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9. ABSTRACT
This report is based on observations made and consultations with various personnel during a 12 day visit to the Tunisian countryside. It is supplemented with information from literature surveys, library research, and experience gained by the author as a professional pomologist and a fruit grower. The purpose of the trip was to: (1) Review information and data available in the National Agricultural Research Institute on fruit and nut varieties grown in Tunisia; (2) Visit existing nurseries experimental plantings and commercial orchards and review their results; (3) Evaluate the physical and climatic conditions of the project area (principally the Makthar delegation) and determine its suitability for fruit and nut production; (4) Evaluate a proposed site for adaptive testing at Ain Seddine and make specific recommendations for utilization. A list of 22 fruit and nut varieties were indicated as possible selections for cultivation at the test site in Tunisia. Of this list, almonds, apricots, dates, figs, grapes, and olives were eliminated in view of the fact that these fruits were already under production in the area. Other kinds of fruits on the list, such as black berries, cashew nuts, strawberries, quince, were excluded due to production, shipping or marketing problems. The remaining kinds of fruit with promise were apples, peaches, nectarines, pears, cherries, plums and hazel nuts. Factors limiting success were considered to be: water for irrigation, understanding of fruit growing by the populace, financing, and patience on the part of the project leaders and populace. The area has no established tradition in the type of fruit culture anticipated and there will be some problems transferring and utilizing modern tree fruit production technology in an underdeveloped area. An approach to establishing tree fruit production is presented, to begin in 1978.

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# REPORT

# ON

# JUNE 1977 TRIP TO TUNISIA

# FOR

# R D PROJECT NO. 664-0285

# "RURAL DEVELOPMENT SILIANA"

BY

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# INTRODUCTION

My trip to Tunisia, accomplished in June, 1977, was made in response to a recommendation that a Pomologist visit the Siliana Rural Development Project area.

The trip's purpose can be stated in outline as follows:

I. Review of information and data available in the National Agricultural Research Institute on fruit and nut varieties grown in Tunisia.

II. Visit existing nurseries experimental plantings and commercial orchards and review their results.

III. Evaluate the physical and climatic conditions of the project area (principally the Makthar delegation) and determine its suitability for fruit and nut production.

IV. Evaluate a proposed site for adaptive testing at Ain Seddine and make specific recommendations for utilization.

This report is based on observations and visits, with various personnel, made during a 12 day exposure to the Tunisian countryside.* It is supplemented with information from literature surveys, library research, knowledge and/or experience gained during 19 years as a professional pomologist and 10 years as a fruit grower.

There is an overriding philosophy behind my evaluations and judgments which concerns the goals of the Rural Development Project itself which is to raise the rural people's quality of life through increased yet diversified agriculture while making optimum use of area's soil water and climate. Fruit production is a valid alternative for this area.

* See preliminary report for listing of places visited and persons contacted.

While optimistic in my approach, I do have these concerns. They are given due thought in this report, as I respond to these questions.

1. How do you establish tree fruit production on an area where there is (a) limited experience as to species and cultivar adaptation; (b) limited production knowledge by the people; (c) limited water resources; (d) limited investment resources?

2. How do you transfer modern technology for intensive agriculture, i.e. horticulture, to what is now and has for generations been subsistence agriculture?

3. What expression should fruit production take: small farm units, cooperative units, corporation or investment units?

4. How do you consider the question of time involved for reasonable accomplishment of goals?

Thus, this report concludes with suggestions and replies to these questions which may serve as a basis of future policy decisions.

## I. Review of information of fruit and nut varieties being grown in Tunisia

Preliminary reading made prior to the Tunisian visit indicates that the following fruits and nuts might be considered for the project area.

| | | |
|---|---|---|
| Almonds | Nectarines | Strawberries |
| Apples | Olives | Walnuts |
| Apricots | Peach | |
| Blackberries | Pears | |
| Cashew Nuts | Pecans | |
| Dates | Persimmons | |
| Figs | Plums | |
| Grapes | Pistachio Nuts | |
| Hazel Nuts | Pomegranates | |
| Macadamia Nuts | Quince | |

Tunisia's varied climate and traditions have resulted in the development of fruit growing in areas where years of experience have delineated the more productive regions. A report filed by E. F. Gibson in January, 1977, titled "A Statistical Brief on Tunisian Agriculture", lists those kinds of fruit which are produced in quantity.

In view of an established production of almonds, apricots, dates, figs, grapes, and olives, these fruits were not considered seriously for the project area although with the exception of dates and figs, there may be possibilities for these fruits. The philosophy behind this point of view is that the project area would be at a disadvantage with respect to production practices already worked out for these fruits in perhaps more favorable locations and with regard to established markets.

Other kinds of fruits on the list have had little or no testing in Tunisia; have specific production requirements which would make them marginal in the project area; have no established market demand; would not ship and handle well under present conditions of marketing; would either not bring a significant market return or would be too slow coming into production. Thus I think it reasonable to exclude the following from the list.

<u>Blackberries</u> - could be grown but they are highly perishable, fragile and unknown.

<u>Cashew nuts</u> -- might be adapted but a high risk, low return crop for the project area.

<u>Macadamia nuts</u> probably sensitive to extremes of temperature found in the project area.

Pistachio nuts - recommended by INRAT for southern regions, may be adapted to steppe regions. This crop has limits as to good cultivars and high production costs.

Persimmons - an adapted crop if cultivated properly but no established market tradition.

Pomegranates - marginal for the project area, Tunisia country does have an annual production of about 13,000 mt although no production reported since 1970.

Pecans - this crop has a deep-soil, high moisture requirement. Testing has been limited. INRAT has recommendations for the north coastal areas.

Quince - this would be an adapted species but fruit is utilized in processing and the market would be small.

Strawberries - possible adaptation in the project area, better adaptation in other parts of the country. Product is fragile and requires special handling to market.

Walnuts - there is no formal testing of this crop in Tunisia. Some of the recent studies in California may have an application to the project area, but in view of no Tunisian experience and the time lag for economic returns, I would not consider English walnuts or Black walnuts.

The remaining kinds of fruit with promise are then apples, peaches, nectarines, pears, cherries, plums, and hazel nuts.

I visited with Mr. Mustafa Lasram, Horticulturist at the Institut National De La Recherche Agronomique De Tunisie and

obtained from him a 1974 publication "Les Varieties Fruitieres Et Cephages Recommandes En Tunisia". We discussed fruit growing and cultivar resting. The outlying research plantings visited during my Tunisian tour were largely those recommended by Mr. Lasram. Comments on those visits are found in the next section of this report. Of the fruit species I am considering worthy of evaluation in the project area, the following are the Tunisian cultivar recommendations.

Apples (For the high plateau and valleys of the north)

Golden Delicious
Red Delicious
Richared
Starkrimson

This is a very limited listing of apple cultivars. It does not include a wide range of harvest nor does it include cultivars which I think would have greater adaptability to the project area.

Peaches (High plateau and steppe region)

| | |
|---|---|
| Springcrest | Suwanee |
| Maygold | Southland |
| Coronet | Early Elberta |
| Redtop | J. H. Hale |

These cultivars are all USA introductions but the list is not extensive nor does it include cultivars accepted in the US as superior to these listed cultivars or recent releases from breeding programs.

Nectarines

No nectarines are recommended. I do not think this is due to nonadaptability but rather to their not having been evaluated or not evaluated sufficiently by 1974.

Pears (High plateau and valleys of the North)

Dr. J. Guyot
Packham's Triumph
Williams
Wilder

This listing does not contain several of the cultivars grown in pear regions of the U.S. or Europe.

Cherries (For the high plateau, valleys of the north, central coast)

Bow Arkoub (of local origin)
Hatif De Bualat
Bigarreau Moreau
Bigarreau Napoleon

These are sweet cherries, cross pollination required. Again, the listing does not contain some of the newer cultivars or compact cultivars.

