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**AN ASSESSMENT OF THE TEMPERATE FRUIT RESEARCH  
PROGRAM AT THE SAN BENITO RESEARCH CENTER**

**by**

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AN ASSESSMENT OF THE TEMPERATE FRUIT RESEARCH  
PROGRAM AT THE SAN BENITO RESEARCH CENTER

Anthony H. Hatch<sup>a</sup>

Introduction

This report contains my observations of the temperate fruit research program at the San Benito Research Station made between May 4 and May 19, 1976. My charge was to evaluate the research personnel, reports, and projects; the physical layout as to land quality, buildings, and equipment; the needs of commercial fruit growers; and make recommendations that might strengthen the fruit research program and improve commercial fruit production in Bolivia. Each subject will be discussed in the order listed, except that recommendations will be made following each subject evaluated rather than in a separate section. Also, I will conclude with some thoughts concerning the future of a Bolivian temperate fruit industry.

Research Program

Personnel

The research staff at the San Benito Research Station is comprised of four full-time fruit specialists, a part-time plant pathologist, and a part-time entomologist. One of the fruit specialists is currently in Japan for graduate study. When he returns, this 6-man team should be able to meet the current research demands. In the long run, however,

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most of the research personnel should have a Master of Science degree with at least one having a Ph.D. degree. He would serve as the scientist in charge of the fruit research program. Subject matter should be divided among them so that each researcher investigates certain production problems and that the total production spectrum is covered.

It is apparent that the research staff members need to acquaint themselves with the latest developments in fruit production. To accomplish this, they need to subscribe to scientific and popular periodicals and to purchase or acquire technical bulletins from research institutions throughout the world. I donated my personal copy of the Modern Fruit Science textbook I brought with me to the library. It is the most recent textbook available and is used by most universities teaching fruit science. The scientific periodicals from the U.S.A. they should subscribe to are the Journal of the American Society for Horticultural Sciences and Hortscience. A popular U. S. fruit grower publication is the American Fruit Grower. I will be glad to furnish the addresses and subscription prices should there be any interest. I do not have this information with me at the moment.

It was often difficult to explain some of the new horticulture technology because the researchers had a difficult time visualizing something they had only read about. My personal opinion is that CID/AID specialists would be considerably more effective if their Bolivian counterparts had actually seen techniques that were trying to be demonstrated and/or taught by the visiting specialists. A considerable amount of time could be saved and frustration eliminated if both CID/AID

specialists and Bolivian counterparts had a stronger vocabulary with which to communicate. Where possible, Bolivian researchers that have studied in the U. S. and are familiar with recent trends in research should be assigned to work with CID/AID specialists. If there are none available then they should be asked to visit research institutions in the U. S. for a short period of time to familiarize themselves with the new research trends.

I can relate to many of the problems confronting the researchers at the San Benito Research Station being the superintendent of a similar fruit research center in Colorado. It is difficult to see how anyone can expect a sound scientific research program to be conducted under the severe restrictions placed on these men. At the moment, they have no budget over which they have any control and are asked to generate a certain amount of income from their operations. I have been assured that a budget has been allocated to the Station this year and that the pressure to run a commercial orchard is being reduced.

Ideally, the budget allocated to the Station would be divided into two separate budgets. A budget for the operations and maintenance of the Station, controlled by the director, and a research budget allocated to each researcher to fund his research. The director and researchers should be consulted on their budget requirements prior to a budget assessment and then be expected to limit their expenditures to the amount requested. Only until the San Benito Research Station is provided a firm and realistic budget will they be able to assume a leadership role and establish a sound temperate fruit industry in Bolivia.

I believe that no government subsidized operation should be in direct competition with private industry. The commercial fruit production that has been practiced in the past is in direct competition with the fruit grower. Any fruit that is salvageable from research blocks and is sold should be done in such a way as to not compete with private fruit growers. Hopefully, research blocks will no longer be sacrificed because of an effort to engage in a commercial enterprise.

