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TEMPERATE FRUIT HORTICULTURE

A STUDY OF TEMPERATE FRUIT RESEARCH AND PRODUCTION IN PAKISTAN

BY

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EXECUTIVE SUMMARY

The objective of this consultancy was to review temperate fruit research and production in Pakistan and to make recommendations for change.

Germplasm: The germplasm situation is reviewed and recommendations are made for importing varieties currently not under test. A mechanism to put Pakistan on a continuous "receiving end" of promising material is proposed. The seedling germplasm base of walnut, almond, loquat, guava, and jujube needs screening in Pakistan for superior clones.

Manpower: The technical manpower base in horticulture is tragically small. A dramatic transfusion of advanced degrees is needed to upgrade the research base. The concept of a National Horticultural Institute is premature and fraught with problems. Short term and long term study at stations abroad are recommended. Strengthening the existing NARC and provincial fruit research elements is suggested.

Nutrient Concentration Fruit Survey: A field survey of fruit orchards is proposed as a collaborative project to begin in June, 1989. Soil, leaf tissue, and irrigation water will be analyzed for nutrient concentrations and correlated with growth/yield/chlorosis ratings. A mechanism to initiate a cooperative research program of NARC and provincial scientists with Stephen F. Austin State University soils and horticultural faculty is explained.

Technical Information Base: Libraries at ARI's and universities need a transfusion of current books and periodicals. NARC should serve as an interlibrary loan/literature review conduit. Libraries at the universities visited need to improve their organization of materials. NARC should compile the annual reports of all fruit researchers into one document to be disseminated to fruit horticulturists.

Agroclimatic Zone Identification: Recording thermographs should be placed in all temperate fruit regions. The weather station at ARI Sariab, Quetta should be used as a model.

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INTRODUCTION

The consultant was invited to Pakistan to examine temperate fruit research and production and to make suggestions for improvement.

The consultant arrived in Pakistan June 18, 1988 and departed July 16, 1988. His itinerary included consultations with PARC and NARC officers and scientists, provincial horticulturists and agricultural officials, and travel to the orchards of Punjab, NWFP, and Baluchistan. The consultant brought with him to Pakistan a supply of promising apple, peach, plum, and nectarine germplasm.

The consultant has twenty years of experience in temperate fruit research and production. His international consultancies include 3 short term USAID assignments to Pakistan in 1980, 1981, and 1982.

The following discussion describes the current situation with respect to the important temperate fruits in Pakistan and makes recommendations for research and other actions to improve that industry.

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OVERVIEW

Temperate fruit production has a long history in Pakistan. Pomologists believe that the migration of **Malus**, **Prunus**, and **Pyrus** species from China and Eastern Asia included an early introduction into the Persian subcontinent. Seedling orchards, wild escapes, and local selections led to types adapted to evolved in Pakistan in the 1950's, accelerated in the 1960's and 70's and are still continuing in the 1980's.

For the purposes of this consultancy report, temperate fruits include those species that generally require a winter "rest" period, often referred to as a chilling requirement. Thespecies are typically deciduous in the winter and can endure temperatures during that time below $0^{o}C$. The chilling requirement, normally expressed as the number of hours below $7^{o}C$, is accumulated and counted during a November 1-February 15 time frame. Great strides have been made in widening the ranges of chilling requirements of varieties. For instance, apple varieties like 'Anna' and 'Ein Sheimer' can crop successfully in very mild-winter areas receiving just a few hundred hours below $7^{o}C$. Peach breeding efforts have led to numerous varieties that can be considered almost subtropical. It is unfortunate that Pakistan did not get on the receiving end of these materials in the 1960's. It is also tragic that very little effort has been made to identify the major agroclimatic zones present in the fruit growing regions. While max-min daily average temperature data is available here and there, no careful multi-year recording thermographic studies are available (exception : ARI, Sariab,

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Quetta). This data could have specifically defined which areas are most adapted to potential varieties. This lack of precision has not hampered a rather amazing distribution of fruit trees in all regions.

Numerous fruit maximization schemes have been fostered by various in-country and external assistance agencies. Reforestation and watershed protection programs can take much of the credit for the impressive number of trees in the ground at this date. Fruit distribution and research projects are currently being undertaken by an Italian project (Agrotec), the Pakistan Forestry Institute, provincial agricultural institutes, ADBP (Agricultural Development Bank of Pakistan), FVDB (Fruit and Vegetable Development Board, NWFP), as well as several private sector projects. There is reason to think that this trend will continue.

Numerous fruit consultancy and status reports have been compiled since the early 1970's: Cochran, 1974; Roghani, 1979; Tomponi, 1980; Creech, 1980, 1981, and 1982; Richardson, 1980; Ballard, 1982; Haq, 1987; Hussain, 1987; Wazir; 1987. In addition to these overview reports, there are project development reports by the Swiss, Australians, New Zealanders, Italians and others. Additional backgrounding is available through the annual reports of the various agricultural research stations and institutes. Everyone seems to agree on several points:

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1. The potential is great. Fruit yields can probably be tripled.
2. Basic care/culture aspects of deciduous fruit orchards are not practiced in the majority of commercial plantings. Fruit quality is often poor.
3. Harvest, post-harvest, and marketing constraints are enormous.
4. The technical manpower base is small and information transfer limited.

There are certainly signs of progress. Pruning and training at Tarnab and Mingora, NWFP is improved over the early 1980's. There is definitely an excellent germplasm base available for screening. Pest management schedules appear to be working at research institutes. Reports and technical information bulletins are more comprehensive and pertinent. There is an attempt, albeit problem plagued, to develop model orchards based on modern technology in farmer fields.

The following sections attempt to describe the current status of various temperate fruits and nuts with strong potential. The germplasm base is described. Various research projects are evaluated. The major problems are analyzed and recommendations are offered.

APPLES

Baluchistan and the NWFP make up the bulk of apple acreage in Pakistan. Production statistics indicate a tripling of acreage and production since 1970.

Table 1. Apple production statistics are given here for the five year averages of 1970-75, 1975-80, and the years 1984-85 and 1985-86. Expressed as tonnes '000'/hectars '000'. a/a: statistics not available or negligible.

YEAR	PUNJAB	SIND	NWFP	BALUCHISTAN	TOTAL
970-75	2.0/0.4	0.3/0.1	14.0/1.2	26.1/3.7	42.4/5.4
1975-80	3.1/0.5	0.2/0.1	39.7/3.4	41.4/5.5	84.4/9.5
1984-85	4.0/0.4	a/a	59.0/4.0	79.0/8.8	142.2/14.0
1985-86	7.8/1.1	0.2/0.1	72.9/6.4	85.9/9.7	166.0/17.3

These statistics and those that follow in this document were compiled from Agricultural Statistics of Pakistan, Government of Pakistan and Provincial briefing papers. A careful inspection of the data indicates that, while acreage increases have been awesome, per acre yield has not improved.

Table 2. Average apple production in tonnes per hectare for the years 1970-1986

YEAR	TONNES PER HECTARE
1970-75	7.8
1975-80	8.6
1984-85	10.1
1985-86	9.6

These figures are particularly distressing when compared to the average yield in developed countries.

Table 3. Apple yield in tonnes per hectare in Pakistan, the United States and New Zealand.

COUNTRY	TONNES PER HECTARE
PAKISTAN	10
WASHINGTON STATE, US	36
NEW ZEALAND	39

The potential for improvement is obvious to all pomologists. Maximum yields of commercially grown Granny Smith apples in New Zealand exceed 100 tonnes per hectare.

Varieties

The main varieties present in commercial fields are Red Delicious and Golden Delicious. An impressive list of apple varieties are under evaluation. Over 135 varieties are being screened at NARC, HFRS Murree, ARI Tarnab, UAF, ARI Qurtta, ARS Mingora, HRS Nowshera, and FVDB farms. Rather than list all of the varieties being tested in 1988, the reader is encouraged to obtain the Directory of Fruit Germplasm Available in Pakistan, compiled by Dr. Daud Ahmad Khan, Pakistan Agriculture Research Council and the annual reports of the various research stations.

This consultant brought with him to Pakistan four promising clones: NY 651, NY 429, Spur Arkansas Black, and Royal Gala.