Plums (High plateau, valleys of the north or general in Tunisia)

Methley
Beauty
Santa Rosa
Golden Japan
Kelsey
Sugar
Utility
Stanley

Hazel nuts - no recommendations

This list includes Salicinia as well as Domestica cultivars and although quite brief, contains the principal cultivars of commerce with minor omissions.

According to Mr. Lasram, in the preindependence days, fruit testing was random and not related to soil types. Sound background information on cultivar testing in Tunisia is therefore probably lacking. The current testing program is still limited but does contain some valuable information on rootstock, pollination requirements, the necessity of irrigation and region of adaptation. The

cultivar testing program, in my opinion, is minimal but more limiting is information on production practices or the application of what is known about production practices.

As part of my assessment of the fruits in Tunisia, I visited the markets in several locations but principally the central market in Tunis and Makthar. Fruit was not listed by cultivar name and I realize that I was not present at the best time for some fruit kinds. I was, however, familiar with fruit maturing in Arkansas and having similar harvest dates to those in Tunisia. The quality of early apples was extremely poor yet the price/kilogram was 5 times that of good oranges and slightly higher than that paid in the U.S. for apples of higher quality. (Part of the quality problem was handling and marketing). Peaches were somewhat better in quality but not comparable to U.S. cultivars in size, shape, maturity, and durability. With prices lower, plums were equivalent in quality to U.S. markets at this season. Apricots were of inferior quality. The only pears at this season were very small and in my opinion not much of a bargain. No cherries or nectarines were seen in the market. Most fruit was free of insect blemish and displays were well culled to remove spoiled fruit, however, bruised fruit was common. Fruit sizing seemed to be a common problem as most fruit noted in the market was not as large as it might have been if grown under better production methods.

Based on information found in the preceeding paragraphs, I would consider the following fruits to have the best potential in the project area, in order of priority: apples, peaches (Nectarines), cherries, pears, plums, hazel nuts.

## II. Visits to existing nurseries and plantings and a review of programs

Visits were made at the following locations where fruit cultivar information was being collected:

1. LeKrib
2. Ain Draham
3. Sfax
4. Tibar
5. Mornag

1. LeKrib: The fruit and variety testing station at LeKrib is located in a natural geographic region called the High Plateau. The project area is also located in this geographic region. Research started in 1965.

At this station there is a sizeable apple, pear, peach, cherry, and apricot testing program, also late flowering almonds and pistachio, but no plums. I saw little evidence of a breeding program although Mr. Lasram had indicated such a program was in effect.

The soil appeared very adequate for fruit production when irrigated and this station was furrow irrigated. The source of water was a well.

Bloom dates of apples, pears, and peaches at this station were comparable to those in central Arkansas. The frost hazard in spring appears to be less than in the production areas of Arkansas.

I viewed at least 20 apple cultivars but did not see a good many which should have been in the testing program.

Many of the apples were not in production although the trees were old enough. In my opinion there are basic reasons for lack of consistent production and consequent greater evaluation.

a. Failure to provide insects for adequate pollination. Apples require cross fertilization and wind pollination does not accomplish this.

b. Failure to thin the crop when a good crop is set; this forces trees into an alternate bearing situation.

c. Failure to balance the vigor of the trees. Some non-bearing trees were overly vigorous from heavy pruning, over fertilization, perhaps too much irrigation and cultivation.

The pear collection appeared to be giving more consistent data than the apple collection. About a dozen cultivars were looked at critically. Jules Guyot, Passe Crassane, Wilder, and Gen. LeClerc all looked well adapted. The pear planting was faced with the same problems as the apples.

In neither of these plantings was there any concerted effort to investigate rootstock effects. Several rootstocks were represented however, but not in a meaningful way for evaluation.

The peach collection contained a mixture of cultivars some of which were clingstone and some nonmelting clingstone types. The collection was not up to date in regards to cultivars released in the U.S. and Canada in the past 10-15 years. Most trees were on almond or peach almond hybrid roots which was laudable. The use of plum rootstocks has failed in this area.

The fruit quality observed was poor, but I would attribute this more to management than adaptability. The trees in this planting were over fertilized, probably over watered and poorly trained in my opinion.

Cherries: No cherry fruit were seen at this location as the trees were young and the collection was small.

Apricots were observed and the trees appeared well adapted and healthy. Some large fruited cultivars were, Hatif Colomer,

Rouge Roussillon, Jamibert Foulon. The better cultivars were Hamid, Nugget, and Kasserine. Although I have not considered apricots strongly for the project area because of significant production, in other areas, this crop should do well if properly managed, including irrigation.

General observations made at this station were that aphids will be an insect requiring vigorous control measures and susceptible cultivars should be avoided. Scab on apples and pears may need to be watched. Nutritional problems and nutrition in general should be monitored by means of foliar analysis and correlation with soil tests.

The program at this site suffers most from: (1) the lack of a thoroughly trained pomologist in residence at the station, (2) more frequent visits by pomologists, entomologists and pathologists from INRAT, (3) untrained labor at the station, (4) lack of record keeping beyond yield data, (5) failure to utilize water and fertilizer efficiently.

2. AinDraham. The fruit planting at AinDraham was located 4 km south of the city in a narrow valley. From the standpoint of site selection, this was an unfortunate location. AinDraham is in a geographic region (Kroumirie-Mogods) that was characterized by steep mountains, narrow valleys and more rainfall than in the project area. The soil was a silty clay.

From the standpoint of yielding any meaningful data on which production recommendations would be made, this planting can only be called a disaster. It was in a state of total neglect. Trees had been browsed upon by grazing animals and deer, training of young trees was inadequate and recent pruning had not been practiced,

although the resident manager said it was being done. It was reported that in recent years there had been good crops of apples, pears, and sweet cherries. It was difficult for me to appreciate this comment. I was able to determine however, that there was sufficient winter cold to satisfy the chilling requirement of sweet cherries and so there would be no serious problems with most cultivars of apples, pears, and peaches. The station altitude was about 739 m.

I would seriously consider the advisability of INRAT continuing to invest money in this test planting, if indeed they are now, unless they are willing to: (a) fence the area in, (b) open the air drainage, (c) provide for irrigation and (d) have a trained technologist living on the site.

3. Sfax. The Olive Research Station about 25 km. north of Sfax contained some studies on regeneration and replacement of olive trees. There was very little work at this station relative to the project area, although I did see some pistachio and peach trees. This station was located on the sandy soil of the Cotiere Centrale region, a geographic region not related in topography and climate to the Hauts Plateau or Basse Steppe regions. While physical facilities were limited, the station appeared to be well managed.

4. Thibar. Cultivar testing was observed at the Agricultural School at Thibar. This location is at the very border between the geographic regions called the Vallees Nord and the Hauts Plateau and was indeed a transition location, however, I feel sufficiently close to the project area environment that results here would be applicable. The valley has a rather unique microclimate which allow citrus and pyrus species to be grown side by side, which in fact

strengthens the concept that freezing temperature is not needed to satisfy chilling, as long as the cool prevails without interruption by long warm spells. Apparently, the citrus tolerates this kind of winter.

The soil at the farm operated by the school was a silty loam. At one location there was a plum variety collection. While not many cultivars were under observation most had a respectable fruit crop and were managed reasonably well. The same can be said for peach trees in this collection. The apricot cultivars, Ponanise and Canino looked good (Canino is a leading apricot cultivar in Israel).

The prunus species in this planting were affected by lime induced chlorosis. There was much variability between cultivars with regard to degree of chlorosis. This could be a rootstock influence, but the rootstocks were not known. This problem could be alleviated by proper rootstock choice or by the use of iron chelates added to the soil. The planting was fertilized by composted animal manure, which unless carefully managed, can lead to uncontrolled nutrition as evidence by excess vigor in some trees.

On the same farm, but at a slightly lower elevation, there was a good test of apples and pears. Apples were found on several clonal rootstocks, M-9, M-104, M-111. The cultivar selection was limited, but did contain kinds with early mid season and late season maturity. The Lodi cultivar has the same faults in Tunisia as in Arkansas.

