural economist and sociologist/anthropologist to have Arabic language capability.

2. As a second, but inferior alternative, recruit agricultural economist and sociologist/anthropologist consultants with Arabic language capability for extended TDY assignments of from six to nine months duration to conduct the studies called for in the Project Paper. This alternative will probably involve substantial outlays for consulting fees and per diem expenses but appears to be the only alternative under the existing contract. For example, while in YAR the authors became aware of a Southern Yemeni faculty member at Sanaa University who had a Ph.D. in Agricultural Economics from the University of Nebraska, and served on the faculty of the University of Minnesota. It was our understanding from the Agricultural Officer in the USAID Mission, Sanaa, that this individual is currently doing some consulting work on the Arizona Sorghum and Millet Project. Our efforts to contact this individual failed, but this alternative should be pursued by the project manager.

The major contractor should not concern itself with what the consultant will do with the data collected as long as the consultant provides the contractor with the analysis and report called for in the consulting agreement. For example, if the individual wants to use the data for a thesis or dissertation at another university this should not be a determining factor if the contractor does not have a person in its own graduate program capable of doing the work.

3. Failing to accomplish #1 or #2 above, renegotiate the contract

to eliminate any socio-economic responsibility and confine the contract to the development of horticultural production technology. We believe this alternative would not be in the best interest of YAR because this approach would ignore the economic and social impacts of the biological research program. However, given the attitude of the Ministry of Agriculture and the current staffing constraints it appears to be the only viable alternative available to the major contractor.

4. The authors strongly recommend that a study of the production and consumption of khat (quat), a major tree crop in Yemen whose leaves possess stimulant effects, be included in the overall analyses of the horticulture program. During our visit to YAR we became aware of the fact that strong competition from khat has caused an increasing amount of the country's agriculture land to go out of fruit and vegetable production in favor of khat. It seems that despite the USAID and other international donor assistance and transfer of technology activities, the possibility exist that this technology will not be accepted because of the competition with khat. We believe it is not too early to investigate the problem.

VII. Extension Activities

Extension activities were inferred in several of the items in the list of services to be rendered. It was envisioned, however, that there would be counterpart extension personnel to relate to. This, of course, was not realized.

Even with limited resources, Tuskegee attempted some extension activities. These included mainly (1) the distribution of thousands of budded and/or grafted fruit trees, (2) providing technical assistance in

cultural practices, and (3) providing training in the process of budding.

Plans had been underway since the initial germination of the citrus seedlings to effect a training session and have a budding school to train agricultural employees of the Ministry in the art of budding.

A committee was selected consisting of the following people: Don R. Merkley, Chairman; Mohammed Sharaf Addin, Ministry representative; Musa Olagabo, Ibb School horticulturist; and Dr. Jami Issa, senior tropical horticulturist.

Initial plans were to hold the school at the IBB training School, where we could have use of the facilities, including dormitory and an eating place. The time was scheduled for three weeks and would have involved approximately twenty (20) students.

All of these plans had to be changed when we learned the Mr. Alagobo would be on vacation and there was some question regarding the use of the buildings.

The date was set ahead to August 16 and notices were sent to all parties concerned. However, ten (10) days prior to starting the school we were advised that we could not go to Ibb and that we would have to postpone the school. We had already decided that we could teach all the necessary factors of budding in five days and since available time to hold the school was running out, we decided to hold the school at Sanaa at the Sanaa Agriculture Office. The latter being unanimously agreed upon, notices were duly transmitted to those expected to be at the school.

It is interesting to note that since the school was going to be held in Sanaa, the Minister of Agriculture, Dr. Hamdani, became much involved in it, asking for signs to be prepared to advertise the school,

inviting several notable people to the opening program, stating that he would be there, and that he would give a speech.