The following clones are recommended for testing:

Tydeman's Red	Lysgolden
Paulared	Criterian
Prima	Hawaii
Jonamac	Ruby
Macoum	Burgundy
Liberty	NJ46
Redcart Cortland	Starkspur Delicious
Empire	Dixiered Delicious
Smoothee	Oregon Spur II Delicious
Jonagold	Washington Spur
Red Jonagold	Spur Banana
Ryanred Spur	Elite Spur Red
Law Spur Red	Ace
Apex	Bisbee
Dark August Red	Elstar
Compact Mac	Firmgold Delicious
Silver Spur Red Delicious	Classic Red Delicious
Gold Spur Delicious	Mov-Spur McIntosh
Nicobel Jonagold	Nured Rome
Nured Spur Delicious	Red Spur Delicious
Top Spur Delicious	

The list could be expanded. Keep in mind that many of these varieties, particularly the spur type, compact, super-reds, are patented. A non-propagation agreement is needed prior to importation into Pakistan. Spur type clones are stiffer trees, with shorter shoots and internodes, and more fruit spurs. They can increase yield 10-20% over conventional non-spur types.

Pollinators: Apples need pollinators, a concept not fully appreciated in Pakistan. A pollinating variety should be placed within a six tree distance (every sixth tree in the row, every sixth row, etc). Some growers in developed countries use specific varieties because of there profuse bloom (i.e. Manchuroan Crab, King David, Snowdrift Crab). Some growers graft one limb of each sixth tree to obtain good pollination without sacrificing yields. Pollination compatibility charts are common

place in developed countries.

A part of the "poor set" problem can be traced to lack of pollinators. For instance, in Mansehra District, it was quite common for this consultant to visit farms where growers had only one variety or just didn't know what they had. Tree give-away schemes should provide several varieties to each grower. In areas where indigenous bee populations are low, hives should be provided. These are generally placed at a one to two hives per acre rate on the downwind side.

Rootstocks

Dwarfing rootstocks increase yields per acre. They accomplish this by increasing the fruit bearing surface per acre. Planted at close spacings, they encourage bearing in two to three years. Apples on seedling types often take six to seven years to enter production. This consultant found it quite common in Mansehra that trees failed to bloom until 10-12 years old.

When this consultant visited Pakistan in the early 1980's, dwarfing rootstocks were scarcely seen. In 1988, importation from Europe of promising rootstocks is widespread and very much in evidence at research stations. While some superior varieties on dwarfing rootstocks have been placed in farmer fields (mostly "model orchard" result demonstrations), the rate of progress has been slow.

Another factor hindering incorporation of dwarfing rootstocks into common practice is improper stool bed development. Because dwarfing rootstocks are clonal, they must

be propagated asexually. This can be done by cuttings under mist, but is usually by stool bed plantings. Rooted 6" cuttings are normally planted in raised beds at very close spacings. They are heavily mulched. The plant is annually cut (before the growing season begins) just above the ground. Suckers push their way through soil and mulch and form adventitious roots. A majority of these are cut away and used as rootstocks for lining out in nursery rows. The process is repeated annually. A stool bed can have a useful life of up to seven years.

At one location, FVDB station at Baffa, Mansehra, I observed MM & EM rootstocks planted in wet paddies with beds at ground level. Phytophthora was rampant and mortality high. Because collar rot is prevalent in so many areas of the NWFP MM 106 (susceptible) should be avoided. MM 111, EM 7 & EM 27 are better choices. Crown rot is a problem in most apple growing regions and can be controlled. The key is to recognize the disease and know what causes it. Flooding, root and trunk damage, and organic matter encourage development. Control involves reducing puddling around tree crowns, selecting varieties and species suited to the soil type, and chemical control, if appropriate. Ridomil and Alliette have been most effective when used as preventative treatments. Peach apricot, and almond are very susceptible to Phytophthora. Plums are less susceptible. Pears are generally quite resistant.

[redacted]

While great strides have been made to bring modern pruning and training concepts to apple growers, the majority of farms are still somewhat neglected. Most consultants have recommended a modified central leader approach with careful attention to wide-angled primary scaffold development in the first 2-3 years. The permanent scaffolds should be spread via tieing or the use of [redacted] possible and yet still achieve the desired framework. After five years the structure is fixed and pruning involves nothing more than removing suckers, competing limbs, damaged limbs, unnecessary laterals, and forked shoots, etc. . Excellent step-by-step bulletins and brochures have been distributed many times in Pakistan.

One aspect that deserves attention is planting. This is particularly important if dwarfing rootstocks are used. If the graft or bud union is placed below ground level, the scion will root and the dwarfing characteristic will be lost. This consultant saw many examples of improper placement.

Pruning older trees presents a different problem because attempting to bring a tree to correct form can temporarily reduce yields. A careful three-year approach to opening up a tree is suggested. Thinning-out cuts, rather than heading-back cuts, encourage sunlight penetration and fruit spur development in the once-dark interior of the tree.

This consultant observed one 2000 tree orchard in upper Mansehra District that had been flat-topped by agricultural officers. Why the entire orchard has been pruned this way and why extension men were acting as a "pruning crew" was not fully explained. The results will be poor, further delaying the progress of fruit orchard development in the immediate area and convincing neighboring farmers that "pruning does no good".

Orchard Floor and Pest Management

Apple trees appreciate good soil drainage. Plants must be established in a manner that water does not lie around the trunk for even a short period of time. Drainage is poor in many valley floor plantings. Consultants are always suprised to see apples in close proximity to rice or other flood-irrigated crops. A move to furrow irrigation is underway. Planting threes on slightly raised beds or berms is an accepted practice with Malus and Prunus species. The common practice in Pakistan of planting on the edges of a bench terrace or paddock is going to continue and is acceptable if the need for drainage is appreciated.

In developed countries, apple orchards are generally dedicated solely to that crop. In Pakistan, particularly the NWFP, apple orchards are often secondary to the agronomic crops grown in the middles. Any scheme to alter this practice is probably doomed to failure. Actually, the practice of intercropping is not objectionable if some respect and space is given to the tree.

The practice of cultivating deep within inches of the trunk is common and disastrous. How this practice can be eliminated is still undetermined. Encouraging shallow cultivation and a down-the-row uncultivated strip should be a part of any outreach or extension effort.

Pest management schedules on research stations apparently work. A six spray program at Mingora is in effect. Apples there looked clean. Fruit at ARI Sariab, Quetta, was of high quality. The late 1970's and early 1980's saw several pesticide subsidy programs come and go. Nearly all consultants encouraged their demise because they were ineffective. Extension never had any business in attempting to be a "spray company". Unfortunately, no mechanism was left in place to provide growers with a range of reasonably priced, effective chemicals. As a result, most growers either do not use pesticides or use them with reduced frequency. When results are poor, they are even more reluctant to use pesticides the next year. Pheromone traps, baits, and confusion techniques are being studied at most locations but little progress has been made towards any wide-scale implementation. Codling moth continues to be a great problem in certain areas, less so in others. Scab and mildew are being controlled with appropriate fungicides. Researchers are encouraged to test some of the newer "third generation" insecticides now entering the market (synthetic pyrethroids, etc.) Sterol-inhibitor fungicides show great promise and should be imported for testing (i.e. Rovral).

Tree Nutrition

A foundation nutrient survey in apple orchards is still needed. Soil, leaf tissue, and irrigation water sampling of apple orchards in the three provinces would pinpoint possible macro/micronutrient problems. The high pH soils common to many fields justify this effort.

Numerous fertilizer trials at various locations have indicated favourable responses to N & P. K is occasionally limiting. Zinc and iron micronutrient problems are suspected. During this consultancy a small survey of Punjab, NWFP, and Baluchistan province orchards was undertaken. With over thirty farmer and research station fields sampled, the data should yield an excellent background data base for a more complete and replicated study in 1989. Samples in this study will be forwarded for analysis to the Stephen F. Austin State University Soils Lab, Nacogdoches, Texas, USA. After analysis, a report will be mailed to appropriate soils and horticultural officers in Pakistan. The report will include a general discussion of the ranges encountered, any imbalances, deficiencies, or toxicities encountered and recommendations for a future cooperative study. (See Recommendation Section). Without a good understanding of three nutrition, it is impossible to accurately define fertilizer recommendations. As it is, most Pakistani horticulturists are only guessing as to fruit tree fertilization practices.