The Mantet was just coming into its season. This cultivar looked good in NW Arkansas this year. Other cultivars were of later maturity. I was able to see Jonathan trees and they seemed adapted.

Pear cultivars were not named, but there were several and they appeared normal in most respects, except for chlorosis.

At this station, there was evidence of a little more application of horticultural "know how" as the plantings were obviously under supervision of someone who was not only trying, but also cared. My principal complaint would relate to lack of fruit thinning and the excessive use of compost as a fertility practice. The plantings were irrigated with water containing 2500 ppm salt, which is somewhat on the salty side.

General comments on work conducted at testing locations: Minimum data requirements on which cultivar recommendations can be made should include the following: date of bloom, date of harvest, yearly yield, rootstock used. To compliment this date, the following records should be kept at the test site: Maximum and minimum temperatures every day, rainfall, irrigation added, time and amount of thinning, sprays required, fertilizer use (amount/tree, time of application), notes on tree and fruit characteristics, pruning, and training practices.

5. Mornag. This INRAT research station is located in the Tunis vicinity, a geographic region designated as Cotiere Nord. While the climate here is unrelated to the project area, this was a valuable visit, as it indicated to me a measure of concern by INRAT for maintaining true to name and possibly virus free sources of stock and scion propagation material. The Foundation Rootstock and Scion Blocks were well conceived and managed. Some information on plums, peach, cherry, and apple rootstocks is being generated at this station which is valuable and applicable to the project area. A modest apple breeding program is also underway at this location, but the

objective relates more to the warmer areas of the country.

I was encouraged by the use of drip irrigation (although in a citrus planting) and the enthusiasm for this approach to irrigation. This is directly applicable to the project area.

Other visits. During the course of my travels across the northern two thirds of the country, I visited many fruit orchards. Comments on observations are as follows:

1. State farm between Makthar and LaKesra. This fruit farm of about 100 ha was in a state of neglect. It possibly stems from the period of collectivization popular after independence. It was a classic example of too large an endeavor with too little technical input. It was not irrigated, but had basins under the trees to impound rainfall. Trees were in a water shortage stress. Sweet cherry trees had a fair crop, but were in low vigor and with nutritional problems as well. There were some apples on all three (?) cultivars present, but most trees had no crop.

This planting convinced me of several things, (1) fruit can be grown in this area, (2) supplementary water is an absolute must, (3) the dry land approach is uncertain, unsure, and inadvisable, (4) windbreaks probably will be a cultural requirement, (5) there will be some disease and insect problems to cope with.

2. On the road to Siliana just outside of Makthar. Apple and pear trees were observed on deep alluvial soil. These trees were quite old. A small stream provided water. This observation further indicated species adaptability to the region.

3. State farm at Chemtou. This visit was highly encouraging as both apples and pears were in full annual production. About 100 ha are devoted to apple production with Starkrimson the principal

cultivar - not a particularly good choice, however, in my estimation. Trees in this orchard were managed in a semi-high density planting, as the result of combining good soil, irrigation, and rootstock choice. Although not known for certain, the trees appeared to be on M-7 semi-dwarfing roots. The semi-high density plantings helps make maximum use of the land by increasing tree number/ha and also yield/ha. River water was used for flood or basin irrigation. The water source was probably marginal with respect to salt tolerance. Much hand labor was required to irrigate this planting and this type of irrigation was disruptive of other orchard practices.

The other management practices were fairly well conceived and executed, i.e., pruning and training, fertilization, spraying (although equipment was greatly outmoded for this size enterprise). A labor force of 70 men was probably 6 times greater than that used in the U.S. for a similar size planting.

This visit was highly encouraging as the terrain and climate (Chardimaou) was not unrelated to that found at Makthar. I consider this orchard enterprise as an example of the potential for the project area.

4. Kairouan. Several orchards were visited between Kesra and Kairouan. This is in the Basse Steppe Region. The orchards were dry land managed. Peach trees in these plantings showed more environmental stress than the apricots. The peach trees also appeared to show insufficient chilling signs and were probably of marginally adapted cultivars. Almonds and olives as dry land crops were more adaptable.

5. Thala. Along the road directly south of Thala some fairly good apricot orchards were observed, as well as a few apples and

cherries. There appeared to be minimal management input into these plantings and no irrigation, but it gave evidence of adaptability of these species in the Hauts Plateau region when sites with good soil are selected. Animal grazing in these orchards was common and contrary to good production capacities.

6. Kasserine. On the eastern edge of this city, a productive apple orchard was observed. This orchard was in the Hautes Steppe region. The trees were in furrow irrigation, healthy, and relatively productive. I do not feel that productivity was related to adaptability, but rather to management. The orchard, since irrigation was being used, could have been planted more intensively.

This orchard also indicated the potential for apples in the project area if given proper management and supervision.

7. Sbettla. On either side of Sbettla, apricot orchards were visited. These were also in the Hautes Steppe geographic region. The trees were managed by dryland farming practices with wide spacing. Cane and/or cactus wind breaks were used, which also doubled, I suppose, as fences to keep out cattle.

## GENERAL COMMENTS ON VISITS TO ORCHARDS IN AND AROUND THE PROJECT AREA

Although orchards were observed in many of the areas visited, I have considered those in this report that relate to the project area and to the crops primarily under consideration for the project area. It appears that orcharding can be accomplished in the project area. Examples of good and bad management related primarily to the use of irrigation and intensification of production practices. Bad management related to neglect or minimal production effort and the hope that some how there would be a little fruit produced. In

general, allowing animals in the orchard correlated with poor management practices, while irrigated orchards showed signs of more intensive management.

## III. Evaluation of project area with regards to climate and soil.

### Climate

The adequacy of a region's climate for tree fruit production is based on an assessment of several factors.

1. Temperature
2. Rainfall
3. Sunlight
4. Wind
5. Relative Humidity
6. Occasional Hazards

Within a region of permissable climate there is the necessity to make site choices which may by reason of exposure, slope, elevation, and soil give particular advantage to fruit production.

Assessment of the climate's suitability in the project area was made by means of comparing climatalogical data for Markthar, Siliana, Oueslatia with that from other regions in Tunisia and fruit production regions in the U.S.

I. Temperature

A temperature profile was established for 7 locations in Tunisia, each at different altitudes. Since fruit production of apple, pear, peach, and plum was observed at LeKrib (in the vicinity of LeKef) and at Chimtou (in the vicinity of Chardimaou). These two reporting stations serve as a reference point.

Using average temperatures as a measure, the generalization is made that the project area is slightly cooler than either LeKef or Chardimaou, which is good. Thus, from the average temperature standpoint, the project area has temperature regime more favourable

Average temperatures C for 7 reporting stations
In Tunisia

| Ave. | Makthar | Siliana | Ouselatia | Lekef | Jenouba | Chardimaou | Grombalia |
|---|---|---|---|---|---|---|---|
| | 973 | 700 | 503 | 665 | 143 | 200 | 50 |
| J | 7.2 | 8.8 | 9.1 | 8.0 | 10.4 | 10.1 | 12.0 |
| F | 7.1 | 9.0 | 9.6 | 7.9 | 10.5 | 10.0 | 11.8 |
| M | 8.4 | 10.3 | 11.0 | 9.6 | 11.4 | 10.6 | 12.9 |
| A | 10.8 | 13.1 | 13.7 | 12.8 | 14.0 | 13.1 | 15.6 |
| M | 15.9 | 18.3 | 18.1 | 17.8 | 18.5 | 18.3 | 19.3 |
| J | 21.6 | 23.5 | 24.0 | 23.1 | 24.0 | 23.0 | 28.8 |
| J | 24.8 | 26.3 | 25.6 | 25.6 | 26.9 | 26.4 | 26.4 |
| A | 25.5 | 27.1 | 26.5 | 27.9 | 28.1 | 27.5 | 27.5 |
| S | 21.6 | 22.8 | 23.0 | 22.3 | 24.3 | 24.0 | 24.5 |
| O | 15.4 | 17.5 | 17.6 | 16.8 | 18.8 | 17.5 | 19.7 |
| N | 11.7 | 13.1 | 13.5 | 13.1 | 14.1 | 14.3 | 16.0 |
| D | 8.1 | 9.5 | 9.4 | 8.9 | 10.5 | 9.6 | 12.5 |

