REPORT

on the

RESEARCH PROGRAM DESIGN

for the

HIGHLANDS AGRICULTURAL RESEARCH STATION

October 3, 1974

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REPORT OF THE ADVISORY TEAM ON THE HIGHLANDS AGRICULTURAL RESEARCH STATION

I. Assignment to the Team

The assignment given to the team can be stated in a Mission-Goals-Objectives framework. The mission defines the scope of the authorization. The goals define the desired end results to be achieved. The objectives identify specific steps to be taken to move toward the goals within the mission. This mission-goals objectives statement is a rephrasing of the "scope of work" contained in the individual contract agreements with the team members.

A. Mission:

To assist the Royal Thai Government (RTG) in the design of a long-term research program including permanent physical facilities, necessary staff, research equipment and facilities necessary for investigation of agricultural development above 1,000 meters in North Thailand.

B. Goals:

To assist the RTG in planning a research program that will result in developing different highland farming enterprises and farming systems that are agronomically, culturally, economically and ecologically feasible as a means to

1. replace opium as a cash crop.

2. protect the watershed by reducing slash-and-burn agriculture.

3. improve the level of living of hilltribe people.

C. Objectives:

1. To recommend crops or classes of crops to be researched initially and specialized fields of research to be covered.

2. To recommend the number and qualifications of Thai staff required to do the research by specific technical field.

3. To recommend the number and qualifications of cooperating American staff required on (a) full-time, and (b) short-term assignment over a five-year period.

4. To recommend the necessary configuration of physical facilities - land and buildings - required for the research program and for accommodating Thai and American research staff over a five-year period, and an annual program for reaching this target.

5. To recommend the equipment and supplies necessary to support the research program for five years with annual time-phasing.

6. To recommend the "technological delivery system" which will convey the findings of the research station to the highland farmers.

7. To comment on the Thai administration and support requirements for making the highland research station an effective and productive institution which is integrated with other research and development activity in the highlands.

8. To comment on other aspects of developing a highland research capability in Thailand as requested by RTG, USOM, or as identified by the team as important issues.

II. Long Term Research Program Design

To accomplish the three mutually consistent goals of

1. replacing opium as a cash crop

2. terminating slash-and-burn agriculture, and

3. improving the level of living of the hilltribe people, the Royal Thai Government, with the support from the United States and the United Nations has chosen to initiate an agricultural research program in the highlands of North Thailand.

A. Constraints Upon the Long Term Research Program

The range of potential crops that can be suggested for inclusion in the research program is restricted by three major constraints:

1. the ecological setting of the highlands

2. the economic setting of the highlands

3. the socio-cultural setting of the highlands people

Important questions to be raised in regard to these constraints are as follows:

1. The Ecological Setting:

   a. Given the latitude, the elevation, the nature of the terrain, the soil types, the rainfall, temperature, and humidity patterns, what crops will grow in the highlands?

   b. What can be done through selection and breeding programs to adapt crops to the ecological setting of the highlands?

   c. What cultural practices, including maintenance of soil fertility, plant spacing, supplementary irrigation, control of weeds, insects and diseases, etc., can be developed to increase the productivity of crop plants in the highlands?

2. The Economic Setting

   a. What is the availability and cost of providing purchased inputs, such as credit, fertilizers,

pesticides, tools and equipment, to farmers in the highlands?

b. What prices or potential prices can highland farmers expect for their crops and how sensitive are these prices to increases in output?

c. How important is risk and uncertainty in influencing decisions to change agricultural practices and enterprises?

d. What are the prospects for developing communications, transportation, processing and marketing systems to support agriculture in the highlands?

3. The Socio-cultural Setting

a. How amenable are highland farmers to changing from traditional to new technology?

b. How sophisticated and complex an agricultural technology can highlands farmers absorb and use?

c. How amenable are highlands farmers to cooperative and group efforts to improve their well-being?

B. Scope and Nature of Research to Accomplish the Goals

1. Research on the Maintenance of Soil Fertility

slash-and-burn agriculture would not exist if the fertility of the soils in the highlands were easy to maintain. In view of (a) the general scarcity and high price of chemical fertilizers on a worldwide basis, and particularly in the remote highlands of North Thailand, and (b) the limited availability or non-existence of transportation facilities and services in the highlands for moving fertilizers to farmers, some alternative means of maintaining soil fertility need to be explored. Use of legumes and grasses in rotations, as cover crops, as green manure crops and for composting needs to be explored.