Adjusting Crop Load

Apples have a normal tendency for biennial bearing. Apples can be encouraged to bear regular crops each year in proper thinning of fruit and the use of Alar/Ethrel chemicals. Reducing stress during the normal June drop period is important. Avoiding excessive nitrogen applications which encourage vegetative growth at the expense of fruit bud development is imperative. Ringing (non-lethal girdling) of major scaffolds can encourage young trees to fruit early and older trees to be more fruitful. Thinning fruit to recommended spacings is often a standard practice with overcropped trees.

Researchers are encouraged to set up trials to test the efficacy of chemical and manual approaches to crop load adjustments.

Harvest, Post Harvest, and Marketing

Apples harvest dates in developed countries are determined by sampling apples for four parameters: total soluble solids, titratable acids, starch, and firmness. For example, a perfect Golden Delicious apple with maximum shelf life would have the following values:

. Total Soluble Solids	--	13%
. Titratable Acids	--	0.25%
. Starch (%)	--	20%
. Firmness	--	16Kg/sq cm.

Pakistani horticulturists appreciate these values but, again, growers are out of the reach of their advice. Every apple

scientist should have an Effigi pressure tester with an 11 mm tip and a hand refractometer. Sophisticated large-scale apple storage companies may also test ethylene concentration, fruit ground color, mineral analysis, and water core.

Post harvest practices in Pakistan involve a long and bumpy road to market. While some field grading is practiced, quality standards are not present. Apples are commonly packed in paper-lined wooden crates. Very little of the crop is stored. Actually, several, now defunct apple storage schemes (UNDP/FAO) in the NWFP resulted in some rather large cold storage buildings. They are not operational. Unless rather large improvements in apple technology that result in apple quality enchancement are incorporated by farmers, there is little point to apple storage studies. A poor apple going into cold storage does not improve.

The marketing system is considered by consultants, Pakistani pomologists, and growers as a major constraint to advancement. The "commission agent" appears to have a head-lock on the apple grower. He may buy the crop for 2-3 years. He often buys when the crop has just set. Not understanding pruning and training, he discourages these essential orchard arts. The grower, his crop sold, often has little incentive left for improving his trade. Growers that have attempted to "sell" their own crop complain they are locked out of auction markets or are "black-balled". While the final product may fetch 12-20 rupees per kilo the grower may receive as little as 2 to 3 rupees (numerous reports). While the entire farm to consumer process may seem

chaotic, it is probably not much different from century old practices. An attempt to change this system is a major undertaking. Cooperatives, marketing associations or commodity groups are not in existence.

Research

Research scientists in Pakistan can be commended for improving the germplasm base, for pruning and training improvements, and for beginning common orchard pests under their control. Research programs have focused on varietal trials, rootstock trials, NPK fertilizer trials, propagation studies, and pest control experiments. The results are reported and available. Some data-taking procedures appear particularly laborious. In some cases, the total number of fruit per tree is counted. This is probably an unnecessary exercise.

Because the research farm is also expected by Finance Ministers to generate income, the researcher is constantly trying to generate rupees. The commission agent confuses data-taking at harvest. This practice discourages tree-pulling when a variety or experiment has outlived its usefulness. My 1980, 1981 and 1982 reports included the following statements, "These research farms are here to produce data, not money". This still holds true today. Income generation should be considered a minor benefit to be sought only if fits into existing studies.

Research Recommendations

1. Varietal trials should continue. An effort must be made to extend the germplasm base to many stations and agroclimatic zones. This consultant sees no value in keeping old and tired varieties that do not perform. Make way for new germplasm on promising rootstocks.

2. Training systems research needs development starting with young trees. The "model orchard" concept is a valid one but all the factors must be incorporated to make a proper impression on growers.

3. Clonal rootstock evaluation and propagation studies need encouragement. If Pakistan is ever to reach a 30 tonnes per hectare average., this is an essential step.

4. Collar rot control studies via cultural/chemical approaches should be conducted in problem areas.

5. Hail protection net studies are underway at Sunnybank, Murree, and should be expanded in that region if apples and other fruits are to ever enjoy any success in the region. Hail damage occurs every year in the region. Hail nets are used successfully in Italy and Mexico. There are plenty of reasons to question why apples were ever promoted in this area.

6. Agroclimatic zones can be identified by setting up recording thermograph stations in the various and potential fruit growing regions.

PEACH

Baluchistan is the major peach producing province in Pakistan. Acreage has expanded only slightly since 1970 with no increase in yield per acre.

Table 5. Peach production statistics expressed in tonnes ('000') / hectares ('000'). a/a: negligible or not available.

YEAR	PUNJAB	SIND	NWFP	BALUCHISTAN	TOTAL
1970-75	1.3/0.2	a/a	2.1/0.3	5.4/0.5	8.8/1.1
1975-80	1.5/0.3	a/a	1.6/0.2	6.8/0.7	9.9/1.2
1984-85	a/a	a/a	2.0/0.4	9.0/0.8	11.0/1.2
1985-86	0.3/0.1	a/a	2.2/0.3	9.6/1.1	12.1/1.5

The average yield of 9 tonnes per hectare is about half of yield averages in the southern United States and one-third of California standards.

Varieties

There is a very impressive number of varieties being screened in Pakistan. Many of these were introduced in 1979 and 1982 and performance data is just now unfolding.

6-A is an Elberta type that ripens late and is susceptible to numerous diseases. It is the predominant variety. It is prone to poor fruit set in low-chilling years (i.e., 1988).

It is interesting to note that of 61 superior peach clones introduced in 1982 by this consultant, less than half are in existence. This loss is particularly discouraging since this

consultant insisted that the varieties be placed at three locations for insurance purposes. Propagation was to take place in the first year with tree distribution the following winter. This rather dramatic loss was not fully explained. Trees were said to have "dried", were "lost", or were "accidentally dug out". Future efforts might take this sad experience into account.

In spite of this, several varieties introduced in 1982 have proven themselves and are rapidly being spread into the NWFP region of Peshawar. Earligrande apears very promising, as does Flordasun and Flordaking. Earligrande, a very early-ripening peach (late April and early May) has size, firmness, and quality and will create a new industry in regions where it is adapted. it is also evident that the early ripening clones avoid much of the problem associated with the Mediterranean fruit fly, a common pest, by maturing before the population surge in mid-summer. A Texas advanced selection, Y7-72, looked very good at Mingora in late June, 1988.

The following varieties are recommended for testing in the low to moderate chilling regions of Pakistan:

TX Y6-51	TX A9-69
Sunbreak	TX M3-17
Hamlet	TX M3-117
Harbinger	TX Y8-61
TX Y6-25	TX M3-112
TX Y17-3B	TX M6-5
TX Y18-51	TX Y3-119
TX Y5-77	Rio Grande
Correl	TX Y11-5
TX Y5-34	TX Y4-60
TX Y18-48	TX Y4-65
TX Y19-51	TX M2-96
TX Y19-23	TX Y5-64
TX Y6-55	TX Y7-55
Idlewild	5-8-72
Flordagold	TX Y5-71
Harken	TX Y8-78
TX Y3-81	TX Y8-131
TX Y17-105	Floridabelle
TX Y7-97	TX Y1Y-82
3-3-7-68	Ellerbe
Sam Houston	Dixieland

Additional germplasm is available from Florida and California breeding programs. It is my recommendation that dormant budwood be collected in late January-early February, 1989. It should be hand-carried into Pakistan for chip budding in March. This is the quickest and easiest way to expand a germplasm base. I also recommend with this and all other fruit crops that <u>every</u> available bud on each budstick be used to insure a good take. This consultant noted that the rubber budding strips used at NARC to T-bud the germplasm carried in by this consultant decomposed and unraveled <u>very</u> fast. This exposed the bud to drying. Budding tape or better rubber budding strips are essential.

This consultant brought with him to Pakistan budwood of Sunbrite, BY 7020, BY 7021, La 9-6-4, Earliblaze, Texstar peach and Redgold, Nectared 4, Nectared 5, and Sunglo 10 nectarine. These were budded at NARC and Tarnab.

Rootstocks

Local peach serves as the primary rootstock. Preliminary trials with Nemaguard and Lovell (U.S.A) are underway.