| Ave. Min. | | | | | | | |
|---|---|---|---|---|---|---|---|
| J | 3.9 | 4.5 | 4.3 | 4.0 | 5.3 | 5.7 | 8.3 |
| F | 3.3 | 4.3 | 5.0 | 3.7 | 5.1 | 5.5 | 7.8 |
| M | 4.2 | 5.2 | 5.5 | 5.0 | 5.5 | 5.5 | 8.4 |
| A | 6.7 | 7.1 | 7.8 | 7.6 | 7.4 | 7.6 | 10.7 |
| M | 10.1 | 11.0 | 11.0 | 12.3 | 10.4 | 11.3 | 13.0 |
| J | 14.6 | 15.1 | 15.8 | 17.0 | 15.4 | 14.5 | 17.8 |
| J | 17.9 | 17.5 | 17.3 | 18.9 | 18.0 | 18.3 | 20.0 |
| A | 18.4 | 18.6 | 18.0 | 21.4 | 18.7 | 20.0 | 20.9 |
| S | 14.3 | 15.9 | 16.2 | 16.9 | 15.8 | 17.1 | 19.5 |
| O | 9.2 | 11.6 | 12.0 | 12.0 | 12.6 | 12.8 | 15.1 |
| N | 7.1 | 6.6 | 7.6 | 7.9 | 6.9 | 8.1 | 10.8 |
| D | 4.4 | 4.6 | 4.6 | 4.9 | 5.1 | 4.9 | 8.7 |

than that in areas where fruit production was observed.

When comparisons are made with U.S. fruit production areas using average maximum and average minimum temperatures, the temperature profile of the project area also looks favourable.

For example, Makthar has roughly the same average maximum temperature in the winter as N.W. Arkansas (an apple area) and cooler winter maximums than Nashville, AR (a peach production area). Winter maximums are warmer than in Farmington, N. Mex. (apple area) and 2 Washington stations, Yakima and Wenatchee (apple areas), yet cooler than apple and stone fruit areas in California i.e., Watsonville and Chico.

The winter average minimum at Makthar is warmer than in the apple regions in the U.S., but where as these regions may have problems of winter cold injury associated with low minimum temperatures, the project area appears to be free of this hazard.

Temperatures during the maturation season affect apple color and fruit quality. June, July, August, and September average maximum temperatures in the project area are roughly equivalent to those in New Mexico. More important is the night or minimum temperatures. Makthar will be cooler than N.W. Arkansas, but warmer than New Mexico or Washington. Thus, fruit coloration may be impaired somewhat. This environmental deficit can be overcome through selection of high color cultivars. Apple color is only a minor consideration in Arkansas apple areas.

Associated with temperature is the hazard and probability of spring frost. This condition within an area can be ameloriated by site selection, i.e., air drainage from an elevated position. The frequency of temperatures below -4°C in March, the usual bloom time according to information from LeKrib, is fairly remote. The temper-

A COMPARISON OF MAKTHAR TEMPERATURES WITH U.S. FRUIT PRODUCTION AREA: °C

| | Ave. | NM | | ARK | | GA | CA | | WASH | |
|---|---|---|---|---|---|---|---|---|---|---|
| Max. | Makthar | Farmingdale | Espanola | Fayetteville | Nashville | Macon | Chico | Watsonville | Yakima | Wenatchee |
| J | 10.5 | 6.3 | 6.4 | 8.9 | 11.4 | 14.5 | 11.8 | 14.8 | 2.9 | 1.7 |
| F | 10.9 | 11.3 | 11.2 | 10.1 | 13.3 | 15.7 | 16.4 | 16.9 | 8.2 | 6.9 |
| M | 12.6 | 15.2 | 14.3 | 13.2 | 16.2 | 20.7 | 19.2 | 17.6 | 13.4 | 12.6 |
| A | 14.9 | 19.1 | 19.3 | 22.3 | 25.6 | 23.0 | 18.5 | 17.8 | 16.6 | 17.6 |
| M | 21.7 | 25.9 | 25.4 | 26.4 | 27.3 | 28.5 | 27.9 | 19.5 | 22.7 | 23.0 |
| J | 28.6 | 31.1 | 30.5 | 25.9 | 31.2 | 32.2 | 33.0 | 20.7 | 27.9 | 26.7 |
| J | 31.7 | 35.0 | 31.7 | 32.4 | 33.1 | 33.5 | 36.3 | 21.2 | 32.1 | 31.7 |
| A | 32.6 | 33.0 | 31.1 | 32.9 | 32.9 | 33.1 | 38.2 | 21.4 | 30.1 | 29.8 |
| S | 28.9 | 27.6 | 26.6 | 28.6 | 30.1 | 32.7 | 31.4 | 23.5 | 26.8 | 26.7 |
| O | 21.5 | 19.8 | 20.2 | 22.9 | 23.9 | 27.4 | 24.1 | 20.6 | 17.6 | 17.1 |
| N | 16.3 | 12.3 | 12.4 | 15.7 | 16.0 | 20.3 | 16.4 | 17.1 | 9.1 | 7.5 |
| D | 11.8 | 6.0 | 7.5 | 11.5 | 12.8 | 18.1 | 10.5 | 13.6 | 6.4 | 4.9 |
| Min. | | | | | | | | | | |
| J | 3.9 | -10.6 | -11.2 | -2.9 | 0.6 | 2.0 | 2.4 | 3.9 | -6.9 | -7.0 |
| F | 3.3 | -6.9 | -6.9 | -1.5 | 0.3 | 1.9 | 4.3 | 5.3 | -2.8 | -3.2 |
| M | 4.2 | -3.6 | -3.6 | 1.0 | 3.5 | 7.1 | 4.9 | 5.4 | -1.0 | -0.5 |
| A | 6.7 | -1.1 | -1.9 | 9.0 | 10.2 | 10.7 | 5.7 | 5.8 | 1.7 | 3.4 |
| M | 10.1 | 3.7 | 3.9 | 14.2 | 13.8 | 14.4 | 10.5 | 8.4 | 4.9 | 7.4 |
| J | 14.6 | 9.3 | 8.5 | 18.3 | 18.5 | 19.3 | 14.6 | 10.3 | 9.3 | 11.3 |
| J | 17.9 | 14.3 | 13.4 | 20.3 | 20.2 | 21.5 | 16.8 | 11.4 | 12.1 | 14.6 |
| A | 18.4 | 13.7 | 12.1 | 19.4 | 20.0 | 12.5 | 15.2 | 11.4 | 10.7 | 13.2 |
| S | 14.3 | 7.2 | 7.3 | 16.9 | 18.8 | 19.6 | 11.8 | 10.3 | 6.8 | 7.8 |
| O | 9.2 | 2.0 | 1.4 | 10.1 | 11.5 | 13.1 | 8.0 | 8.1 | 1.9 | 3.0 |
| N | 11.7 | -4.0 | -5.1 | 3.1 | 3.2 | 5.7 | 5.7 | 6.0 | -1.5 | -1.2 |
| D | 8.1 | -8.0 | -9.5 | 1.1 | 1.9 | 5.6 | 2.4 | 3.2 | -2.7 | -3.1 |

Reporting Stations

Farmingdale and Espanola, New Mexico - apples and some plums.
Fayetteville, Arkansas - apples, some peaches.
Nashville, Arkansas - peaches.
Chico, California - stone fruits
Watsonville, California - apples
Yakima and Wenatchee, Washington - apples, cherries, pears, some plums
Macon, Georgia - peaches

ature of -4°C is the minimum temperature an apple or pear can endure in bloom and still have 10% survival. This temperature is about 1°C lower for stone fruits. Frosts in the project area should be less limiting and less hazardous than in most fruit production regions in the U.S.