Salary increases need to be made to properly compensate the San Benito Research Station researchers for their expertise. I believe they are receiving inadequate salaries for the Bolivian standard of living when compared with their colleagues in other foreign countries and their standard of living.

A key position that needs careful consideration is that of a qualified mechanic. His position not only requires him to maintain orchard equipment, but also to modify equipment to meet research specifications. The latter often requires an individual with an imagination and the experience necessary to use his imagination.

### Reports

The annual reports I reviewed appeared to be accurate and properly written. However, no attempt was made to statistically analyze the data contained in the reports. This may have been the result of an inadequate statistical proficiency on the part of the researcher and/or the inability to maintain viable research blocks. Prior to this year, some research blocks were sacrificed in favor of commercial blocks. Research results

were often influenced by a factor not part of the research design. The primary limiting factor has been water. In many cases, research blocks were completely lost because they dried up. Under such conditions, the results reported are virtually useless.

If the research situation can be corrected so that reliable data can be obtained, the results of such work should not only be published in an annual report, but also in technical bulletins and a scientific journal. I strongly endorse the recommendation made by the Consortium for International Development to publish a Bolivian Agricultural Journal (5). It will encourage the Station researchers to conduct good research so that they can have their work published. It will also teach them to be more meticulous in their work. The Bolivian Agricultural Extension staff should be charged to synthesize research reports into extension publications for fruit growers where appropriate.

### Projects

The only identifiable fruit research blocks are those established by Mr. Simeón Rodríguez. Most of the research he is conducting is adaptive rather than basic. However, I believe that adaptive research is currently needed so that established pomological technology can be adapted to Bolivian conditions. Basic research can wait until the current production problems have been resolved.

A considerable amount of variety testing is currently being conducted on temperate fruit species (4). Variety testing has and will always be an important activity of any fruit research station. However,

such testing must be done based on some logic or it becomes useless. For example, approximately 50 different peach varieties have been tested at the Station with only the Tejon variety from Argentina showing any promise. This is what one would expect knowing the chilling unit requirements of each variety and the number of chilling units normally accumulated at the San Benito Research Station. The 49 varieties could have been disqualified immediately without further testing had this criterion been considered. This would have saved all the time and money spent in arriving at the same conclusion through field trials. The logical conclusion drawn was that the local peach seedling varieties were superior and where variety testing should be directed because foreign varieties were not adaptable to Bolivian conditions. As a result, 155 seedling varieties have been tested with only 12 surviving the preliminary screening. These remaining 12 varieties have yields about 1/3 of what they should be. Had the researchers recognized earlier that a major limiting factor was the low number of chilling units and knew that excellent peach varieties with low chilling requirements are commercially available in Florida and California, they could have acquired these varieties and be further along than they are in recommending peach varieties for Bolivia. The same logic should prevail for selecting other specie varieties for Bolivia. Only until they have exhausted all the information and plant material from other research institutions should they launch their own fruit breeding program.

The rootstock selection program should also follow the same logic as variety testing. Find out what rootstocks are already available that

possess characteristics needed for local conditions. Rootstocks with low chilling requirements will have to be selected for all temperate fruit species. Crown gall resistance in peach rootstocks is another important criterion for rootstock selections.

Additional research being conducted by Mr. Simeon Rodriguez involve peach tree planting distances, training systems, pruning techniques, and fruit thinning. These research blocks are well designed statistically and should provide important information. Also, they will serve as excellent demonstration blocks for fruit grower inspection.

After carefully reviewing the fruit research projects and visiting potential fruit areas, I believe the research priorities to be the following:

1. Where available, the maximum and minimum temperatures need to be analyzed using the Utah State University phenoclimatological model for chilling units and growing degree hours for each area being considered for potential orchard sites. Since the chilling unit and growing degree hour requirements for the proper development of temperate fruit crops are rather specific for each variety, the results from the temperature analysis would serve as excellent criteria for selecting species and varieties for a given area. I am taking 8 years of temperature data from San Benito with me to be analyzed and returned. Hopefully, the value of such information will be recognized and additional temperature information sent from other areas for similar analysis.