Planting and Training

Peaches are very sensitive to poor soil drainage and much of the growing areas in the NWFP are subject to this problem. A rising water table and heavy monsoon rains can be blamed for high tree mortality. This problem would be expected with nectarine, almond, and apricot. Most commercial plantings of these crops should be planted on raised "berms" or ridges. For example, if trees are spaced 26' x 15' the rise from the middle of the row to the line of the row is normally 6-12". This insures that excessive rains move away from the tree into drainage channels. This simple preplant operation can greatly improve tree productivity in tight soils. In many fields the irrigation channels could also be used to encourage fast draining of fields after heavy downpours. The predominance of sandy loam clays and silty clays indicate that this approach is justified. Immediate trials are recommended.

The peach should be trained to the open center form. It is this consultant's opinion that researchers have accepted this concept. Growers have also accepted the single main trunk, three or four primary scaffold approach. Tree height continues to amaze foreign consultants. Light summer pruning (before July) is recommended with height reduction as an objective. Trials are recommended.

There are many training systems under study in developed countries. Some promise to increase yield 3-fold. These include French Axe, "Y", Ebron-espalier, Tatura Trellis, hedgerows.

Orchard Floor and Pest Management

As for all other fruits, minimal root disturbance is best. Prunus is more sensitive to weed competition than Malus or Pyrus. The accepted procedure is to create a weed-free strip 6'-8' wide down the tree row with a grass alley down the middles. In Pakistan, the intercropping practice, in the NWFP for instance, precludes this possibility. At any rate, trials should be limited to testing systems that give the roots a "space of their own". The common practice of cultivating deep within inches of the trunk is a sure way to encourage diseases, stress, and poor production.

Pest management is the major constraint with peach in Pakistan. The fruit fly attacks the fruit especially near maturity. As a result, many commission men pick the fruit gourd green to lessen the incidence of infested fruits. Because fields are often small, repeated sprays are needed on a very frequent

basis. In large orchards, air-blast sprays would allow total coverage and reduce the pest. Termites, the flatheaded borer, and other borers attack peach. Again, these pests are controlled at search stations with 6-8 applications. The key, of course, is to control the first generations. Pheromone traps, baits, and confusion strips show promise in developed countries but results often depend on what neighboring orchards are doing.

Because pest management is expensive, tedious, and difficult for Pakistan growers, I recommend that researchers focus on early-maturing types while developing control techniques for later-season, more susceptible varieties. The early maturing types bloom in February-March and fruit in May. This results in an 8 week spray program which is much more manageable.

Harvest, Post-Harvest, and Marketing

Common harvest practices are generally the same as for apple. The peach, with its higher susceptibility to bruising and rot, is often picked immature. This destroys quality. Developed countries pick the fruit based on the change in the ground color. Color-coded plastic cards are available that are supplied to each picker. The change in color from green to yellow includes a "straw" hue. That is acceptable.

Peaches need to be moved to the consumer as quickly as possible. Removing field heat prior to shipping is a standard approach in developed countries. Refrigerated trucks to distant markets is the norm. Peaches can be coded by hydrocooling (fast) or room coolers (slow). The feasibility of this in Pakistan is

unknown but the distant market of Karachi will necessitate precooling and refrigerated trucks if quality is to be maintained. Refrigerated railroad cars are available and may be the logical alternative. Any export potential with peach will have to utilize a "fancy pack" approach. Panta-packs involve extruded plastic liners that support each peach. The boxes support one or two tiers of these trays.

APRICOT

Baluchistan and the NWFP comprises the major proportion of apricot production. Production statistics indicate that acreage has more than doubled since 1970.

Table 7. Apricot Production Statistics. Expressed as tonnes ('000') / hectares ('000'). a/a: not available.

YEAR	PUNJAB	SIND	NWFP	BALUCHISTAN	TOTAL
1970-75	a/a	a/a	5.8/0.6	13.4/1.5	19.3/2.1
1975-80	0.3/0.1	a/a	6.2/0.6	23.3/2.1	29.8/2.8
1984-85	a/a	a/a	12.2/1.2	39.0/3.2	52.0/4.4
1985-86	0/4/0.1	a/a	11.4/1.2	42.0/3.6	53.8/4.9

Yields per acre have risen only slightly since 1970 and average about 11 tonnes per hectare. Yields are less than half of California, USA standards.

Varieties

Over 50 apricot varieties are under test in Pakistan. The primary variety is Trevatt and is prone to limb breakage. The inclusion of Goldrich, Rival, Sungold, and Earligold is recommended. Washington State University has an active breeding program with several early-ripening, frost - hardy types. Additional varieties worth testing include: Traverse, Haroger, Hargrand, Amal, Sayeb, Boccuccien Liscia, and Sancastrese.

Rootstocks

Peshawar local peach, Swat local peach, Hari apricot, bitter almond and Peshawar local plum are used as rootstocks.

Planting and Training

An open center form is recommended. Apricot trees are also trained in developed countries to spindle, central leader, and hedgerow systems. This consultant has observed some truly enormous trees in the fertile valley floor soils of the NWFP. Other consideration as for peach.

Orchard Floor and Pest Management

Considerations same as for peach. This species is generally more late spring frost sensitive than peach.

Harvest, Post-harvest, and Marketing

Considerations are essentially as for peach.

PLUMS

The NWFP is the leading plum producing province followed by Baluchistan. Production statistics indicate a doubling of acreage without an increase in yield per hectare.

Table 8. Plum production statistics expressed in tonnes ('000') / hectares ('000'). a/a: negligible or not available.

YEAR	PUNJAB	SIND	NWFP	BALUCHISTAN	TOTAL
1970-75	0.1/a	a/a	21.3/1.4	6.3/0.6	27.7/2.0
1975-80	0.1/a	a/a	21.3/1.8	9.0/0.7	30.4/2.5
1984-85	1.0/a	a/a	30.0/2.8	12.0/1.2	47.0/4.0
1985-86	1.3/0.2	a/a	29.9/2.8	13.0/1.1	44.2/4.1

Varieties

Fazli Manani is the major commercial variety. Over 62 varieties are under test in Pakistan. This consultant brought to Pakistan with him budwood of Byrongold, Nimr # 9, AU Roadside, Segundo, Shirley, Frontier and Kobstar. These were disseminated to NARC and Tarnab.

Future releases are imminent and advanced selections look very promising. Additional varieties worth importing include California Blue, Empress, Mount Royal, Superior Angeleno, Superior Black Diamond, Superior Black Gold, Superior Black Star, Yakima, Zucchella, Morris, AU-Amber, AU-Rubrum, AU-Rosa, AU-Cherry, and a selection, BY 69-350.

Rootstocks

Peshawar local peach and Swat local peach, Hari apricot, and Peshawar local plum are used as rootstocks. Trials with GF 677, GF 1969, GF 655-2, and Pixy are recommended.

Planting and Training

Open center is recommended with particular emphasis placed on maintaining some leaf shading on major scaffolds. Considerable sunscald is evident in many orchards. Tree height reduction is recommended.

Orchard Floor and Pest Management

This crop is approached in the same general manner as in most of the intercropped fruit orchards. Recommendations as for peach.

In the NWFP, termites and the flat-headed apple tree borer (Sphenoptera cadkhani?) are wide-spread and cause tree death. Because the flatheaded borer mines beneath the bark, the pest must be controlled by following a regular spray schedule. The current termite control approach is Heptachlor. Diazinon granules are recommended by this consultant as a promising and safer long term alternative.

Harvest, Post harvest, and Marketing

As for peach.

Recommendations

1. Continued varietal testing. Improved varieties that extend the season, have less brown rot problems, and lower chilling requirements are being released.

2. Pest control studies as for peach.

PEAR

The NWFP is the principal pear growing region with most acreage in the Peshawar vale. Acreage has increased about 50% since 1970.

Table 9. Pear production statistics expressed in tonnes (000')/hectares (000). a/a: negligible or not available.