2. Rainfall

There is little doubt that the rainfall in the project area represented by the Makthar data is not sufficient to produce the fruit species under consideration in quantity and quality. By way of contrast however, in the apple production areas of Farmington, New Mexico and Yakima, Washington the annual rainfall is only one third of that experienced at Makthar. From December through March the Makthar rainfall is roughly equivalent to that found in N.W. Arkansas for the same time period.

The project area winter rain is adequate enough to recharge the soil, to provide the possibility of rainwater harvest and to flush some salts from the tree's root zone. For 6 months of the year, rainfall is of such an intensity that a 2.54 cm accumulation in 24 hrs is not uncommon. Rains of such quantity would probably have flushing activity.

It appears quite possible that the deficiency in rainfall can be adjusted through irrigation methods and that rainfall harvest should be considered in areas within the project where wells are not sufficient to meet orchard needs.

The fact is retained that annual rainfall averages conceal seasonal variation and distribution. Thus, data of this type is not to be depended on for tree fruit production needs, particularly in the summer. The risk factor is so great that production without

Rainfall: A comparison with several U.S. apple production areas.

MM Rainfall[1]

| | Makthar Tunisia | Farmington[2] N. Mex. | Yakima Wash. | Fayetteville Ark. |
|---|---|---|---|---|
| Jan. | 81.3 | 7.8 | 33.7 | 65.0 |
| Feb. | 67.3 | 3.6 | 19.8 | 77.2 |
| Mar. | 88.3 | 19.1 | 14.7 | 85.3 |
| Apr. | 53.5 | 9.2 | 13.0 | 121.1 |
| May | 35.2 | 7.0 | 14.0 | 151.9 |
| June | 14.2 | 20.2 | 18.5 | 128.7 |
| July | 27.3 | 9.0 | 4.1 | 92.2 |
| Aug. | 26.7 | 19.4 | 6.4 | 85.9 |
| Sept. | 48.0 | 35.2 | 7.8 | 104.1 |
| Oct. | 93.2 | 44.5 | 14.7 | 90.2 |
| Nov. | 13.1 | 11.4 | 24.4 | 82.0 |
| Dec. | 47.5 | 14.4 | 28.4 | 64.5 |
| Tot. | 595.6 | 200.8 | 199.5 | 1148.1 |

1 - Based on long term average for US stations and average for four years 1970-73 at Makthar.

2 - Fruit produced only on irrigated land.

irrigation should not be considered. The dry land farming concept is not compatible with fruit production of the species being considered for the project area.

3. Sunlight

There should be no problem with adequate sunlight.

4. Wind

Observations indicate that wind breaks have been used in connection with orchard plantings. Constant wind pressure is more of a factor than occasional storms. Wind may affect tree training, insect flight during pollination, and application of pesticides and fruit finish. The occurrence of Sorocco storms is not of a great enough frequency or duration to be considered as limiting.

5. Relative Humidity

In general, relative humidities during the fruit development period was found to be lower than that experienced in humid production regions in the U.S. and equivalent to that found in arid regions. This condition is a climatic attribute with regards to fruit finish and reduction of disease hazard.

6. Occasional Hazards

Almost all fruit production areas are subject to certain weather hazards which are a part of the climate, but occur as isolated or infrequent incidents. In this category, with respect to the project area hail, the Sirocco winds, and flash floods during the winter would be matters of concern, but not to such an extent as to cast doubt or the advisability of fruit production throughout the region.

In viewing the climate in total, I would say that it is to be considered as favorable. The one exception, rainfall, is fortunately the one climatic factor which many can successfully circumvent by

irrigation. Judicious site selection within the area of permissable climate gives additional advantages. Furthermore, there is some opportunity to select cultivars of species which will be most adaptable to the climate as found.

It must be mentioned that data presented on climate represents in many cases, but not all, four year weather averages (1970-73) as long term averages were not always available. The assumption is made that these averages do not deviate very much from actual long term averages.

7. Soil

A soil satisfactory for fruit production must be judged on the following characteristics based on their order of importance.

1. Drainage
2. Water holding capacity
3. Reaction pH
4. Infiltration
5. Mineral content
6. Depth
7. Absence of toxic elements

The soils in the project are varied and undoubtedly there are some which are highly desirable and those which are totally unsuitable. I was not able to collect sufficient data on soil types in the area. I did observe profiles in some washes.

One feature concerning orchard soils is that they are the geographical feature which is most easily altered, i.e., they can be drained, tilled, broken up, inverted, pH adjusted, leveled, contour, benched, and fertilized.

1. Orchard soils must have good internal drainage with the characteristic to reach field capacity to the rooting depth within a day or two following heavy rainfall or irrigation. The type of soils that should be avoided are those poorly drained, heavy in

texture or light textured and droughty. Silt loam, or clay loams with good internal drainage are the most desirable.

2. While drainage is of the up most importance, the soil body should have a good water holding capacity, i.e., well drained clay soils are better than well drained sandy loams.

My view of the soils in the project area based on observations of vegetation and profiles is that there should be enough suitable soil sites to meet the needs of any orcharding projects.

3. A pH range of 5.5 to 6.5 is best, but rootstock selection allows for deviations from this range.

4 From observations, I would judge that high pH will be a problem on adapted soils. The second problem will be finding soils with good infiltration, good water holding capacity, and internal drainage to a satisfactory depth.

As the project moves ahead, orchard sites must be selected individually as to suitability for tree culture. A fortunate aspect of this selection is that sites do not need to be large. Land tracts of 2-100 ha would suffice.

Probably more limiting than site size with suitable soil will be water availability for the site. To this extent, water becomes a problem. At Chemtou, I observed flood irrigation with water containing 3,500 - 3,000 ppm salts. This was above the value generally considered safe for orchards. Water should be tested to see that sodium does not exceed 80 ppm and chlorine 110 ppm. Yield losses generally result when salt concentration equals 3 millimohs/cm conductivity.

5 For the most part, soil fertility levels can be adjusted following soil testing and monitoring tree growth by means of foliar analysis. The most critical element is nitrogen. It is also one of

the most easily manipulated elements.

6. A soil depth of 1 meter for 80% of the root zone and 2-3 meters for anchorage is desirable. Shallower soils will have insufficient water holding capacity and not provide for adequate self standing anchorage.

7. The problem of toxic elements in a soil relates to the solubility of elements as they relate to the soil reaction. Sodium might possibly be the one element of concern. Saline soils should be avoided. Lime induced chlorosis can be adjusted through rootstock selection and chelated minor elements.

8. Infiltration is important in terms of a soil accepting irrigation and/or rainfall while avoiding erosion due to run off. Orchard floor management can improve this characteristic in a soil or destroy it.

My view of the soils in the project area based on observations of vegetation and profiles is that there should be enough suitable soil sites to meet the needs of any orcharding projects.

CHILLING OR COLD REQUIREMENTS

THE fruit species under consideration for the project area fall into the category of plants requiring a chilling period to break the physiological resting stage. Temperature is an important factor as it acts positively in the breaking of rest.

Species have different chilling or cold requirements, and although this is known in a general way by the exact amount of cold needed to break rest is not known. Cherries and apples have the highest cold requirement with pears and plums less. Peaches have a cold requirement less than that of apples, but some cultivars have practically no cold requirements at all.