2. Variety trials should be continued but as discussed earlier. Exhaustive searches for already proven varieties having the desired

characteristics should be made before initiating a domestic breeding program. Peach and apple varieties should be the first species researched since they have the largest market potential. I am willing to do what I can to locate desirable varieties and see that they are shipped to San Benito. Someone from San Benito should acquire some trees of the peach variety "Rey del Monte" from Uruguay or Argentina.

Management practices should be developed for the apple seedling variety known as Vinto. It has excellent dessert quality, but needs to have a more attractive external appearance. Apple scab seems to be a problem with the fruit.

3. Rootstock selection needs to continue, but again, as previously described. Apple and peach rootstocks must have low chilling unit requirements. In addition, peach rootstocks must be resistant to crown gall. Crown gall is a major problem with commercial blocks and, unless resolved, will restrict future peach plantings. Again, I can search out rootstock sources in the United States and have the appropriate ones shipped to Cochabamba.

4. An adequate plant protection research program must be instituted. Contrary to the Ballard, et al. (3) and Ward (6) reports, a great number of insects and diseases were seen while visiting different orchards. Mites, aphids, wooly aphid, San José scale, and flat-head borer were some of the insects found. The diseases consisted of brown rot, bacterial leaf spot, powdery mildew, mistletoe, moss, and crown gall. Most trees received no preventive treatments while only a few used metasystox.

Aldrin or dieldrin was applied to the trunk and main scaffold limbs of peach trees at the San Benito Research Station every 3 months to control the flat-headed borer. It is very likely that the residue levels would be high in the fruit. The cupric oxide and wettable sulfur applied to control diseases seemed to be effective but excessive. No attempt seemed apparent to test the newer chemicals nor establish an effective spray program. What preventative measures have been established seem to be by chance rather than by a systematically developed program. The life cycles of the different pests need to be monitored so that an effective spray program can be developed without excessive applications of pesticides.

5. Of those designated as potential fruit growing areas (1), the upper Cochabamba valley seems to be the best area suited for apple and peach orchards. The major problem in this area is the lack of a good supply of irrigation water. Thus, irrigation and soil management research needs to be initiated.

The four common soil management systems used in orchards in the United States are clean cultivation, cover crop, permanent sod, and permanent sod plus herbicides. Under clean cultivation, the orchard floor is kept free of weeds by discing. Under the cover crop system, a winter grass is sown in late summer and early fall and then disced under the following spring. The orchard floor is kept free of weeds during the summer by discing. A permanent sod system maintains a shallow rooted grass sod the year round. The grass is cut periodically. Applying a

herbicide strip 3 feet from either side of the tree trunk in a permanent sod system is fast becoming the most popular soil management system, even in irrigated areas. Economics favor the latter system. It is recommended, therefore, that herbicide research be initiated as soon as feasible.

Perhaps of greater importance is the need for irrigation systems research. Basin irrigation is currently being used at the Station, but a nonuniform wetting pattern was obvious. Trees near the head of the row were generally larger than those near the end of the row. Furrow irrigation is a little more efficient but unless the furrows are properly designed, a similar wetting pattern would be obtained. A drag-line sprinkler system is an excellent irrigation system and can be efficient if designed properly. It is more costly to install than the furrow or basin systems but the savings in water usage would soon compensate for the additional costs. Drip irrigation is the most efficient system and may cost a little more than a dragline sprinkler system, depending on emitters used and if little filtering is required. The sophistication of the system limits its use to knowledgeable people. Since it involves precise scientific facts, the margin for error is greatly reduced leaving virtually no room for mistakes or equipment failure. However, I would not hesitate to recommend its use to anyone that I feel is sufficiently competent and is starting a new orchard. Established trees raised under one of the other irrigation systems have a hard time adjusting to drip irrigation.