2. Soil and Water Management Research

With much of the highlands already denuded of forests, there is urgent need for systems of soil and water management in these denuded areas to reduce soil erosion, silting and flooding in the lowlands. If

part of the already cleared lands are to be utilized in more permanent types of agriculture, it is especially important that attention be given to protecting these lands from erosion and rapid runoff.

3. Selection and Breeding of Crop Plants for the Highlands

Some crop plants have received sufficient testing to give strong indication of adaptability to the highlands. Other crop plants have received limited testing and some have received no testing at all. Breeding to enhance adaptability specifically to the highlands is relatively unexplored. Selection and breeding for high yields of quality products is considered a key element in the total research program for the highlands. To meet the threefold objectives of (a) replacing opium as a cash crop, (b) protecting watershed by reducing slash-and-burn agriculture, and (c) improving the level of living of hilltribe people, three primary classifications of crops to be researched can be specified:

a. Cash Crops

Clearly cash crops as a replacement for opium should receive first priority in the context of the existing situation. Based on limited observations and visits by team members with knowledgeable people familiar with the situation in the highlands, the crops that should receive consideration include coffee, tobacco, beans, potatoes, peaches, tea, vegetable and floral seeds, apples and pears. More careful consideration over a longer period of time by researchers may modify this list by deletions or additions.

b. Protecting Watersheds by Reducing Slash-and-burn Agriculture

If slash-and-burn agriculture is to be reduced and agriculture is to be more permanently located it will be necessary to give attention to soil building and erosion control crops. These crops should be included in rotations, used as cover crops, used as green manure crops and used as composting material. Generally, we are speaking of legumes and grasses. The bean crops, listed above as cash crops, are suggested again

here. In addition, such crops as tropical Kudzu, clovers, Lespedeza and Desmodiums should be considered. Grasses might be introduced which would be superior to Imperata grass both for erosion control and for grazing. Pangola grass might be considered.

c. Subsistence Crops

One of the reasons the hilltribe people grow opium is to obtain cash in order to buy rice and other commodities for subsistence. Furthermore, the level of subsistence and nutritional status of the hilltribe people appears to be far from satisfactory. Research on subsistence crops to increase productivity and to reduce the risk of crop failure should be included in the research program. These crops include rice (adapted to highlands conditions), corn and sorghum (primarily as livestock feed but partially for human consumption), sweet potatoes, Chinese cabbage, onions and peppers. Here again, the researchers employed on the highlands station may find, after more careful consideration, that this list needs to be modified by additions or deletions. For a more extensive list of crops that might be considered, see Appendix I.

4. Pest Control

Some crop plants are known to be subject to losses due to diseases and insects in the highlands. The extent to which other crop plants may be subject to losses due to diseases and insects is not known. Weed and brush control may also become a serious problem. Two approaches to pest control can be suggested: (1) chemical control and (2) biological control, including selection and breeding for resistance to diseases and insects. As in the case of chemical fertilizers, the difficulty of moving chemical pesticides into highland farms suggests that emphasis be placed on biological control. Furthermore, the sophisticated knowledge needed for chemical control and the impact of chemicals on the environment may preclude extensive use of chemical methods in the highlands.

5. Post-harvest Handling and Processing

Much is known about post-harvest handling and processing of crop plant materials but its applicability to the highlands is not known. Lack of adequate transportation, processing and cold storage facilities in the highlands would put significant limitations on bulky and/or perishable products on most highland farms. As crop potentials and priorities begin to emerge, attention needs to be given to research in this category.

6. Economics of Production and Marketing

Even though it may be technically possible to grow cash crops that yield well in the highlands, there is no assurance that those crops will be economically feasible. Three kinds of economic research need to accompany the production research:

a. Production economics, including farm management systems,

b. Marketing, including economics of transportation, storage and processing, and

c. Price analysis, including the response of specific commodity prices to changes in outputs.

7. Other Research to be Incorporated in the Long Term Program

Numerous additional kinds of information on specific cultural practices need to be developed concurrently with previously listed categories of research. Little verifiable information is known about crop response to specific cultural practices in the highlands. Included would be

a. Optimum date of planting

b. Optimum rate of seeding or planting (plant spacing)

c. Optimum seedbed preparation

d. Optimum rate and timing of supplemental irrigation

e. Propagation, pruning and thinning practices

C. Plant Introduction System

Man has moved plants about with him and has introduced them into new areas for thousands of years. With the migration of man and the development of new agricultural areas, various commodities are grown in different countries depending upon their adaptability. Although this type of plant migration was extremely effective in the initial establishment of agriculture in various parts of the world, at the same time a considerable amount of this material containing valuable genetic characteristics for use by plant breeders, has been lost because of the lack of a systematic system of cataloging, maintaining and keeping track of the material.