The formula for calculating the accumulation of chilling hours needed to break rest is as follows. This is the most recent of several that have been used.

| Temperature range °C | Chilling units accumulated/hour | |
|---|---|---|
| 1.4 | 0 | |
| 1.5-2.4 | 0.5 | |
| 2.5-9.1 | 1 | critical temps. |
| 9.2-12.4 | 0.5 | |
| 12.5-15.9 | 0 | |
| 16-18 | -0.5 | |
| 18 | -1 | |

This formula states that at temperatures between 1.5 - 12.4°C chilling units will accumulate. The Makthar, Siliana, Ouselatia data for Nov., Dec., Jan., and Feb. temperatures indicate that the average temperatures fall within the 1.5 - 12.4°C range for the most part. The average maximum temps seldom exceed the range when chilling is negated and the average minimum temperature is in the positive accumulation range. (all 3 months)

Thus, if the figure of 1/4 of the hours of a day can be counted on as accumulated chilling hours, a total of 720 will be accumulated from November through February. If the figure of 1/2 of the time (12 hr/day) is used, a total of 1440 hours of chilling is accumulated. The chilling required to break rust in apples and cherries would be in the range of 1000 hours.

It appears therefore, that there is sufficient cold weather in the project area to satisfy the cold requirements. This was also visually observed by noting apples, pears, and cherries on trees in the project areas.

Occasional warm periods in the winter do not seem to be of long enough duration or high enough temperatures to be of serious consequence. Certainly they are no more extreme than encountered in Arkansas.

A literature review of practices practical in overcoming problems associated with insufficient chilling was conducted. If, because of abnormal deviation from the usual winter weather pattern, a season of insufficient chilling would occur, methods can be employed to overcome the hazard to production. Knowledge of this condition will depend on keeping an accurate count of chilling hour accumulation at locations in the project area.

## CHILLING REQUIREMENT

| Station | Altitude | Average Maximum Temperatures °C | | | |
|---|---|---|---|---|---|
| | | Month | | | |
| | M | Nov. | Dec. | Jan. | Feb. |
| Makthar | 930 | $16.4^{4}$ | $11.8^{2}$ | $10.5^{2}$ | $10.3^{2}$ |
| Siliana | 700 | $19.6^{4}$ | $14.4^{3}$ | $13.2^{3}$ | $13.7^{3}$ |
| Oueslatia | 503 | $19.5^{4}$ | $15.0^{3}$ | $13.6^{3}$ | $14.2^{3}$ |
| | | Average Minimal Temperatures °C | | | |
| Makthar | 930 | $7.1^{1}$ | $4.4^{1}$ | $3.7^{1}$ | $3.3^{1}$ |
| Siliana | 700 | $6.6^{1}$ | $4.6^{1}$ | $4.4^{1}$ | $5.8^{1}$ |
| Oueslatia | 503 | $7.6^{1}$ | $4.6^{1}$ | $4.2^{1}$ | $5.2^{1}$ |
| | | Average Temperatures °C | | | |
| Makthar | 930 | $11.7^{2}$ | $8.1^{1}$ | $7.2^{1}$ | $7.1^{1}$ |
| Siliana | 200 | $13.1^{3}$ | $9.5^{2}$ | $8.8^{1}$ | $9.0^{2}$ |
| Oueslatia | 503 | $13.6^{3}$ | $9.4^{2}$ | $9.1^{1}$ | $9.6^{2}$ |

Possible Hour of Chilling

| | 24 hr/day | 8 hr/day | 12 hr/day |
|---|---|---|---|
| Nov. | 720 Acc | 180 acc | 360 acc |
| Dec. | 744 1464 | 186 366 | 372 732 |
| Jan. | 744 2208 | 186 522 | 372 1104 |
| Feb. | 672 2280 | 168 720 | 336 1440 |

1- accomodating chilling at 1 unit/hr
2- " " " 0.5 "/hr
3- not accumulating chilling
4- negative chilling 0.5 unit/hr

V. Evaluate a proposed site for adaptive testing at Ain Seddine and make specific recommendations for utilization..

I. Site Evaluation. A tree fruit nursery at Ain Seddine was built during the cooperative period of the 1960's and subsequently abandoned. This site was selected as a possible location for nursery and adaptive fruit plantings.

F. Randolph Vigil in a February 1, 1977, report described the physical condition of the site. I viewed this site in June, 1977.

The nursery site, from here on identified as the test site, is located on the south face of a slope. There is strong air drainage down a canyon extending to the west. This area is also exposed to strong winds. A windbreak of Juniper trees was consequently planted around the three land areas which have been benched to make them level.

While drainage is down the river, flow, to the west, there is also a deep canyon on the east edge of the site. Some fruit trees were noted on the dry land across this canyon and also on the canyon's edge. Here the undisturbed soil profile was observed and it appeared to be adequate as to depth, but questionable as to the possibility of rock out croppings. This disadvantage would be overcome on the test site where the beds have been benched.

The three fields on the right side of the entry road were not measured as to area, but estimated to be about 1.5 ha each for the 2 smaller rectangular fields and 2 ha for the almost square field. The soil in these fields was quite rocky, a factor which would be a limitation in nursery stock production, but not adaptive planting and cultural tests. The east end of the first bench below the water basin appears to be low and wet from the spring's overflow. The middle

bench appeared to have the best soil, but may be over manured as it now has some vegetable production on it. The third bench, now abandoned as is the first, has a slight slope to the southwest, but this would not detract from its use in test plantings.

In the areas to the left of the entry road there were some surviving sweet cherry trees (cropping), a plum tree, and a walnut tree. (There is doubt in my mind as to whether or not these fields are being considered as part of the test site, but I would hope that they would be included at some future date if not now). Also, in adjacent areas, particularly on the south side of the highway (P4), there were some apple, cherry, and hazel nut trees surviving in dry land culture and in competition with grain farming. Thus, there is reason to assume that climatic adaptation to fruit trees at the test site is not a major concern. Evidence of insect, disease, and wind damage to trees was noted and indicates that cultural practices to overcome these problems will need to be imposed on plantings. No damaging hail injury to older trees was noted.

The water source of this site is a capped spring located some distance up above the nursery beds and back into a small draw. This source is said to have a long record of never going dry and is reported to have a flow of about 3 liters/minute. Water from this spring is capable of being collected in a holding basin about 20' x 45' x 10' deep. This holding basin is high enough above the nursery field level so that gravity flow or low pressure 3-5 PSI irrigation could be utilized from it.

A second spring is located on the hill about 200 yards to the left (west) and its flow is directed to a holding basin (3) sections, which is about 120' x 40' of undetermined depth, but shallower than

the previously described basin. The flow from this second spring was not known and may go dry in summer. It is at a slightly lower level than the first, but would serve to irrigate the cleared fields with abandoned or neglected orchards located to the left side of the road leading into the test site area.

There are two building shells at the test site. The long building, 22 x 7 m is in the most repairable condition and could be converted into equipment, tool, and supply storage. The small building could be made into an office and clean store house.

A serious drawback at the test site is lack of electricity. While electrical supply is not necessary in most fruit production operations, it would be of value at a test site for pumping water, equipment repair, operation requiring motors, cleaning, general lighting, etc.

Summary as to test site evaluation.

The test site appears adequate to serve the purposes which I am about to suggest. To put the test site into a minimum operational condition, I would suggest the following:

1. Clean, seal, and fence off the water basins and drain overflow away from fields.
2. Map and survey the fields to be used.
3. Sub-soil the benches on the right side of the entry road and plow. Fall plant to rye.
4. Reconstruct breaks in the stone walls.
5. Refurnish the largest building so that it has windows, doors, bins, and locks.
6. Do a minimum amount of roadway construction.
7. Fence the site to keep out browsing and grazing animals.

8. Have soil tested and characterized. This could be done in Arkansas if samples can be sent.

9. Purchase of necessary supplies and equipment - see attachment.

2. Recommendations for utilization. While the test site was used as a fruit tree nursery in the 1960's, I would strongly urge that this use philosophy be abandoned. There are several reasons for this. Nursery production is a highly skilled and intensive horticultural project. In the Makthar area there is not the expertise in common labor to carry out the required operations. Nursery production requires the best of soils and land type. I do not judge the test site adequate in this regard. Lastly, the sources of fruit cultivars and root stocks in use today are so varied and under restrictions for propagation by plant patents, quarantine for virus indexing, etc. that one nursery would in all probability not be able to supply the cultivars wanted in the project area. This is noted when the cultivar list and possible source sheet of this report is examined.