As the program opened there were nearly fifty people in attendance with Dr. Hamdani, the American Charge de Affairs; Mr. Newman; Dr. Hana P. Peterson, Agricultural Development Officer; Mohammed Sharaf Addin, Co-Manager of CID; Don R. Merkley, Chief of Party; and other officials and translators at the head table. Arrangements for television video and photographers had been made, and all facets covered for this "first" horticultural school held in the Yemen Arab Republic.

After speeches by Mr. Merkley, Mr. Newman and the Minister of Agriculture, Dr. Hamdani, were made, the school officially got underway. The five-day school lasted for seven days with both theory and practice of budding and grafting being taught, as well as selection of rootstocks, varieties, pests and diseases, and general cultural practices.

Thirteen students took the course and at the close of the training session, each was given a certificate of completion by the Deputy Agricultural Minister, Mr. Mokbil.

The budding and percentage of "take" will determine our success of training when the 70,000+ seedlings are budded in January and February of 1982.

VIII. Training of Yemeni Nationals

It was recognized in the program development stage that the key to long-term development rested, to a very great extent, in the training of Yemeni Nationals in the area of horticultural development.

Two categories of training were recognized:

1. Professional staff training for the horticultural program in Yemen; and
2. Technical training for field staff personnel to undertake the supervision of on-site operations.

The success of the training component of this project rested with the ability of the YAR to identify and release to the project candidates for training. Unfortunately, no candidates were identified for the technical training.

In 1978, one candidate from the professional staff in the Ministry of Agriculture was identified for training in the United States. This person was Mr. Yahia Hussein Al-Habshi, who was serving as horticultural officer for the project. His report of activities while in the states is included here.

"During my observation training to various locations in California, Arkansas, Florida and Alabama, I observed the highest techniques of modern improved cultural practices. The following illustrates observations in each of the areas which I visited.

California State

June 18 - July 23, 1978

1. Vineyear, orchards and grape variety block.
2. Observation and discussion of grape varieties in California compared to Yemeni varieties.
3. The orchard of CSUF to observe harvesting, transportation and packing of peaches for fresh market. Also I observed the irrigation system.
4. The orchards of plums, peaches, almonds, figs, apricots, walnuts, citrus fruits, variety block and the various cultural practices.

5. I went with Dr. Ibrahim Michael to tour several citrus growers and vineyards in the Fresno area with emphasis on pest management by biocontrol.
6. I went with Dr. H. Gawad to tour the local retail nurseries in Fresno to observe types and qualities of plant material available for home gardeners and various agricultural tools which could be used in Yemen Arab Republic.
7. I observed and discussed grape cultural practices and saw a raisin processing plant at CSUF.
8. I went with Drs. Badr and Gawad to the farm of Mr. J. Garabedian, a grower and breeder of grapes, peaches, plums and nectarines to observe and discuss with him the techniques and methods of grape breeding.
After lunch we went on a tour of Ballantine Packing House in Sanger, California to observe packing of peaches and plums. Then we visited a cold storage facility, i.e., forced air cooling SO_2 fumigation rooms and control room.
9. The principles of a sprinkler irrigation system as it applies to nursery operation and landscaping was also observed.
10. I went with Dr. Ibrahim Michael to the west side area to study, observe and discuss the various methods of pest management on grapes and cotton by biocontrol.
11. The various orchards, vineyards in Reedly and toured the new packing house of Ballantine Produce Inc., to observe packing of plums and nectarines, particularly the hydro-cooling methods.
12. I visited the various supermarkets in Fresno to observe the various types of fruits and vegetables for quality and the marketing of produce at the retail level.
13. Toured the Kearney Horticulture Field Station at Parlier to observe and discuss the various experiments on grapes, peaches, nectarines, olives, figs, walnuts and almonds.

We further discussed the use of Gibberelins and girding techniques used in the production of Thompson seedless table grapes.