The term plant introduction should mean that there is a national organization which systematically introduces plant germ plasm into the country. It then becomes essential to increase the material, maintain all germ plasm lines, evaluate them, publish inventories listing material available, and then distribute this germ plasm material to plant researchers where needed.

In the more advanced countries changes in agricultural production from a simple subsistence type of agriculture to one that produces a diversity of products for both local and export consumption, not only for food but also for oils, for medicinal properties such as those containing anti-cancer agents, for rapidly growing plants which can provide raw materials for plastics. Many other uses could be cited.

Prior to introducing plants into a country there should be some system of plant exploration and communication. This system may range from a survey of little known regions of the world, including Vavilov's conception (1962) of geographic centers of genetic diversity, to communicating with countries such as the U.S.A. which has a tremendous array of genetic materials that may be obtained through their plant introduction system on both the Federal and State levels. Other countries have similar facilities. The centers of origin of major crops and potentially new crops still have a tremendous reservoir of germ plasm of potential value. However the local and primitive types are disappearing rapidly as modern agricultural methods of clean cultivation and the extensive use of improved varieties supplant older agricultural methods. Crop breeding is

often dependent upon wild stocks and therefore collection and preservation of this germ plasm for the future benefit of Thailand agriculture may be required. Collections of this kind of germ plasm should be able to provide plant scientists with some or all of the following materials:

1. Cultivars

   a. advanced cultivars

   b. primitive cultivars

   c. strains with specific characteristics, such as resistance to certain insects, diseases, etc., or have morphological characteristics that may be desirable for a certain area.

2. Wild Progenitors of Crops

3. Wild Species of Potential Use as New Crops

The team believes that the establishment of a plant introduction system for highlands agriculture will be extremely helpful in developing a progressive agricultural program for that area. Many new plant materials have already been introduced into the area, but unless a central station, charged with the responsibility of collecting, keeping records, maintaining, increasing and distributing, plant materials is established, much of this valuable germ plasm will eventually be lost for use by plant breeders and other scientists. It is anticipated that the need for the program will grow when additional germ plasm is needed by the plant breeders from explorations and a national plant introduction system is inaugurated for Thailand.

Although not charged for making further recommendations, the team would like to suggest that if it becomes feasible the Department of Agricultural Technology give consideration to the need for developing a national network system for handling plant introductions for the entire country. It is obvious that a substantial amount of valuable germ plasm already introduced, and which will be introduced in the future, will be lost unless such a system is developed. Obviously, the Highlands station could not handle the job alone.

A very brief description of such a system might be as follows:

1. Establish a central office in the Department of Agricultural Technology.

2. Establish two or three additional plant introduction stations in strategic locations throughout the country. These could be developed on the same site as existing research stations. They would be operated in the same manner as that described for the Highlands station. These should be established where they can best perform under their particular climatic conditions and major cropping patterns.

   The central office would have the responsibility of receiving all plant introductions coming into the country, assigning accession numbers, identifying material and collecting other pertinent information. It would also have the responsibility of assigning the introductions to the station best suited to handle the particular material received. After multiplication of the material it should be interchangeable from one station to another and accessible to any researcher regardless of his location.

   The team realizes that an intensive detailed study would be required before any such program could be considered.

D. Technology Delivery System

It is intended that the Highland Agriculture Research Station will produce research results that will be used by highland farmers. A firm linkage between the Station and those who advise farmers needs to be established if the resulting packages of technology are to be communicated to the farmers.

The Highland Station, itself, should not be charged with the full responsibility of delivering research results directly to all the farmers. To do so would result in needless duplication since several other agencies already have "extension" workers in direct contact with farmers in the highlands. These agencies include the Department of Public Welfare, the United Nations Program for Drug Abuse Control, the King's Hilltribe Program, the Border Police Patrol and others.

Rather, the Highland Station should have a built-in capability of putting together the knowledge gained from research into "packages" and the capability of communicating those packages to extension workers. Methods of communicating information include intensive training sessions, demonstrations, printed materials, radio programs, etc.

In addition, there should be feed-back mechanisms through which information from extension workers and farmers would flow back to researchers. If there are problems related to the applicability of effectiveness of the packages of technology or the individual practices included in the packages, these should come to the attention of the researchers. Any other pertinent observation or problems pertaining to agricultural production in the highlands should become a part of the backlog of information available to researchers.

E. Site Selection

The long-range program design must give consideration to the site at which the facility will be located. The site will significantly influence the program design and the scope and usefulness of the research results to the geographical area and the people it is intended to serve.