6. The yield and quality of the fruit need to be improved. The average peach tree yield, as reported to me, is 40 kilos. This is about 1/3 of the average peach tree yield in the large peach growing areas of the United States. The difference in variety fruitfulness plays a big role in the amount of fruit a tree will bare but so do cultural practices.

Perhaps the most important of these cultural practices is mineral nutrition. Fruit trees must be properly nourished if they are to perform at capacity. Considerable evidence exists that many trees in commercial orchards in the Cochabamba area are suffering from the lack of adequate fertilization. Before meaningful mineral nutritional research can be conducted on fruit trees, leaf analysis results must be available. Crop yields can be reduced or otherwise affected before any visual changes in the normal tree development can be detected. Also, there are no correlations between the level of elements in the soil and the level of elements in tree leaves. This is understandable since soil samples are taken in the top 30 cm. of the soil and the tree root system can penetrate a couple of meters into the soil. If a plant tissue analysis laboratory exists in Bolivia and is available to tree fruit researchers, then one would not have to be established at San Benito. However, if one does not exist or is inaccessible to the tree fruit researchers, then one should be established at San Benito.

The other cultural practice research such as fruit thinning and tree spacing, training, and pruning being conducted at San Benito is adequate at this point.

7. Post-harvest physiology research will need to be conducted as the fruit industry grows and fruit is stored. However, this program could wait until it is determined that the fruit industry is going to expand.

8. While very important studies in marketing fruit need to be made, I feel this responsibility should not be that of the San Benito Research Station. This should be the responsibility of the Bolivian Agricultural Extension Service in cooperation with private industries.

If CID/MACA wishes to contract my services again next year, but at an earlier date, to return on a short-term basis to review the implementation of the suggested research projects and initiate others, I will try and make myself available. In addition to establishing new varieties and rootstocks, which can be done without me being present, a foliar analysis program and irrigation systems need to be established which might benefit by my presence.

### Physical Layout

#### Land quality

The land at the San Benito Research Station is of a sandy loam type and deep. It gently slopes to the south and overlooks a large valley floor. I would classify it as an exceptionally fine orchard site, except for the water shortage. The 4 ha. across the road north of the Station they plan to use as nursery is a poor soil. It will require a considerable amount of leveling and contains some salt. A better nursery site would be in the southeast corner of the Station that is now planted to grain.

The irrigation water currently available through the existing wells would be sufficient to meet the irrigation needs if they all had pumps and were linked to an efficient irrigation system. Pumps have been received for wells currently without pumps but have not been installed. If more wells are to be drilled, rather than to drill any more small 20 meter deep wells, a large 200 to 300 meter deep well should be drilled.

### Buildings

The current buildings are rather scattered and would not be functional as laboratories without considerable remodeling. They might suffice as offices but dividers would need to be installed to provide the staff with some privacy. I would suggest, if possible, an office and laboratory building be constructed to accommodate all research personnel working at San Benito. It would facilitate the interchange of laboratory equipment or make it easier for researchers to use each others laboratory if the need arises. The old buildings could be used as storage units or dismantled. One of the best office/laboratory facilities I have seen is located at the Pennsylvania State University Fruit Research Center at Biglerville, Pennsylvania, a research center the size of San Benito. I will obtain a copy of the blueprints and forward them to IBTA for their consideration. Modifications would have to be made but it could serve as a base.

In addition to an office/laboratory complex, a mechanic shop and farm equipment storage shed needs to be built. The existing facility is too small and is not properly equipped. A good shop is indispensable

to a research program because research equipment has to be built or existing equipment modified for specific project needs. This generally requires the use of an oxygen cutting torch and arc welder which are not currently available.

The greenhouse facility is adequate for the fruit research needs provided some minor repairs are made, a fan installed, and a few other greenhouse furnishings included. Additional greenhouses may have to be constructed as work load requires. Space should be allotted for them.