14. Saw demonstrations and practices of grape propagation by green cuttings of grapes in the greenhouse. Demonstration and discussion of method of training young grape vines at the CSUF vineyards.
15. Toured S & J Ranch in Fresno, reviewed and observed the cultural practices for various crops including citrus, almonds, pistachios, figs and others. Emphasis on the uses put on various methods of irrigation, e.g., furrow, sprinkler and drip irrigation.
16. I visited the USDA Horticultural Field Station in Fresno. Our discussion with Dr. D. Remming who is responsible for breeding projects at the USDA was very fruitful. We also talked about the availability of varieties suitable for the climatic conditions in YAR.
17. I reviewed the various research being done at the Lincove Station with specific references to the production of virus free scionwood, rootstock, trials and pest control projects.
18. Designing and installing sprinkler systems including balanced pressure on various lines, checking for leaks, and using different patterns, e.g., full circle, half circle, quarter circle, square and strip.
19. At the University of California Horticultural Field Station at Parlier I observed the facility placing emphasis on the various cultivars of nectarines, plums and peaches under evaluation.
20. I visited the local farm advisor's office to get information on their Extension Service system in California and I acquired technical bulletins and publications.

21. Toured Nonini's Grape Nursery. I reviewed and observed the operations of a typical grape nursery. My attention was drawn to the making, handling and storage of grape cuttings, as well as techniques utilized in planting and care of young vines.
22. I attended a field day at Kearney Station and observed the methods of the Extension Service in weed control, irrigation trials in vineyards and orchards.
23. I attended a lecture on the various methods of citrus harvesting with emphasis on mechanization. Then we went to several citrus growers of Corona, Foothills Lemon Co. in the Riverside area to look at the various methods of irrigation including furrow, sprinkler, spaghetti, and drip irrigation.
24. Toured the University of California at Riverside orchard and observed various fruit and other crops in the experimental fields, including citrus, figs, jojoba, beans and tomatoes. We also went on a tour of the greenhouse facilities and observed the handling of newly grafted citrus seedlings and automatic irrigation inside greenhouses. I saw a slide presentation of the citrus industry in California.
25. I visited the USDA Salinity Laboratory at Riverside and observed the facilities in this laboratory.
26. Visited Willits and Newcomb Co. in Arvin. This tour was to observe the facilities of citrus seed extraction from fruits and the subsequent treatment. This treatment was threefold involving hot water, drying, and treatment with fungicides. Seed and budwood storage and germination test on citrus seeds was also illustrated. Later that day I visited Duncan Nursery to observe that citrus nursery and the cultural practices employed in caring for citrus seedlings from the time of grafting to transplanting the trees.

Fayetteville, Arkansas

July 22 - 28, 1978

1. On Monday, July 24, 1978, I met with Dr. Roy Rom in his office, and we discussed a cross section of fruits that were commonly grown in both Yemen and Arkansas.
2. I went with Dr. C. C. Schaller, Extension Horticulturist with fruits and pecans to visit the Blueberry Hills Farms, Inc., at Eureka Spring. I observed and discussed the blueberry and blackberry cultural practices, and varieties in this orchard.
3. Visited with Dr. Roy Rom at the farm of Mr. G. Smith to observe and discuss cultural practices of the blackberry, blueberry, strawberry and muscadine grapes.
4. Toured the Clarksville fruit substation and observed and discussed the various experiments on apples and plums, peaches, grapes and blackberry.
5. Attended a field day at the University of Arkansas at Fayetteville, Horticulture Food Science Department. Topics covered were fruit storage, grape varieties, cow-pea, blueberry, strawberry, tomato, okra, apples, orchard and trickly irrigation systems.

Lake Alfred, Florida

July 29 - August 4, 1978

1. I visited the Florida Department of Citrus and the Experimental Station to observe and discuss the varieties of citrus and virus diseases of citrus trees.
2. I discussed with Dr. Mohamed A. Ismail
 - a. The suitable citrus varieties for the climatic condition in YAR.
 - b. The recommendations for degreeing Florida fresh citrus fruits.
 - c. Removal of ethylene dibromide from citrus fumigation chambers.