An earlier team, headed by Dr. R.H. Brannon (1972) screened several possible sites for the establishment of a Highland Agricultural Research Center in Northern Thailand. The team proposed that the research center should be located at the lower section of Doi Inthanon, just below the Siriphom Falls. The site, with an area of approximately 1,640 rai, was believed representative of the opium growing area of Northern Thailand and other hilltribe farms, with an elevation used for opium growing which is 900 - 1,500 m. (Brannon, et.al., 1972[1/]) or 1,000 - 1,600 m. (Williams, 1974[2/]). While opium poppy will also grow above 1,600 m. there is actually very little usable land in Thailand which is above 1,600 m. elevation (Williams, 1974).

1/ Brannon, R.H., et.al., 1972. A pre-feasibility study of a Highland Agricultural Research Station for Northern Thailand.

2/ Williams, L., 1974. Thailand current and potential crops - An evaluation of germ plasm requirements. AID, Washington, D.C.

The proposed site, however, has been earmarked for a major tourism and recreation development and the area above Siriphom Falls has been suggested as an alternate site for the highland research center.

The team, after two trips, the first by foot on September 5, 1974, starting from the Meo village below the falls and the second on September 18, 1974, by helicopter, have serious reservations about that site for the following reasons:

1. The site is not typical of the areas of Northern Thailand used for opium production and for hilltribe farming.

   a. The site, ranging from an elevation of 1,500 m. to 1,900 m. is higher than most of the opium growing areas in Northern Thailand.

   b. The site does not have sufficient level land (under 20% slope) for research plots, for administration and research facilities and also for residential sites for research personnel.

   c. The site, being too high, has a tendency to be under cloud cover more than typical hilltribe farms and is also subject to occasional strong winds (Oughton*).

   d. Although the team could not confirm this, it is believed that only granitic soils are represented at this site and that no limestone soils are present.

2. The proposed site is not readily accessible to sources of supplies and services needed for efficient operation of a research station. In addition, this location will pose exceptional hardship for both Thai and U.S. personnel with families and children unless facilities such as a school, hospital and community facilities are established. Due to its isolation, it probably will be difficult to attract and hold good U.S. and Thai researchers and their families at this location. A good, productive research program requires continuity. Rapid turnover, particularly of Thai research personnel, will not enhance a productive research program.

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* Oughton, G. Technical Advisor, Tribal Research Center, Chiang Mai, Personal communication.

3. The cost of developing the site for the research program, for housing and for community facilities will be high. The team recommends that in order to minimize the cost of developing community facilities, further consideration should be given to selecting a site which would be less costly to develop and operate, which is more accessible and relatively close to existing communities with facilities that the research personnel and families can use.

   The following criteria are offered in the selection of an alternate site for the Highland Agricultural Research Station:

   a. Elevation of the site should be within 1,000 to 1,300 m. with access to slightly lower (800 m.) and higher areas (1,500 - 1,600 m.) to encompass the elevation ranges of opium growing areas.

   b. Soil type(s) should be representative of the opium growing areas and hilltribe farms, which would include both granitic and limestone areas.

   c. Site should be in close proximity to existing hilltribe settlements and farms.

   d. Site should also be reasonably close to a lowland city or community with existing facilities for personnel and families.

   e. Site should be readily accessible or close to existing transportation or road system.

   f. Site should include at least 200 acres (500 rai) of land with less than 20% slope and with available water for irrigation.

   g. Climatic conditions should be typical of hilltribe farms and opium growing areas of Northern Thailand. The site should not be subject to strong winds, prolonged periods of cloud cover, extremes of temperature, etc., which are not typical of the hilltribe farms.

   The team believes that the Highland Agricultural Research Station has the potential of developing into a larger, possibly an international research center, so additional area for expansion should be readily available. The proposed site at Doi

Inthanon, being inside the National Park area, might not have additional area available for expansion.

The team strongly recommends that further consideration be given to a site that would be an alternate to that proposed above the Siriphom Falls at Doi Inthanon.

III. Five Year Research Plan

A. Identification of Crops and Classes of Crops for Priority Consideration

1. Major Crops

The team subscribes to the philosophy that it is better to do a good job with a few crops than a poor job with a large number of crops. It therefore recommends that initial research work of the highland research station be concentrated on the following crops and classes of crops.

a. Tree Crops - Coffee, Tea, Peaches, Pears and Apples. Tree crops believed best for the highlands of Northern Thailand are coffee, tea, peach, pear and apple. Both coffee and tea produced in the highlands at elevations of 1,000 m. to 1,500 m. or even to 1,800 m. are milder in flavor and superior in quality to those grown at lower elevations and in the lowlands. Highland grown coffee plants are also more vigorous and capable of resisting some serious diseases such as coffee rust, Hemeleia vastatrix, a disease which often prohibits the growth of plants at low elevations.