Year	Punjab	Sind	NWFP	Baluchistan	Total
1970-79	6.7/1.1	a/a	14.7/1.0	0.8/0.1	23.3/2.2
1979-80	8.1/1.2	a/a	22.5/1.8	0.8/0.1	31.3/3.1
1984-85	a /1.2	a/a	30.0/2.4	1.0/a	33.0/2.4
1985-86	2.4/0.3	a/a	30.6/2.5	1.0/0.1	34.0/2.9

Varieties

Keiffer, LeConte and Batang are the main varieties. Local types are also present. Over forty varieties are currently being screened in Pakistan. The last five years has seen several "red" sport introductions in the United States. These are recommended for trial. Varieties worth importing: Canal Red, Super Red, Seckel, Onwards, Sensation, Red Bartlett, Duchess, Devoe, Monterrey and Improved Fertility.

Root Stocks

Batangi is generally used as a rootstock for pear scion varieties. Seedlings of Pyrus calleryana are known to be a good rootstock for pear. Quince 'A' and Quince 'B' are dwarfing rootstocks and are in Pakistan studies. Naak and BA-29 are being evaluated.

Orchard Floor and Pest Management

Pear is generally not disease and insect prone. It is tolerant to wetter soil conditions than most temperate fruits. Intercropping is common as with all fruit crops. No major pest problems reported.

Harvest, post-harvet, and marketing

As for apple, with "poor economics" a common complaint from growers.

ALMONDS

Baluchistan is the primary almond growing province.

Table 9. Almond production statistics expressed in tonnes ('000') / hectares ('000'). a/a : negligible or not available.

YEAR	PUNJAB	SIND	NWFP	BALUCHISTAN	TOTAL
1970-75	0.1/a	a/a	0.4/a	16.6/5.5	17.1/5.7
1975-80	a/a	a/a	0.3/0.2	22.7/6.1	23.0/6.3
1984-85	a/a	a/a	a/0.4	27.0/6.4	27.0/6.8
1985-86	a/a	a/a	0.8/0.3	28.4/6.7	29.2/7.0

Yields appears to have increased slightly.

Varieties

There are about twenty varieties under test. Very little work has been done with almond in the NWFP but agroclimatic zones that are suited to this nut are available. Non-Pareil appears promising in terms of yield. Varieties are available from U.C. Davis, California and are recommended for testing.
There is a tremendous seedling germplasm base in Baluchistan that needs screening.

Rootstocks

Nemaguard, local peach, bitter almond, and Hari apricot have been tested as apricot rootstocks. Bitter almond and Nemaguard look promising.

Orchard Floor and Pest Management

As for peach, siting almonds correctly depends a great deal on climate before dehiscence. Dry weather encourages proper maturation.

Harvest, Post harvest, and Marketing

After proper maturation, the dried almonds have good shelf-life and are easily transported.

GRAPES

Grapes are grown almost exclusively in Baluchistan and acreage is static.

Table 10. Grape production statistics expressed in tonnes ('000') / hectare ('000'). a/a : negligible or not available.

YEAR	PUNJAB	SIND	NWFP	BALUCHISTAN	TOTAL
1970-75	a/a	a/a	0.6/0.1	25.0/2.3	25.6/2.4
1975-80	a/a	a/a	0.2/0.1	28.5/2.4	28.0/2.5
1984-85	a/a	a/a	a/a	26.0/a	26.0/a
1985-86	0.2/a	a/a	0.1/a	28.3/2.8	28.6/2.8

Varieties

About 20 varieties are under test in Pakistan. Kishmish, Shundehani, Haota, and Saibi are the four primary varieties in Baluchistan. Varieties recommended for trial include: Concord, Seibel 13053 - Cascade, Kuhlman 188-2 Foch, Baco-Nair, Catawba, Seibel 5279-Aurora, Vidal 256, Seyve-villard 5-276 Seyval, Seyve-villard 12375, Villard Blance, Interlaken, Himrod, Suffolkred, Concord Seedless, Thompson Seedless, Mars, Venus, and Reliance. There are numerous local varieties in Baluchistan. The UNDP/FAO Project at Sariab ARI, Quetta is attempting to categorize the germplasm. Many are excellent.

Rootstocks

Grapes are generally propagated from hardwood cuttings in Pakistan. Local grape species should be tested as rootstocks.

Planting and Training

Grape research in Baluchistan should continue to examine some of the numerous trellis designs that have increased yields in developed countires. The Geneva double curtain and modifications are recommended. Ringing and GA (gibberellic acid) studies are encouraged to increase yields and size.

Vineyard Floor and Pest Management

Baluchistan's scant rainfall has framed planting systems. Vineyards are often designed to catch runoff water in trenches that are three to four feet deep. These wide trenches are lined out as in a maze. Grapes are planted at the base of these trenches and the vines are helped to "scramble" to the surface. This interesting and novel approach works. It conserves moisture and reduces sunlight, wind, and sand burn. This practice has encouraged mealy bugs but their control is understood by most growers.

OTHER CROPS WITH POTENTIAL

WALNUTS

The walnut is an accepted crop in Pakistan with Juglans regia seedlings the predominant type. Varieties are now being tested. This consultant and others have consistently recommended a two-to-three year screening of the germplasm base. Because most trees are planted down roadways and the edges of fields they are respected and encouraged. There are probably dozens of superior types that deserve evaluation. For instance, Mr. Idris Khan, a young lawyer and apple grower near Kurabunda, Mansehra, related to me that he knew one tree that consistently produced walnuts in "bunches" with good yields. Other locations can boast of individual trees with superior characteristics.

PECANS

The pecan varieties imported by this consultant into Pakistan in 1982 are doing well at Tarnab and Mingora. They are 10'- 15' in height, of good vigor and just beginning to crop. They all appear to be suffering from zinc deficiency which would be expected in the high soil pH's. Zinc sulphate sprays will alleviate the problem. Because the pecan case bearer is not present and other diseases and insects are apparently not serious, Pakistan would surely have a production advantage over many countries. I strongly recommend that pecan seed (any good variety) be imported and the trees distributed. The average run of seedlings make good trees and can always be topworked later to improved varieties.

BRAMBLES

Black berries and other brambles in the lower pH soils deserve testing. Recommended varieties : Brison, Brazos, Rosborough, Womack, Cherokee, Comanche.

JUJUBES (Ber)

There is an excellent seedling germplasm base of Zizyphus mauritania that deserve screening. This consultant has noticed numerous large and obviously well-adapted trees. The Chinese jujube, Zizyphus jujuba, should be imported and tested.

GUAVAS AND LOQUAT

While classically these should not be considered as temperate zone fruit crops, this consultant would like to repeat his earlier assertions that the germplasm base (numerous seedlings) certainly contains many superior clones. It deserves a coordinated effort.

RESEARCH

Temperate fruit research in the three provinces is hampered by a lack of technical manpower. For instance, since 1982, only one Ph.D. has been granted in the field of pomology. When one considers the great numbers of agronomist Ph.D.'s present in Pakistan it is much easier to understand the great gains made in cereal grain production in this country. Those same gains could be repeated in fruit production.

NARC :

The fruit program is a part of the horticultural effort at the National Agricultural Research Center, Islamabad. Dr. Daud Ahmad Khan, Coordinator, directs the work of one senior scientist officer and six scientific officers. The temperate fruit research effort focuses on variety evaluations, fruit fly, green aphid, brown rot, termite, and crown gall control. Another experiment is attempting to define the impact of leaf size and number on yield and fruit size. Other experiments involving fertilization and propagation are underway. In a related fruit project at NARC, Agrotec is establishing numerous projects under drip and micro sprinkler irrigation. The soils program under Dr. M. Salim, Principal Scientific Officer, has excellent instrumentation and is a resource for the horticultural research effort.

PUNJAB

Temperate fruit research in the Punjab at the provincial level is headed by Dr. Mohammed Hussain, Director, Horticultural Research Institute, Faisalabad. He directs the effort of nine horticulturists.