3. Visited the packing house in Winter Haven.
4. Discussion with Dr. A. W. Feldman the young tree decline, sand hills decline and virus diseases on the citrus trees.
5. Visited Southern Citrus Nurseries in Dundee. Mr. Tom Thayer hosted the tour to observe the citrus nurseries, and the cultural practices employed in caring for citrus seedlings from the time of planting seeds, to grafting, to balling the trees and distribution to the growers.
6. I visited the Department of Agriculture, Division of Plant Industry Citrus Budwood Registration Program. Observed and discussed the facilities of citrus budwood certification program for the growers registered nursery plants in Winter Haven.
7. I went with Dr. Fouad Basiouny from Winter Haven to Gainesville. In the morning we visited the University of Florida and observed and discussed their facilities. Also visited the USDA Gainesville Quarantine Facility and discussed the general guidelines for the introduction and indexing of citrus propagation material in Florida.

Tuskegee Institute, Alabama

August 5 - 13, 1978

1. I visited the experiment station and observed and discussed the varieties of muscadine grapes, peaches, sweet potato, tomato, eggplants, cowpea and okra with Dr. Booker T. Whatley, Dr. B. D. Mayberry, Dr. George Cooper and Dr. Mohamed Sarhan.
2. Visited the Cooperative Extension Service in Haneyville. Visited the Bennett Brother Farm in Greenville and observed and discussed the varieties of sweet potatoes, peanuts, and grapes. The best variety of sweet potato was Jewel which yielded about 21.5 ton/ha and is highly resistant to wilt and nematode.

3. A meeting was held in Dr. B. D. Mayberry's office in the presence of Dr. George Cooper, Dr. M. Sarhan and Mr. Jeffery Lee to discuss how we could better the tropical and subtropical horticulture project in YAR. This meeting centered around the methods of acquiring plant material and increased communication between the Tuskegee staff in Yemen Arab Republic and Tuskegee Institute.

Conclusion

"The main aim of my visit to the four states in the United States was to observe horticultural research work and demonstration as well as new techniques in the fruits of the temperate and tropical areas. This included the work being done with nectarines, apples, peaches, pears, grapes, plums, figs, apricots, citrus, blueberry, blackberry, strawberry, walnuts, almonds, peanuts and sweet potatoes.

"I observed that the fruit industry in the United States was very highly developed and illustrated a high standard of agricultural excellence. This differs from the standards in Yemen and it is my hope that some of the cultural practices and technology can be utilized in development projects in Yemen.

"This opportunity further allowed me to refresh and increase my knowledge in modern day technological techniques spanning a variety of agricultural disciplines which I hope will help to upgrade the food production in my country."

IX. Evaluation

This project did not have an outside evaluation until near the end of the contract. At that time, a comprehensive evaluation was done

by the Ronco Consulting Corporation. Tuskegee recognizes this evaluation as fair and impartial. For this reason, the Executive Summary of the Ronco report is included here.

"This review of the Tropical and Sub-Tropical Fruit Improvement Project in Yemen (No. 279-0024) comes five years after signature of the Project Agreement.

"An implementing contract was not concluded until ten months after that (May 1977). Under the contract, services were to end in December 1979. A contract team was not in place, however, until the Fall of 1978, and not functioning normally until early 1979. In April 1979, the contract was extended to September 1981.

"The negative effects of delay have been lasting. Principally, the project suffered a loss of "credibility," which accounts in part for the YARG's (Government of the Yemen Arab Republic) reluctance to commit its people to the undertaking. Morale suffered. It became difficult to coordinate project inputs.

"Our findings with respect to AID's performance in organizing the project would support the following statements.

- . Faced with the dilemma that no bids were received for the implementing contract, AID sought out and accepted a contractor whose qualifications were known to be limited in this field.
- . AID funding of the project was adequate in amount; but allotments and authorizations to spend were made in a fashion that inhibited orderly forward planning.