Only the highlands have temperatures low enough to provide the necessary chill required in the production of deciduous fruits such as peach, pear and apple. These fruits command high prices in tropical countries because of the high cost of transporting them from temperate zone countries. Because of the long growing period in Thailand, it may be possible to produce two crops of fruit a year through the various processes or methods of flower induction or forcing, such as cultural methods or chemical or hormonal sprays.

These tree crops have several advantages over other crops when grown in the highlands, among them are (a) favorable climatic conditions for these crops in the highlands, (b) availability of land and labor for the production of these crops in the highlands. (c) A greater comparative advantage for these crops in the highlands. In essence, although lychee, longan, mango, avocado and other tropical fruits can be grown in the highlands, the highlands will not be able to compete with the extensive production in the lowlands.

b. Vegetables, Ornamental Crops, Legumes, Cereals and Tobacco

There is substantial production of various vegetables in Thailand. For example, about 300,000 hectares (1,875,000 rais) were devoted to approximately 30 different kinds of vegetables in 1963 and over 649,000 hectares (4,061,250 rais) in 1967. Vegetable production was mainly for the local market, especially for Bangkok, where the demand for fresh vegetables is great. A limited amount of vegetables is processed or canned since the canning industry is just recently being developed.

Production of fresh vegetables in the highlands by the hilltribes would be not only for the local market but also for their own use since vegetables are important in improving their daily diet which consists mainly of rice.

Another opportunity for the highlands is the production of certain vegetable and floral seeds for local and international markets. Favorable climatic conditions in the highlands along with a relatively high value per unit of volume presents highland farmers with an advantage over the lowland farmers in this venture.

Production of corn, upland and paddy rice and other short maturing crops for subsistence will also serve as insurance against the inability of hilltribe people to purchase subsistence food from the sale of cash crops. Together with some leguminous crops, such as soybeans, mung beans or string beans, whether for green pods or seeds, and some popular ornamental crops, vegetables can be utilized in intensive crop rotation and multiple cropping schemes. This diversification in the utilization of highlands for agriculture will provide the hilltribes a better balanced food supply as well as a steady source of cash crops for the market.

The use of multiple cropping schemes employing leguminous crops, corn, upland rice, vegetables and ornamental plants will also serve as an excellent means of maintaining and/or regenerating soil fertility, thereby inducing more stable and permanent types of agricultural operations.

There is an important and already flourishing market for ornamentals, flowers, and foliages, both in Thailand and abroad. Introduction of other ornamental crops such as anthurium and better selections or varieties of existing floral crops might offer the opportunity to develop additional cash income.

Development of vegetables, ornamental crops, legumes and cereals is important in the development of a stable highlands agriculture. Subsistence and cash income is necessary during the relatively long period before tree crops can attain a profitable level of production. Coffee, for instance, takes about three to five years before full production is attained.

The short term or early maturing crops can also be interplanted in the tree orchards, serving as ground covers to minimize weed growth, soil erosion and run-off as well as providing partial shade and protection for the young tree seedlings, especially coffee. They also will serve as materials for maintaining or regenerating soil fertility.

2. Miscellaneous Crops

Preliminary screening or observation works on additional crops for adaptability to highland environment is recommended. The following crops are recommended or suggested for this category of research work:

a. Fruit Crops - avocado, mango, lychee, longan, plum, banana, guava, and other native fruits which are available.

b. Nut Crops - macadamia, chestnut

c. Medicinal, Spice and Oil Crops - lemon grass, pepper, tangkue

d. Root Crops - taro, yams, cassava, potato, sweet potato

e. Vegetables - native vegetables

f. Ornamental Crops - rose, carnation, orchid, and other native ornamental plants.

g. Pasture - legumes and grasses for range and forage for livestock.

Other crops not listed may be introduced for preliminary observations. An intensive research program may be implemented for those crops which show excellent potentials for production in the highlands. The extent of research and development for such crops will depend upon availability of funds and staff to conduct the research work and also on the economic potential of the crop for the highland farmers.

The above listing does not close the door to other crops which could be tried and investigated at the highland research station, whether for the highlands of Northern Thailand or for other agencies or countries should the research station expand to become an international highlands research station. This possibility can happen if additional funding and interest is given to the research station by other countries, foundations or agencies. This option of expanding the research station into an international research station with an international scope is left for the Director-General of the Department of Agriculture and the Royal Thai Government to decide.