If a cold storage unit is not designed into the office/laboratory building, then such a structure will need to be built. A unit being proposed by the fruit research staff includes 2 cold rooms, each with a 25 ton capacity. This would be approximately 1000 bushels per room which is an appropriate capacity for research. One room would be used for apple storage and the other for peach storage. In my files, I have blueprints for a small cold storage unit that was published by the U.S.D.A. I will forward a copy to IBTA in case it can be of use.

### Equipment

I will make only some general comments concerning laboratory and orchard equipment at this point since an equipment request list containing specific items can be found in Appendix A. Most of this equipment is being requested by the San Benito Research Station staff while a few pieces of equipment are some that I feel have been overlooked. The quantity of some of the nursery items would indicate that they intend to run a commercial nursery. I question the advisability of a commercial nursery operation.

There is a considerable amount of equipment that is not being used because of needed repairs. It appears that many pieces of this equipment require minor repairs because their outward appearance give the impression that they have not been used that much. Someone should carefully examine each piece of equipment closely to determine the nature of its problem before a new one is purchased. One such equipment is a Japanese high pressure sprayer. All that appears to be wrong is a leaky packing. If it can be repaired, then the 100 gallon high pressure plot sprayer listed in Appendix A could be eliminated.

### Conclusions

My reaction to what I have seen at the San Benito Research Station and visiting different areas in the Cochabamba Department is that a temperate fruit industry could be established in this area, especially the drupe species. Of the areas visited, the upper Cochabamba valley appears to be the best area to initiate a fruit industry. Its major problem is irrigation water. This could be resolved by drilling wells, building a canal system and pumping from rivers and reservoirs, or both. This valley has the largest amount of irrigatable land, some of the best soil, and perhaps the best microclimate. This area is serviced by an asphalt highway and a railroad. Rough roads would make it hard to transport soft fruit from other areas such as Capinota.

The technical training of the San Benito Research Station fruit researchers needs improving. For the fruit research program to develop

new technology, it will need researchers with proper training to enter the realms of the unknown. Training at the Bachelor of Science level is not sufficient while a Master of Science degree would be marginal and a Ph.D. degree preferred. Training of interested individuals should begin as soon as possible so that they can be employed within the next 3 to 5 years. The Station should be ready for them by then.

An extensive educational program will need to be instituted to train farmers in correct horticulture practices. Visits to the San Benito Research Station should be encouraged by the agricultural extension staff and demonstration orchards established in key locations. This could be a joint effort between research and extension personnel. However, research personnel should not do it on their own. Extension publications on fruit culture are badly needed.

The need for technical assistance was expressed by several small fruit growers and their orchards indicated as much. Peach trees were never pruned causing a loss of bearing surface. Poor insect and disease controls were practiced where attempts were made. Most of the fruit trees were never treated. Most orchards were interplanted with a grain or vegetable crops. This needs to be discouraged because of incompatible cultural practices. Practices favorable for vegetable and grain production hinder fruit tree development and viceversa. This may be the primary cause of crown gall in many orchards.

The orchardists need to be protected against dishonest salesmen who take advantage of their ignorance and sell them faulty plants or chemicals. A plan has been submitted to the Ministry of Agriculture to

establish a regulatory agency to be known by its abbreviated name as CODEFRUT (?). This agency would not only be charged with the responsibility of protecting the orchardist but also provide him with technical assistance and establishing a political climate to encourage fruit production. While approving the goals of CODEFRUT, I disapprove of the groups involved. Private industry and orchardists should be the groups responsible for seeking political solutions to problems and not the governmental agencies. The governmental agencies such as IBTA could provide data to private industry and fruit grower organizations as requested to help them make a political stand. Government regulatory agencies such as plant protection and seed certification should be more active in protecting orchardists against faulty plants and chemicals.