- Hameed Mazhar Sheikh, Ayub ARI, Faisalabad
- Mian Irshad ul Haq, Ayub ARI, Faisalabad
- Mahmood Ahmed, HFRS, Sunnybank, Murree
- Mahmood Khan, Ayub ARI, Faisalabad
- Ch. Niaz Ahmed, D.G. Khan Res. Sta., D.G. Khan
- Ch. Abdul Haq, Mango Res. Sta., Shujabad
- Malik Mohammad Nazir, Hort. Res. Sta., Soan Valley, Nowshera
- Ata-Ur-Rehman, Citrus Res. Sta., Sahiwal
- Malik Mohammad Zaman, Barani ARI, Chakwal

Of these, only two have temperate fruit research responsibilities. Malik Mohammad Nazir has created an ambitious project with 6 stations: Kanahatti, Nowshera, Sodijaiwali, Khura # 1, Khura # 2, and Khatwai. He is evaluating the potential of low-chilling peach, apple, almond, plum, saffron, and others. His program shows great promise. The second major temperate fruit thrust is the Murree range. Mahmood Ahmed has two Asst. Research officers with four substations. Apples, peaches, plums, pears and apricots are being tested at the various elevations. Agrotec has provided testing material. Hail net evaluation looks promising.

In the Punjab, Faisalabad Agricultural University has a large horticultural faculty that involve themselves in various research projects. Sixteen faculty are directed by Dr. Mahmood N. Malik. Six of the faculty are involved in fruit research. The faculty graduates 50-100 MSc graduates per year. Because of its location, the university has a difficult task in regards to temperate fruit studies. Low-chilling cultivars need testing at this location.

NWFP

Temperate fruit research is well developed in the NWFP.

TIPAN has consolidated the Research Stations of Tarnab and Mingora under the Agriculture University at Peshawar. This effort will insure future coordination and accountability in the fruit program. Twenty-four MSc candidates are pursuing research projects under the direction of three horticultural professors; Professor Hafiz Inayatullah, Dr. Faridullah Wazir Khan, and Mohammad Ishtiaq. Nine of the thesis research projects are related to temperate fruits.

At Tarnab, Dr. Saifullah Khattak directs the efforts of a horticulturist, Mr. Iftikhar Haq, a plant pathologist, Mr. Sabir Hussain Shah, and an entomologist, Mr. Gul Nawaz. There are three Asst. Horticulturists and 15 Research Officers. TIPAN and other schemes have improved the research budgeting problem and allowed an expansion in activities. Lack of technical staff is a difficulty. There has been a lack of technical in-country and

out-of-country training in Pomology. Lack of land is a problem at Tarnab. The library, while improved since this consultant was last here in 1982, needs a major transfusion of materials. The research effort at Tarnab focuses heavily on variety evaluation. Nearly 80 varieties of peach, 23 varieties of nectarine, thirty-four varieties of plum, nine varieties of pecan, five varieties of almond, 23 varieties of pear and others are being studied. Rootstock studies are second in scope. Propagation, pest management, and fertilization studies are also present.

At Mingora, Swat, Mr. Tasleem Jan acts as Horticulturist and directs the efforts of an Asst. Horticulturist and 3 Asst. Research Officers. Research focuses on variety evaluation, training systems, plant nutrition, propagation, rootstock adaptation, and studies of fruit drop and self-fertility. Lack of transportation was a complaint. Difficulties in the Outreach Fruit Maximization Project center on manpower. Budgeting is improved.

Baluchistan

Temperate fruit research at ARI Sariab, Quetta, focuses on varietal evaluation, rootstock evaluation, irrigation requirements and practices, nutrient requirements and application, cultural practices/orchard floor management, plant protection, training/pruning practices, nursary production practices, and post harvest physiology. Three "model farm" projects are underway in the valley with a goal of forty acres in scattered locations. This is a component of the DFDP (Deciduous Fruit Development Project), a joint venture of the Government of Baluchistan, Government of Pakistan, and FAO. At Sariab ARI there are 87 positions allocated but only 42 filled. The staffing includes 17 BSc, 24 MSc, and one PhD. There are several studying abroad for the MSc and PhD. Several faculty have enjoyed short term training abroad.

RECOMMENDATIONS

Germplasm

Pakistan needs to be on the receiving end of the latest germplasm. Past importations have been sporadic at best. Further complicating this aspect of fruit development is the number of "importers". Various agencies and private sector efforts has led to an unknown germplasm base.

I recommend that a mechanism be established to funnel germplasm to the appropriate Pakistan fruit stations. The materials should be placed in several agroclimatic zones to insure that its true potential is revealed. If necessary, I would be glad to serve as a conduit. Past requests from Pakistan directed to my office have been frustrated by purchasing procedures and time constraints.

A mechanism might work like this:

1) Request is made to my office.
2) Phone contact with appropriate sources and arrangements made for billing.
3) Material mailed to George White, Plant Quarantine Center, Beltsville, Maryland.
4) Phytosanitary certificate attached to material.
5) If trees, air mail shipment to Pakistan.
   If budwood, hand carried to Pakistan via Pakistan-bound U.S. personnel.
6) Disseminated via NARC to appropriate fruit research stations.
7) Propagated in 1st year for planting at scattered substations.

The seedling germplasm base of walnut, almond, apricot, guava, loquat, and jujube should be screened for superior types. The wealth of material is astounding and numerous worthwhile clones are in the offing. This effort could be coordinated at NARC and searches run by the various provincial horticulturists in each promising area. This has long range implications not only for Pakistan but for other countries as well.

Nutrient Concentration Field Survey

I am recommending a nutrient concentration survey of temperate fruit orchards in Pakistan. A large sampling of soil, leaf tissue, and irrigation water in June-July, 1989 could be analyzed and correlated to various parameters of productivity (Yield: High, Medium, Low; Vigor: High, Medium, Low; Chlorosis: Intense, Medium, None; etc). This project has been presented to the Land Resources Section faculty, NARC and their enthusiasm for a collaborative effort is appreciated. Soil pH encountered, rocky parent material, and frequent growth and chlorosis problems encountered suggest such a survey is warranted.

Nutrient concentration surveys of numerous fruit crops have yielded a better understanding of plant growth. Correlating nutrient levels with plant vigor often reveals specific elements present in deficient or toxic amounts, or reveals nutrient imbalances in need of correction. Horticultural specialists are able to fine-tune grower recommendations after analyzing trends and correlations. This consultant has been involved for several years in work of this type.

The Soil Lab at Stephen F. Austin State University is blessed with an ICP, inductively coupled plasma instrument. The instrument allows rapid. sequential analysis of macro and micronutrients. Besides P, K, Ca, Mg, and S, the instrument delivers reliable readings of Fc, Mn, Cu, Zu, Mo, B, and Na. Our lab routinely analyzes thousands of farmer and research samples per year. The value of irrigation water analysis is dependent on irrigation water source. Water will be analyzed for Ca, K, Mg, B, Na, bicarbonates, Carbonates, SSP, SAR, and conductivity.

The entire data base of nutrient concentrations and growth/yield ratings can be statistically scrutinized via DFA, discriminant factor analysis.

A collaborative project of this type could serve as an excellent "cross-referencing" technique to build confidence in the values obtained. It is my recommendation that NARC Land Resources Section be responsible for soil analysis and the SFA State University Lab be responsible for leaf tissue and irrigation water analysis. Cross referencing could be accomplished by each lab analyzing 10% of the other lab's responsibility.

All samples should be collected, dried, and organized by one NARC scientist. Vigor/growth/chlorosis ratings should be by one man to reduce variability. Shipment of soil and leaf tissue into the United States is governed by APHIS laws. I have made arrangements with Frank Cooper, USDA/APHIS/PPQ, Federal Ctr.

Building, Rm 666, Hyattsville, Maryland 20782, (301-436-8248) to have the SFA Lab set up for legal importation of foreign soil, leaf tissue, and irrigation water. The permit number will be forwarded to Dr. Abdul Rashid, NARC and the USAID/WINROCK/MART office.

Because this consultancy involved numerous farm and research station visits, this consultant undertook a small survey of his own. About 30 locations were sampled. It is my recommendation that these samples be shipped to the SFA Soils Lab for analysis. This preliminary sampling will help on Soils Lab personnel design standards for next year's extensive project. If desired, NARC could analyze some of the soil and leaf tissue samples. This cross-referencing might be a useful "practice" step before undertaking the 1989 nutrient field survey.

The goal of this collaborative project is to set up an ongoing experimental effort. If successful, studies could be expanded into many areas.

Experiments that alleviate chlorosis and pH problems could be designed and initiated in Pakistan in a cooperative effort with the SFA Soils Lab. Visitations by this scientist or our SFA Soils Lab Director to Pakistan might be valuable. Visitations by the Land Resource Section, NARC or Pakistan horticulturists to the SFA Soil Lab would enhance local fruit orchards, and experiment stations the viability of a continuous cooperative program. Joint publications, exchange of ideas, problem solving, experimental design, and other components might evolve in this

effort. Funding of this proposal is undetermined.