B. Nature of the Research to be Undertaken

1. Major Crops

The team believes that the program of research for those crops selected for concentrated research should encompass a wide range of activity so as to lead to a first approximation of a total management system for each of the crops. Prior to initiating any research on those crops, the project leaders should make a thorough search for the "state of knowledge" about the crop and its adaptability to the highlands region. Identification of "bottlenecks" to successful production in the highlands region as a basis for initiating new research activity should be mandatory. There should then be a team approach of as many disciplines and scientific specializations as possible to put together "packages of technology" that can be transmitted to highlands farmers. The team offers the following suggestions by crop and crop classes subject to further review and confirmation by the researchers assigned to the highlands, as a basis for the five year research plan.

a. Research on Tree Crops:

1) Preparing to Initiate Research
The first step is to plan, layout and construct propagation units that will be satisfactory for multiplying horticultural tree crops. Local materials should be used such as bamboos, wooden posts and soils and organic materials for preparing soil mixes for potting. Washed river sand may also be used in preparing planting media. A plant shed is needed for planting seeds, handling pots and flats, to provide space for bins of potting soils, sand and peat moss and to provide a protected area for mixing potting media, and for seed germination, protected from rain and strong winds. Storage space for small tools and for chemicals such as fertilizers and spray materials should be provided.

Propagation chambers with and without intermittent mists, constructed of locally available materials, should be constructed for rooting cuttings of various trees and shrubs.

Slat or lath houses are needed with varying degrees of shading for hardening rooted cuttings and seedlings. A greenhouse of either glass or plastic material is needed having a simple system of heating to provide warm conditions for out-of-season germination of seed and having cooling rooms for stratifying fruit tree seeds to break dormancy.

A site with deep, rich soils should be selected nearby the nursery to be used as nursery seedbeds and nursery rows for propagating rootstocks required in grafting collections of varieties of tree fruits. Simultaneously, suitable experimental sites for observational and variety trials should be selected and laid out for the grafted and rooted materials as they become available.

2) Initiating Tree Crops Research
After the propagating nursery structures are constructed and rootstocks are available for graftage then:

a) A nationwide collection program should be planned and implemented in cooperation with the Plant Introduction Unit of the Station. Local varieties of arabica coffee, tea, peaches, pears, and apples should be collected as the situation permits. Scions and cuttings should be propagated at the research station. The Horticulturist and his staff should participate in the survey and collection to become thoroughly familiar with the cultural practices of the area and the problems of production and marketing.

b) The collections should be screened and selected varieties used in future observation and variety trials as the research program develops.

c) Introductions of foreign varieties through the station's Plant Introduction Unit should be initiated. These selections will eventually be tested in observational and varietal trials. The Horticulturist and staff with his American counterpart will, then, be ready to proceed with the research plan to improve the production and quality of the selected horticultural crops. The best sites should be selected for each tree crop to be researched keeping in mind slope, soil type, depth and pH, and the presence of shade and air circulation.

After the planting and screening of the local selections and the introductions are completed then, the selected varieties should be further tested in varying environments available to test their performance using such variables as elevation, percent shade, disease resistance, fertilization, rootstocks, and methods of planting.

Fruit, coffee and tea varieties to be retained in the germ plasm pool should be planted to develop parent budwood orchards to serve as future sources of disease free propagation materials. These plantings must be isolated from other trees by appropriate borders to be determined by the researchers. A regular spray and disease control program must be rigidly adhered to in order to maintain the

fruit tree species collection free of diseases; preferably, each fruit tree species would be isolated, separately.

At least two sets of record books should be maintained, one to be retained in the office, the other to be used in the field in collecting plot data. Notes to be taken concerning growth response, morphological data would be the responsibility of the tree crop researcher.

The specific research projects for the various tree crops will be more or less similar.

The staff, required for the conduct of horticultural tree crop research, besides the Horticulturist should include one Grade 3 officer (bachelor science degree) for coffee and tea, one for peaches, apples and pears and one for the secondary crops such as lychees, longan, macadamia, chestnuts, medicinals or drugs, essential oils, spices and herbs.