In a more positive vein, I suggest that the following as use for the test site:

I. Test species adaptability and more particularly cultivars of those species to the project area.

II. Demonstrate cultural methods.

III. Serve as a location for problem research, specific to the RD project area.

IV. Serve an information base for development of a systems approach and full utilization of fruit production as it relates to various size production units.

I. Adaptability Phase

Preliminary findings indicate that species adaptability of those selected for consideration in the project area is somewhat of an academic question; however, cultivars of these species vary in their adaptability to a specific location. A fundamental purpose of the test site would be to evaluate cultivars with a high degree of expectation for adaptation. Since in the species suggested for observation there are an untold number of cultivars not to mention root stock options, some hard and calculated risk choices as to just what to test have to be made. To reduce the list some, I have used the following criteria on which to base my choices.

1. The fruits should avoid competition with each other and fruit produced elsewhere.

2. There should be a seasonal sequence of maturity.

3. The requirements of the people must be considered: i.e., Tunisians like sweet fruit, red fruit, medium size fruit.

4. Shipping and handling requirements must be considered if the fruit is to appear attractive and have high quality in the market. Thus, a suggested list of cultivars by species for testing has been drawn up. See attachment.

A 4-5 tree planting of each cultivar is to be established at the test site with uniform cultural practices and data collection used. If the project is approved, I would assist in designing the planting plan, drawing up a cultural practice program and uniform data collection form.

II. Demonstrate Cultural Methods.

Most of the cultural methods used in tree fruit production observed in Tunisia, with the exception of Chimtou, were based on out-

moded practices or adaptation to dry land culture. I propose that the test site be used to demonstrate methods of intensive orcharding and be more attractive to smaller land units, 1-10 ha. These practices would bring greater economic return to individuals or families, yet could be expanded if cooperative units are formed. The intensive medium high density (250 tree/ha) systems I have in mind consist of tree size control through cultivar type, rootstock selection, training, growth regulation, and water control, specifically trickle irrigation. Demonstrations would be limited to a few cultivars, but require larger tree numbers. I would design systems for apples and peaches, which would involve known successful practices, yet those that could be utilized in Tunisia and by its people.

Since demonstrations are an effective teaching tool, they would serve as a means of introducing technology and practices not now known in the project area. This lack of knowledge will be one of the serious drawbacks to establishing tree fruit plantings in the project area.

In the same vein, the test site could be used as a class laboratory for the school at Makthar. An area could be designated for this purpose and this should include other horticultural crops; i.e., vegetables which could be produced from family plots. Thus, a learning base in the community would be established.

III. <u>Serve as a Location for Research Problems Specific to the RD Project Area</u>.

While the test site is not to be thought of in terms of a research farm, there is great opportunity here for working out small research problems that might be specific to the local area. There will be established plantings, available equipment, hopefully,

trained personnel and local interest. For example, programs on water use, bloom delay, weed and pest control could be screened here prior to general recommendation to the area. This must relate to grower concern and grower application.

IV. Information Base for Development of a System Approach and Full Utilization of Fruit Production as it Relates to Various Size Production Units.

Horticultural information obtained from adaptive testing, demonstrations, and applied research could be integrated with that of Agronomists, Soil Scientists, Engineers, Economists, etc. to draw up proposals which would define production units, costs, and expected returns. These could have as limiting factors, size of water source, size of suitable soil area, equipment limitation, capitalization, labor units; i.e., family, extended family, cooperatives, investment enterprises, etc.

Marketing and transportation would be important, but out of the realm of this report.

As tree fruit production grows in the project area, there would develop the need for certain ancillary services; i.e.:

1. Cooperative marketing.
2. Quality control.
3. Alternate use for fruit (one suggestion would be drying fruit for winter resale, a processing function utilizing little water and utilizing excess sunshine; another, juice.
4. Suppliers of equipment, fertilizers, repair machines, etc.

Philosophy

If tree fruit production is to be established in the project area and if the altruistic goals of the RD project are to be reached, those

factors which are most limiting to success must be carefully assessed. In my view the four most limiting factors are:

1. Water for Irrigation. This might well limit the size of plantings as water for orchards must be utilized efficiently and shared with other needs for water. Thus, site selection must be tied to a water source and new conservative irrigation systems; (i.e., trickle irrigation) and programs need to be designed for growers.
2. Understanding of Fruit Growing by the People. The populace is either unaware of the inputs required for intense orchard culture or they may be hampered by tradition which must be abandoned; i.e., intercropping, dry land culture, grazing in orchards, indiscriminate use of animal manure, etc. Thus, strong educational leadership, supervision, educational programs, and incentive programs may need to be used for a generation.
3. Financing. By nature, orchards require financial investments through at least three years from planting before a break-even or economic return is reached. This fact must be accepted. Somehow, credit provisions or direct aid grants must be worked out in order to stimulate activity and learning during the development period of orchards.
4. Patience on the Part of the Project Leaders and Populace in the RD Area. In developing tree fruit production in the project area, two factors must be kept in mind. (1) The area has no established tradition in the type of fruit culture anticipated. (2) There will be problems associated with the utilization or transfer of modern tree fruit

production technology to an area which is essentially underdeveloped from the standpoint of educated people, facilities, or method for transfer of information, roads, electricity, services, and supplies. The situation is not unique nor impossible. The statement is made merely to point out that planning must be done carefully, the attempts should not be overly ambitious (i.e., a factor which I feel is a reason for the failure of collectivism of the 1960's). The results will be slow in developing and patience must be practiced by all individuals involved. Tree fruit production is a long term process with rewards for those persons with ambition, perseverance, and patience.

Suggestions for an approach to establishing tree fruit production:

1. Establish plantings at the test site, as previously indicated, spring of 1978.

2. Survey the project area for persons and select those who would be interested in tree fruit production and who appear to be good risk individuals. Winter 77-78.

3. Conduct site survey on land of those persons selected, checking on adequacy of soil type, land orientation, water supply. Spring, 1978.

4. Select possibly 6-10 pilot planting areas 1-5 ha and develop planting plans and irrigation systems, and budgets. Summer, 1978.

5. Establish first grower plantings. These should be partial or expandable orchards as these would not have the advantage of findings from the test site program. In future years, they shall be enlarged as grower proficiency increases and cultivar and cultural practice information evolves. Spring, 1979.

6. Develop long range plans for marketing and product utilization. 1979.

7. Make plans for supervision of the test site, Extension services to growers and utilization of opportunity to use the test site and local school for educational purposes. 1978.

8. Expand program gradually as the concept of tree fruit culture is accepted by the people.

Incentive programs will need to be worked out with growers in which financial aid is tied directly to following recommended practices. Failure to do so would result in forfeit of monetary grants or credit extended for purchase of trees, equipment, etc.