Manpower

The great progress made in agronomy can be repeated in horticulture. The strong emphasis that Pakistan has placed in breeding/genetics/agronomy should be shifted to fruit and vegetable production. There are only five horticulture PhD's in Pakistan and only one produced since 1982. Without a transfusion of fruit talent, progress will be slow.

Short term and long term training programs in Australia, New Zealand, U.K., Europe and the United States are essential to upgrading this industry. One month workshops can solidify a better understanding of training and pruning systems, pest and orchard floor management, crop load adjustment, fruit color, size and quality enhancement, and post harvest improvements.

It is this consultant's opinion that the creation of a National Horticulture Institute (NHI) is premature. The staffing of such a faculty would necessitate "robbing" existing provincial, federal, and private sector agencies. Locating the faculty would prove equally difficult. It would be impossible to find a location suited to the wide diversity of horticultural crops. Locating at an existing ARI (i.e., Tarnab) would unfairly dislocate other programs. Locating an institute in one province would inflame sentiments in the other provinces in a negative way. "Territorial imperative" is an ongoing obstacle. Instead, it is my recommendation that existing ARI's, ARS's, and the

effort at NARC be strengthened.

Another problem related to manpower is the "talent pool" available for advanced studies, the popularity of breeding/agronomy/genetics/engineering/veterinary science has resulted in the brightest students choosing fields other than horticulture. It is discouraging that horticulture has taken such a "back seat". It is my recommendation that these other disciplines be screened for enthusiastic, bright candidates willing to make a change to horticulture. This would alleviate some of the TOEFL and academic problems that currently exist in the "qualified candidate" talent pool.

Technical Information Base

Many of the same problems encountered by this consultant in the early 1980's. Libraries are often disorganized. Current literature and interlibrary loans are often unutilized. It is this consultant's recommendation that PARC be used as a "clearing house" for literature review requests. It is important that MSc thesis studies are based on current research knowledge. This consultant recommends that PARC compile and review all of the temperate fruit research in Pakistan into one document. This would be valuable in coordination and would encourage dialog among fruit scientists.

Agroclimatic Zone Identification

This consultant recommends that recording thermographs be installed in the various fruits regions. The Sariab ARI, Quetta, weather station might be used as a model. The information gathered in a five year period would help horticulturists understand climatic constraints in each region.

APPENDIX 1

Terms of Reference

Temperate Horticulture Specialist

The purpose of this consultancy is to review the existing temperate fruit and nut research activities and production situation in Northern Pakistan and Baluchistan and to make recommendations how research and production can be improved. Recommendations should include specific germplasm that should be tested in Pakistan, institutions (and individuals) around the world that could be helpful in solving Pakistani research and production problems, and educational institutions where Pakistani students could find study and research programs particularly applicable to the ecology of Pakistan. If possible, the consultant should also bring with him any germplasm he feels can offer special promise to fruit and nut researchers and producers in Pakistan. The consultant should be prepared to present 2 or 3 seminars on horticultural topics of this chossing appropriate to Pakistan's ecology.

The consultant will visit research and production locations in Pakistan to further his understanding of the level of research and the problems of production. He will be guided in developing agenda by Dr. Daud, Consultant (Hort), PARC, Dr. M. Saeed, AID Agronomist, and horticultural specialists of NWFP, Baluchistan, and Punjab. The length of this consultancy will be about four weeks, beginning mid-June, 1988.

The consultant's final report (a draft must be prepared before he leaves Pakistan) should consist of his findings and observations together with a set of recommendations to improve research and production of fruit and nuts in Pakistan. A suggested outline of the consultant's is attached. The following points should be addressed in the report.

1. A general description of the production zones for major temperate fruits and nuts with an appraisal of the cultural practices now in use and the relative yields obtained.
2. A description of the major varieties of fruits and nuts currently being produced in Pakistan together with a listing of varieties that the consultant believes have high potential.
3. An overview of the current research being done on temperate fruit and nuts with an indication of when the research is being done, the number of scientists involved, their level of training, and an estimate, if possible, of the funding available.
4. As assessment of the potential for the export of fruits and nuts currently grown in Pakistan, and those not now grown but potentially valuable.

In the report the consultant should give a listing of centers of excellence around the world for research on these topics. Names of individuals who are research leaders on pertinent research topics should be given.

The consultant should also suggest locations overseas where training of horticulturists may be undertaken for temperate horticulture that are particularly appropriate for Pakistanis.

APPENDIX 2

ACKNOWLEDGEMENTS

Bill Wright and Taki Izuno are responsible for making this consultant's itinerary run as smoothly as it did. Mukhtar Ahmad, NARC S.O., was of great help in the Murree/Peshawar/Mardan/Mingora visitations. Hameed Mazhar Sheikh was a personable and informative horticulturist on my trips to Murree and Soan Valley. My friends, Faridullah Wazir Khan, Abdul Hadim Syed, Iftikhar Haq, and Tameel Jan were of great help. Mohan Shah proved to be an enthusiastic guide for my visitations in Mansehra District. My friend Malik Mohammad Nazir provided his consultant with two productive and interesting days in Soan Valley. Mr. Sarfraz Azam's steady assistance throughout my entire stay is due a special note of thanks.

There are numerous other horticulturists, provincial officers, NARC personnel, and growers who opened their doors and hearts. Many thanks. Let us all Plan and Plant for a better Pakistan.

APPENDIX 3

Itinerary

June	18	Sat	Arrive Islamabad on BA 223 0730. Reviewed [illegible] Discusse itinerary and project focus with Izuno.
June	19	Sun	NARC, USAID, PARC visitations.
June	20	Mon	Field plots NARC.
June	21	Tue	Hill Fruit Research Station and substations, Murree.
June	22	Wed	Proceed to Soan Valley, fruit substation, Sodijawali.
June	23	Thur	Soan Valley farms and substations.
June	24	Fri	Rest.
June	25	Sat	To Peshawar and Peshawar Agric. Univ.
June	26	Sun	Agric. Univ. Peshawar field plots. To Tarnab. Seminar.
June	27	Mon	To Tarnab, then proceeded to Mardan. At Farm of Ikramullah Khan, pruning demonstration and "seminar", recorded on VCR. Proceed to Mingora, Swat.
June	28	Tue	Mingora, Swat ARI and local farms. Return to Islamabad.
June	29	Wed	Proceed to Abbottabad, Mansehra Dist. ARS. Local farms.
June	30	Thur	Inspected fruit production region toward Kohistan, local farms. Return to Islamabad.
July	01	Fri	Rest.
July	02	Sat	NARC, Report writing.
July	03	Sun	NARC, consultations with Land Resources Section, Agrotec Project directors.
July	04	Mon	NARC, consultations.
July	05	Tue	NARC seminar presented to Horticulturists. Conversations with M.Sulyman Khan.

July	06	Wed	NARC, report writing, Air travel to Faisalabad.
July	07	Thur	Agric. Univ. Faisalabad, seminar. To Research Farm. Return to Islamabad.
July	08	Fri	Rest.
July	09	Sat	NARC, report writing.
July	10	Sun	NARC, Report writing, Flight to Quetta accompanied by Dr. Saeed, USAID.
July	11	Mon	Visits to Pishin, Gulistan, Maizei fruit orchards.
July	12	Tue	Visit and consultations at ARI, Sariab.
July	13	Wed	Return to Islamabad (13:45), report writing.
July	14	Thur	USAID, NARC, ADBP consultations, report writing.
July	15	Fri	Rest.
July	16	Sat	Depart for U.S.A BA 224 10:00 a.m.