3) Suggested experiments on coffee:

a) Variety trials for arabica coffee to compare introduced with local selections as to size of berry, resistance to diseases, size of plant, type of growth, production and quality. In the beginning, large numbers of varieties should be tested with the purpose of selecting a few superior disease resistant types to be used for rapid multiplication for use in micro-climate trials and then to demonstration plantings.

b) Effects of varying degrees of shading on growth and yields of arabica coffee. This trial is important not only in determining the effect of varying degrees of shading on production but also in determining the effect of shade trees on soil erosion and the vigor of the coffee plants. A number of tree species, (preferably leguminous) and cash crops of banana, pigeon pea,

cassava, etc., which provide moderate shade and minimum root competition should be evaluated. The cash crops would be used for temporary shade.

c) Effect of different systems of pruning upon performance of arabica coffee. Some systems of pruning are planned in such a way that the unpruned plants provide sufficient shade for the pruned plants, thus eliminating the need for shade trees. Various systems should be compared. The systems should be simple and easily understood so the hilltribe people can adopt the necessary management techniques.

d) Effect of different rates and time of application of commercial fertilizer and animal and green manures upon yields, and disease resistance of coffee. As previously mentioned animal manures and composts should be emphasized if the farmer can be interested in adopting compost practices.

e) Methods of intercropping, spacing, planting, terracing on control of erosion and maintenance of soil productivity.

4. Suggested experiments on tea:

Tea, like coffee, produces its highest quality leaf when grown under the cool, moist mountainous environments 1,000 to 1,200 m. elevation having a well distributed rainfall. Many collections should be made of local indigenous varieties growing in the above elevation in Thailand as well as the Indian teas, Ceylon teas, China teas and the Assam hybrids or Darjeeling teas of Nepal. Tea thrives in deep, well drained soils of moderate acidity such as the soils that exist in the highlands.

Suggested projects would be:

a) Variety trials using both local and foreign varieties.

b) Effect of interplanting leguminous green manure crops, vegetable legumes and trees for (lopping) upon growth, production, quality of tea and control of erosion.

c) Effect of rate and time of application of fertilizer upon yield and quality of tea.

d) Experimental trials of crossing Abyssinian tea and others.

e) Trials in methods of processing tea using simple, locally available hand equipment.

5. Suggested research on peaches, apples and pears.

The local peach variety seems to be exceptionally well adapted to the Thai highlands and because of this, use should be made of the local peach as a rootstock for budding improved local selections as well as for foreign introductions. Pears and apples also appear to be quite productive in some areas but much research remains to be done to work out improved cultural practices and in finding and developing improved varieties. These fruits command very high prices in the local market. Improved productivity and quality of fruit would be of value to the economy of the hilltribes.

a) Peaches

(1) Varietal trials to include the better local selections and as many low-chill varieties from Florida, California and other highland research stations.

(2) Rootstock trials - seed of other low-chill varieties which may produce more vigorous seedlings with high seed germination would be useful.

(3) Studies on flowering habits, using cultural and chemical methods to induce flower initiation and out of season fruiting; the effect of fruit thinning and time of harvest on quality and size of fruit; and insects for pollination.

(4) Pruning and training trials to determine the amount of wood to remove, the tree scaffold systems, the size of tree best suited for the hill areas.

(5) Identification and control of diseases, viruses and insects of peaches.

(6) Time and methods of budding, grafting for successful take.

(7) Methods in harvesting, storing, packing and processing of peaches to conserve quality and to develop alternative uses for peaches.

b) Apples

Apples are not as well adapted to the highlands as are peaches. Present temperate zone apple varieties were developed for environments much different from those existing in the highlands. Many diseases and unusual flower behavior are to be expected. Therefore, as many low-chill varieties as possible should be tested. Intensive research is needed on methods and season for inducing off-season flowering for producing two crops annually, such as withholding water, defoliation and the use of hormones. The effect of cultural practices, pruning, fruit thinning and hormones on size and quality of fruit as well as on the size of fruit tree best adapted to hill environment is needed. Some breeding work eventually will be required to develop more suitable varieties of apples and peaches for the highlands than the presently available temperate

varieties. Some experimental breeding already is underway in other countries. A small scale breeding scheme with local varieties as one of the parents using vigorous introductions to broaden the germ plasm bank might be initiated.

It must be remembered, the micro-climate exists due to differences in elevations, winds and humidity. Some of the temperate fruits can be expected to perform better in some of these micro-climates than in others. Therefore, it will be necessary to screen these sites (slope direction, winds, air drainage, etc.) thoroughly in siting the tree test plots.

(1) Variety trials: To observe and compare vigor, time of fruiting, spur formation, resistance to fire, blight, fruit size, fruit quality, bearing habits and storage life of fruit.

(2) Pruning and training trials to determine suitable scaffold systems, tree size, effect of branch spreading, on spur formation and production.