As production increases, better quality fruit will need to be produced to entice more people to eat fruit. Also, the opportunity may arise to export both fresh and processed fruit. This will require the production of fruit varieties known in foreign markets. The seedling varieties presently being grown will have to be replaced by better fruit selections. The researchers need to look abroad for these better selections. Also, as the fruit prices stabilize lower than the current prices, higher yields per ha. will be needed to offset the effect of lower prices. Proper variety selection and management practices will provide these increased yields. As fruit becomes less expensive and home canning material become available, Bolivian housewives will follow the trend throughout the world to do more home canning. The fruit produced should satisfy this demand. For example, white fleshed peaches

are good only for fresh consumption while yellow fleshed varieties cannot only be consumed fresh but also can be processed.

The farmer interested in starting an orchard will need to be provided with long-term financing. Orchard establishment costs are high because plant material and orchard equipment are expensive and it requires 4 to 8 years before returning a profit, depending on species. Without adequate credit, the fruit industry would have a slow start.

Somehow the College of Agriculture at Cochabamba needs to recognize its important role in helping establish a progressive fruit industry. There should be a much closer working relationship between the university faculty and the San Benito Research Station staff. Unless the faculty assumes more of an interest, their students will be inadequately trained to assume any leadership roles in the fruit industry when they graduate.

In summary, my conclusions are that a drupe fruit industry could profitably be initiated in Cochabamba provided it has strong leadership. I am not convinced at this point that apple and pear industries would be as profitable. More research is needed before any conclusions can be drawn. If olives have a good market, an olive industry would do well because the olive tree development is very good in this climate. Grapes can be grown in most of the Cochabamba Department valleys provided varieties are properly matched with the microclimate of the area being planted.

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## APPENDIX A

Equipment List for Temperate Fruit Research at  
the San Benito Research Station

Quantity	Item Description	Remarks
2	15 horsepower rototillers	Want 2 in case one breaks down. Have one now that could be fixed.
1	overhead sprinkler system	For research on bloom delay. Size was not specified. I see no useful purpose for this system.
1	dragline system	I concur. Size was not specified.
1	trickle system	I am neutral on this one. Size was not specified.
1	200-400 gal. airblast sprayer with motor	Needed badly.
1	100 gallon high pressure sprayer on wheels for plot work	Needed if they cannot get the Japanese sprayer to work.
1	100 gallon 3-point hitch weed sprayer for herbicide application	Good for both fruit and cereal research with boom modifications. My suggestion.
1	offset rotary mower for tractor with a 6 to 7 ft. swath	To mow weeds in orchard. Needed.
6	Planet Junior planters, model 25	For grape work.
2	Planet Junior planters	
24	square headed shovels for nursery work	Quantity is questionable. Half that many would be sufficient.
50	hand pruners	Recommend about 1/2 as many.

Quantity	Item Description	Remarks
30	loppers	Recommend about 1/2 as many.
20	pole pruners	Recommend 5 at the most.
50	pruning saws	Recommend about 20.
24	garden trowels	
24	pitch forks	About half as many if they stop inter-cropping.
24	rakes	About half as many.
100	budding knives	25 should be enough for research work.
24	grafting knives	15 should be enough for research work.
3000 m.	deer fence	Current fence around San Benito is in excellent condition.
	canning equipment	Should work with Dillman and/or Vasquez.
2	magness pressure tester for fruit	
2	refractometers	
1	arc welder	For shop.
1	oxygen cutting torch	For shop.
	shop tools	Enough to equip a shop.
1	fruit sizer (Marwald Ltd.)	My suggestion for plot work.
1	electronic statistical calculator	Desk top with paper tape printout.
1	1/2 bushel picking bucket	Demonstrator so they can make more.
5 lb.	budding rubber bands	
2	refrigerators	One for seed vernilization at 43°F and the other for storage.

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Quantity	Item Description	Remarks
1	water distillation unit	My suggestion.
500 ft	fine nylon mesh screen 8 to 10 ft. wide	Mesh should exclude bees.
1	photographic camera	Reflex lens for research pictures.
	tensiometers or gypsum moisture blocks	Enough to adequately monitor irrigation.
3	spray masks with spare cartridges	Badly needed.