APPENDIX 4

LIST OF CONTACTS

1. Dr. Daud Ahmad Khan, Consultant (Horticulture) PARC, Islamabad.
2. Mohammad Saeed, USAID, Islamabad.
3. Guilran Manzini, NARC, Agrotec Project, Islamabad.
4. Mr. Biji, NARC, Agrotec, Islamabad.
5. Z.M. Niazi, Sr. S.O., NARC, Islamabad.
6. Mukhtar Ahmad, S.O., NARC, Islamabad.
7. Khalid Mahmood Karashi, S.O., NARC, Islamabad.
8. Abid Hussain Shah, S.O., NARC, Islamabad.
9. Hafeez-ul-Rehman, S.O., NARC, Islamabad.
10. Altaf Qader, S.O., NARC, Islamabad.
11. M. Latif, S.O., NARC, Islamabad.
12. Dr. M. Salim, Principal S.O., Resources, NARC, Islamabad.
13. Ikramullah Khan, Member Board of Directors, ADBP, Islamabad.
14. Sarfraz Azam, Farm Tech. Dept. ADBP, Islamabad.
15. Dr. Mohammed Hussain, Director Hort. Res. Inst., Faisalabad.
16. Hameed Mazhar Sheikh, Horticulturist, Ayub Agric. Res. Inst., Faisalabad.
17. Mahmood Ahmed, Horticulturist, Hill Fruit Res. Station, Sunnybank, Murree.
18. Altaf-Ur-Rehman, Asst. Res. Officer, HFRS, Sunnybank, Murree.
19. Riaz-Ur-Rehman, Asst. Res. Officer, HFRS, Sunnybank, Murree.
20. Malik Mohammad Nazir, Horticulturist, Hort. Res. Sta., Soan Valley, Nowshera (Dist. Khoshab).
21. Shahid Javed Butt, Asst. Res. Officer, Tissue Culture, Ayub ARI, Rawalpindi.
22. Syed Manzur Hussain, Asst. Res. Officer, Tissue Culture

Lab., Ayub ARI, Rawalpindi.

23. Zahid Hussain, Asst. Hort, Soan Valley, Nowshera (Dist. Khoshab).

24. Abdul Aziz, Asst. Res. Officer, Soan Valley, Nowshera, (Dist. Khoshab).

25. Farid Majeed, Asst. Res. Officer, Soan Valley, Nowshera, (Dist. Khoshab).

26. Mubarak Ali, Asst. Res. Officer, Soan Valley, Nowshera, (Dist. Khoshab)

27. Prof. Hafiz Inayatullah, Director of Instruction, Agric. Uniiversity, Peshawar.

28. Faridullah Wazir Khan, Associate Professor of Hort., Agric. Univ., Peshawar.

29. Jehangir Khattak, Soils, Agric. Univ., Peshawar.

30. G.M. Khattak, Vice Chancellor, Agric. Univ., Peshawar.

31. M. Siddique, Dir. of Research, Agric. Univ., Peshawar.

32. Dr. Saifullah Khattak, Project Director, of Horticulture, Tarnab.

33. Abdul Qadim Syed, Director General, ARI, Tarnab.

34. Iftikhar Haq, Hort., Tarnab.

35. S. Sabir Hussain Shah, Plant Path., Tarnab.

36. Gul Nawaz, Entomologist, Tarnab.

37. Iftikhar Khan, Fruit grower, near Tarnab.

38. Maxine Thompson, IBPGR, fruit and nut germplasm search out of Corrvallis, Oregon.

39. David Brenner, IBPGR, out of Corvallis, Oregon.

40. Rohan Shah, Asst. Res. Officer, Agric. Res. Sta., Dhodial, Mansehra.

41. Gulfam Jehangiri, Outreach Director, Agric. Res. Sta., Dhodial, Mansehra.

42. Mukhtar Nawaz, FVDB, Fruit Nursery Farm, Baffa, Mansehra.

43. Ret. Gen.Mumtaz Khan, Fruit grower, Mansehra.

44. Faheem Khan, Fruit grower, Mansehra.

45. Moulvi Abdul Qadar, grower, Kuzaband.

46. Ghulam Mohammad Khan, grower, Mansehra.

47. Idris Khan, grower, Mansehra.

48. Abdul Rashid, Principal S.O., Land Res. Section, NARC, Islamabad.

49. Kenneth McNabb, Pak. Forest Inst., Peshawar.

50. Mohammed Suleman Khan, State Dept., Islamabad.

51. Dr. Mahmood N. Malik, Agric. Univ., Faisalabad.

52. Musahib-ud-Din Khan, Agric. Univ., Faisalabad.

53. Ghulam A. Chatha, Agric., Univ., Faisalmabad.

54. Muhammad Siddique, Agric. Univ., Faisalabad.

55. Muhammad Ibrahim, Agric. Univ., Faisalabad.

56. Aslam Pervez, Agric. Univ., Faisalabad.

57. Riaz Ahmad, Tissue Culture, Agric. Univ., Faisalabad.

58. M. Sandhu, Land Resources, PARC.

59. Muhammad Imtiaz Malik, ADBP, Islamabad.

60. Dr. Abdul Hameed Bajoi, D.G. Sariab ARI, Quetta.

61. Mr. Hickey, UNDP/FAO, Sariab ARI, Quetta.

62. Dr. J.B. Robinson, UNDP/FAO Short-term Consultant, ARI Sariab, Quetta.

63. Nek Mohammad, Fruit Dev., ARI Sariab, Quetta.

64. Mohammed Rashid, Horticulturist, ARI Sariab, Quetta.

65. Abdul Hameed, Soil Chemist, ARI Sariab, Quetta.

66. Mr. Yusuf, A.O. Extension, Pishin.

67. Abdul Bari, Horticulture Station, Pishin.

68. Haji Mohammad Qasi Khan, fruit grower, Gulistan Karez.

69. Haji Mohammad Abas, fruit grower, Maizai.

APPENDIX 5

Recommended Temperate Fruit Study Stations

1. Agricultural Research Southern Region, Southeastern Fruit and Tree Nut Laboratory, PO Box 87, Byron, Georgia (contact person: W.R. Okie).

2. Horticultural Sciences Dept, Texas A&M University, College Station, Texas (contact person : David Byrne).

3. Horticultural Sciences, Michigan State Univ., East Lansing, Michigan (contact person : Ron Perry).

4. Horticulture Sciences, U.C. Davis, Davis, California.

5. Tree Fruit Research Center, Washington State University, Wenatchee, Washington 98801. (contact person : Bruce Barritt).

6. East Malling Research Station, East Malling, Maidstone Kent, U.K. (contact person : J. E. Jackson and J. W. Palmer).

7. Institute Co Hiv. Arboree, Via Filippo Re 6, 40126, Bologna, Italy (contact person : S. Sansavini)

8. Dept. of Agric., Agric. Instit., Yanco, N.S.W. 2703 Australia (contact person : R.J. Hutton).

9. New Zealand Agric. Engineering Instit., Lincoln College, Canterbury, New Zealand (contact person : J. S. Dunn and M. Stolp).

10. Horticultural Science, University of Arkansas, Fayetteville, Arkansas (contact person : Roy Rhom).

APPENDIX 6

BIOGRAPHICAL SUMMARY SHEET

NAME: David L. Creech

ACADEMIC QUALIFICAIONS:
B.S. Texas A&M University 1970 Hort
M.S. Colorado State Univ 1972 Hort
PhD Texas A&M Univ 1978 Hort

YEAR OF BIRTH: 1948

YEAR BEGAN PROFESSIONAL WORK EXPERIENCE: 1978

COUNTRIES OF WORK EXPERIENCE: PAKISTAN, GUATEMALA

WORK EXPERIENCE:

1978-1979: Extension Horticulture Specialist, Texas Agricultural Research and Extension Center, Overton, Texas.

1979-Present: Professor of Horticulture, Stephen F. Austin State University, Nacogdoches, Texas.

GENERAL QUALIFICATIONS:

My academic training and work experience has focused on temperate fruits. I have fifteen years experience as a commercial peach grower at Nacogdoches, Texas (35 acres). My research effort has focused on rabbiteye blueberries, an emerging new industry in Texas. Fruit nutrition studies at Stephen F. Austin State University have resulted in oral papers and publications at the state, regional, and national levels. A complete listing is available on request.

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Stephen F. Austin State University
Nacogdoches, Texas 75962
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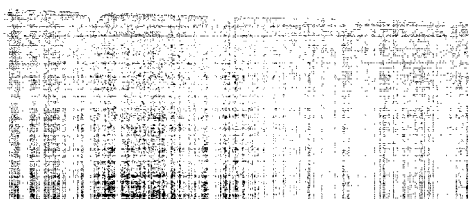

APPENDIX 7

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