Equipment Needs for Test Site

Category

| | | Priority |
|---|---|---|
| I. | Weather Station | |
| | A. Max-min thermometer | 1 |
| | B. Rainguage | 1 |
| | C. Evaporation pan | 2 |
| | D. Recording Hygro-thermograph | 3 |
| | E. Anemometer | 2 |
| II. | Production and Planting | |
| | A. Small tractor | 1 |
| | B. Small sprayer handgun or fixed boom | 1 |
| | C. Plow | 1 |
| | D. Harrow | 2 |
| | E. Disc | 1 |
| | F. Brush hog or mower | 1 |
| | G. Flat bed low trailer | 2 |
| | H. Herbicide sprayer | 1 |
| | I. 18" auger (one time use) | 2 |
| | J. Subsoiler (one time use) | 2 |
| | K. Misc. hand tools: shovels, hoe, rakes, pruners | 1 |
| | L. Possibly stakes for tree training. | 2 |
| | M. Soil sampler | 1 |
| | N. Tensiometers | 1 |
| III. | Irrigation and water | |
| | System for drip irrigation | |
| | Polyethylene main line | 1 |
| | " laterals | 1 |
| | emitters | 1 |
| | regulators | 1 |
| | Sand or other filter | 1 |
| | Pressure system for drip irrigation, if gravity system does not deliver enough pressure to use emitters in the 15-30 PSI range | |
| | Gasoline or electric pump and hose | 2 |
| VI. | Building | |
| | A. Tractor and sprayer storage | |
| | B. Tool storage | |
| | C. Fertilizer bins | |
| | D. Separate: herbicide and pesticide storage bins | |
| | E. Rest room facilities, wash areas | |
| V. | General | |
| | A. Security gate | 1 |
| | B. Enough fencing to keep animals from foraging on the property | 1 |
| | C. Separate stock watering trough using overflow from spring, but below and away from the irritation source | 2 |

Adaptive Planting

A. Production Considerations

1. Water Management
2. Pollination
3. Fertility (utilization of manures)
4. Pest Control
5. Disease Control
6. Weed Control
7. Erosion Control
8. Pruning Methods
9. Training Methods
10. Rootstocks
11. Thinning
12. Intercropping (noncompetitive)
13. Wind Control

B. Performance Evaluation

1. Date of bloom
2. Degree of set
3. Yield and precosity
4. Harvest season
5. Quality
6. Tree condition and growth character
7. Dormancy problems

## CULTIVARS RECOMMENDED FOR ADAPTIVE PLANTING TEST

1. Apples

| Cultivar Name | Source | Price Ea. | |
|---|---|---|---|
| 1. Jersey Mac | 1, 2 | $3.00 | 11.00 fr. |
| 2. Vista Bella | 2 | $3.00 | |
| 3. Paula Red | 2 | $3.00 | |
| 4. Starkspur Early Blaze | 5 | $4.95 | |
| 5. Ozark Gold | 1 | | 11.00 fr. |
| 6. Chieftan | 3 | $4.00 | |
| 7. Mollies Del | 2 | $3.00 | |
| 8. Jonadel | 4, 7 | $4.00 | |
| 9. Stark Gala | 5 | $4.95 | |
| 10. Matsu | 1,2 | $3.00 | 11.00 fr. |
| 11. Orleans | 6 | NC | |
| 12. Idared | 2 | $3.00 | |
| 13. Empire | 2 | $3.00 | |
| 14. Yellow Newton | 2 | $3.00 | |
| 15. Spartan | 2 | $3.00 | |
| 16. Nu Red Jonathan | 1 | | 11.00 fr. |
| 17. Smoothie | 2 | $3.00 | |
| 18. TopRed Delicious | 1 | | 11.00 fr. |
| 19. Red Spur Delicious | 1 | | 11.00 fr. |
| 20. Stark Splendor | 5 | $4.95 | |
| 21. Spigold | 2 | $3.00 | |
| 22. Early Maturing Selections U of A Breeding Program | 6 | NC | |

Rootstock to be M-106

<u>Nursery Source</u>

1. Star Fruits
   BP 27
   84270 Vedene, France

2. Hilltop Orchards & Nursery Co.
   Hartford, MI 49057

3. Interstate Nurseries
   Hamburg, Iowa 51640

4. Earl May Nursery
   Shenandoah, Iowa

5. Stark Bros. Nursery
   Lousiana, MO 63353

6. U of A Hort. Dept.
   Fayetteville, AR 72701

7. Neosho Nurseries
   Neosho, MO

2. Peach

| Cultivar Name | Source | Price Ea. | |
|---|---|---|---|
| 1. Candor | 1, 2, 3* | $2.50 | 20.00 fr. |
| 2. Harbelle | 1, 2 | $2.50 | |
| 3. Redhaven | 1, 2, 3* | $2.50 | 20.00 fr. |
| 4. Harken | 1, 2 | $2.50 | |
| 5. Sunhigh | 1, 2 | $2.50 | |
| 6. Glohaven | 1, 2 | $2.50 | |
| 7. Blake | 1, 2 | $2.50 | |
| 8. Loring | 1, 2, 3* | $2.50 | 20.00 fr. |
| 9. Cresthaven | 1, 2, 3* | $2.50 | 20.00 fr. |
| 10. Redskin | 1, 2 | $2.50 | |
| 11. Large fruited Peento | 4 | gratis | |
| 12. U of A selections | 4 | gratis | |

*Rootstock - GF 677

Nursery Source

1. Haley Nursery
   Smithville, TN 37166
   (lovell roots)

2. Hilltop Orchard & Nursery Co.
   Hartford, MI 49057
   (Harford roots)

3. Star Fruits
   BP 27
   84270 Vedene, France

4. U of A Hort. Dept.
   Fayetteville, AR 72701

3. Nectarines

| | Cultivar Name | Source | Unit Price |
|---|---|---|---|
| 1. | Stark Early Blaze | 1 | $5.95 est. |
| 2. | Stark Sunglo | 1 & 2* | $5.94 18.00 fr. |
| 3. | Stark Redgold | 1 & 2 | $5.95 18.00 fr. |
| 4. | Fantasia | 2 | 18.00 fr. |
| 5. | U of A selections | 3 | gratis |

*Rootstock from Star Fruits GF-766

Nursery Source

1. Stark Bros. Nursery
   Louisiana, MO 63353

2. Star Fruits
   BP 27
   84270 Vedene, France

3. U of A Hort. Dept.
   Fayetteville, AR 72701

4. Pears

| | Cultivar Name | Source | Unit Price |
|---|---|---|---|
| 1. | Dr. Jules Guyot | 1* | 11.00 fr. |
| 2. | Williams | 1 | 11.00 fr. |
| 3. | Spartlett | 2 | $2.50 est. |
| 4. | General Le Clerc | 1 | 11.00 fr. |
| 5. | Passe-Crassane | 1 | 11.00 fr. |

* Rootstock - Common Franc

Nursery Source

1. Star Fruits
   BP 27
   84270 Vedene, France

2. Hilltop Orchards and Nursery Co.
   Hartford, MI 49057

5. Cherries (sweet)

| | Cultivar Name | Source | Unit Price |
|---|---|---|---|
| 1. | Bigarreau Moreau | 1 | 12.70 fr. |
| 2. | Bigarreau Ulster | 1 | 12.70 fr. |
| 3. | Bigarreau Napoleon | 1 | 12.70 fr. |
| 4. | Bigarreau Marmotte | 1 | 12.70 fr. |
| 5. | Bigarreau Van | 1 | 12.70 fr. |

Rootstock - St. Lucie SL-64

<u>Nursery Source</u>

Star Fruits
BP 27
84270 Vedene, France

6. Plums

| Cultivar Name | Source | Unit Price |
|---|---|---|
| 1. Methley | 1 | 14.00 fr. |
| 2. Golden Japan | 1 | 14.00 fr. |
| 3. Reine-Claude D'Althan | 1 | 14.00 fr. |
| 4. Stanley | 1 | 14.00 fr. |
| 5. Reine-Claude De Bavay | 1 | 14.00 fr. |

Rootstock: Myroblan

Nursery Source

Star Fruits
BP 27
84270 Vedene, France

7. Filbert Nuts (hazel nuts)

| | Cultivar Name | Source | Unit Price |
|---|---|---|---|
| 1. | Barcelona | 1 | $2.95 |
| 2. | Du Chilly | 1 | $2.95 |
| 3. | American | 1 | $2.95 |
| 4. | Fertile De Coutaro | 2 | 2.65 fr. |
| 5. | Bergeri | 2 | 2.65 fr. |
| 6. | Merveille De Bolwiller | 2 | 2.65 fr. |

<u>Nursery Source</u>

1. Bountiful Ridge Nursery
   Princess Anne, MD 21853 USA

2. Georges Delbard
   16 Qual De La Megisserie
   Paris 1 France

Roz C Rm