- . It is a credit to the AID Mission's sense of responsibility that it accepted the burden of mobilizing and coordinating YARG contributions to the project; but it was not successful, on the whole, in doing so.
- . Working in difficult circumstances, the AID Mission was slow and inefficient in completing the physical development of the research stations.
- . AID/Washington can be faulted for discontinuity in staffing for project management.
- . Until recently, relations between the AID Mission and the Contractor were strained. Small problems were allowed to fester. Lack of operational budgets hindered orderly planning; responsibilities overlapped.
- . The AID Mission's management of the project has improved over the last half year, with the resolution of a number of administrative problems. The physical condition of the stations is fair. The Mission and the Contractor have responded effectively to YARG's interest in plant dissemination.

"YARG was prompt in allocating land for the research stations, but both sites had serious disadvantages. It did not live up to its commitment to assign project counterparts, to make personnel available for training, and to insure a regular supply of project labor. It also cancelled planned socioeconomic studies designed to provide a context for future development of horticulture work. The YARG's principal interest

in the project was short-term dissemination, rather than long-term testing, of imported tree varieties. This put it at cross-purposes with the original concept of the project as primarily a research activity. The project having responded to this interest, YARG appears more inclined to support it.

"Our findings with respect to the Contractor include the following:

- . It has performed with dedication within the limits of its own capacities and the constraints of the working environment.
- . It contributed to (but was not the sole cause of) delay in the posting of a contract team.
- . The Contractor lacked the experience and the on-campus and on-site scientific qualifications to meet its contract responsibilities in full. For example, systematic records of plantings and tests were not kept.
- . While having fallen short in research work, the Contractor did make the required reports; did prepare adequately for socioeconomic studies (preparations that can be utilized in the future); and is now caring in a highly improved manner for ongoing work at the research stations.

"The purpose of the project was to "create the potential for future institutionalization of horticulture work in Yemen..." through the establishment of research stations, personnel training, testing and dissemination of improved technology, collaboration with other agencies in a research "network," and so forth.

"A number of deciduous and tropical varieties are being tested at stations created by the project and at several "outreach" sites (governmental and private). However, research activity as a whole has been limited, including work on improved cultural practices. Other project activities such as training have been neglected. The stations themselves represent the principal achievement in "institutionalization."

"The project has had no measurable effect on sector goals concerning crop diversification, farm income, and nutrition.

"A number of recommendations are made in connection with redesign and extension of the project. Major themes include:

- . Building on project achievements, however limited. An entirely new start would be wasteful.
- . Recognize and adapt to the fact that top faculty will seldom accept two year assignments taking them away from their professional career ladders.
- . Raise sights on contract team staffing, in a wider range of functions.
- . A balanced research/dissemination program is desirable with improved research techniques and development of nurseries for propagation.
- . Consider ways to move the government toward greater participation in the project.
- . Devise ways to transfer project management responsibility to the Contractor.

- . Coordinate project research with horticultural research elsewhere.
- . A fresh effort should be made to initiate in-country, third country, and U.S. training."

X. Recommendations

Tuskegee considers its experience to be mutually beneficial to itself and to the Yemen Arab Republic. Many attempts were successful while many others were disappointing. Out of all of this came realizations which may not have been achieved otherwise.

Based on the Tuskegee experience, several recommendations are made, as follows:

- The need for long-term research is so urgent, that it should not be de-emphasized in favor of the need to produce plants for distribution to farmers;
- Fruit trees should not be distributed until they have been budded or grafted and tested in the experiment stations;
- High priority should be given to the concept of the importance of the socio-economic study;
- Every effort should be made to develop the new temperate zone station at Al Irra and discontinued efforts at Bir Al Shaif; and
- The Ministry and the Mission should agree to develop a road and adequate facilities for the station at Jarouba or move the station to a more accessible location.

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