(3) Effect of cultural practices such as manuring time and amount of irrigation.

(4) Chemical treatments to prevent premature fruit drop and improve fruit quality.

(5) Effect of tree spacing, inter-cropping, cover cropping and terracing on soil erosion and maintenance of soil fertility.

(6) Other trials such as time and method of grafting on percentage take, effect of season of transplanting on subsequent growth, and use of clonal rootstocks may be used on a very limited scale as some are known to

be susceptible to disease and to have brittle, weak roots, particularly EMIX. Dwarfing may be obtained through pruning standard size trees. Pruning naturally decreases the root systems which causes dwarfing.

(7) Rootstock trials to compare the local vigorous crab apple to introduced standard size and dwarfing root stocks as to compatibility, growth, vigor, production and the effect of interstocks on compatibility, i.e., crab root, the East Malling or standard interstock then grafted to the scion variety. If at all possible, the local crab apple should be used because of its exceptional vigor and adaptability.

(8) Effect of storage conditions upon flavor and keeping qualities.

(9) Breeding work: In time, it probably will be desirable to breed for the development of better adapted fruits for the highlands. This should be on a small scale in the beginning. Frequent contacts with other Highland Research stations are necessary to prevent duplication of efforts and to take advantage of up-to-date research knowledge.

6. Phasing of Research on Tree Crops

The first three years would be required for making fruit tree and coffee collections, introductions and multiplications for planning and establishing research studies and for building up libraries and staff. Although, research data would not be available within three years, some useful information about existing varieties and approved cultural practices could be collected, evaluated and passed on to farmers during this period. Already much as been learned by observational trials and research previously conducted in Thailand during the past decade.

During the third to fifth or sixth years, investigations in coffee and tea, such as variety, cultural practices, manuring and other agronomic trials would get underway. Similar trials on fruit tree crops would begin about the fifth year due to required rootstock and grafting procedures which require longer periods of time.

Staff training during the first three years would be confined to that provided on the job in the conduct of field research. At about the third year, additional training could be provided, if deemed desirable, by short-time consultants (30-60 day periods) and through attendance at seminars, short courses and conferences. At the end of the third year the better lower grade officers could be selected and provisions made for Master of Science or Ph.D. training.

Some good research data useful to growers could be expected by the seventh year, particularly on coffee and tea, since these crops are grown from seedlings and begin bearing during the third or fourth years.

Tree crop breeding might be initiated about the eighth year. By that time considerable knowledge will have been accumulated about existing fruit varieties and, if none are found suitable which, very likely will be the situation, breeding programs may need to be implemented to develop adaptable varieties of tree fruits.

Time Phasing of Research Program Diagramatically Might Be:

Year	1	2	3	4	5	6	7	8	9	10
1. Station Development	x	x	x							
2. Peach Research										
a. Rootstocks		x	x	x	x					
b. Collections			x	x	x					
Introductions			x	x	x					
c. Varietal trials					x	x	x			
d. Pruning-Training					x	x	x	x		
e. Seeds-Rootstocks			x	x	x					
f. Effect of cultural practices. Chemicals on flower initiation					x	x	x	x		
g. Virus-diseases					x	x	x	x		
h. Harvesting storage processing					x	x	x	x		
i. Isolated virus free tree fruit collections								x	x	x
3. Coffee Arabica										
a. Introduction		x	x	x	x					
b. Varietal trials			x	x	x	x	x	x		
c. Effect of Cultural Practices			x	x	x	x	x	x		
d. Erosion Control			x	x	x	x	x	x		
e. Establishing virus/ disease free collections						x	x	x		

Year	1	2	3	4	5	6	7	8	9	10
4. Tea -(Camellia bohea) China -Camellia Viridis India -Assam hybrids = (Assam x China)										
a. Variety Trials			x	x	x	x	x			
b. Erosion Control Trials			x	x	x	x	x			
c. Manuring			x	x	x	x	x			
d. Agronomic trials Spacing, pruning, etc.			x	x	x	x	x			
e: Processing				x	x	x	x			
5. Apple (Malus sylvestris)										
a. Collections		x	x	x						
b. Variety Trials			x	x	x	x	x			
c. Erosion Control			x	x	x	x	x			
d. Growth-flower initiation studies (two crops per year)				x	x	x	x			
e: Rootstocks trials				x	x	x	x	x		
f. Breeding work							x	x		
g. Processing, packing marketing storage				x	x	x	x	x		
6. Pear										
Same as for above fruits except:										
a. Rootstock and inner stock trials.				x	x	x	x	x		

b. Research on Vegetable and Ornamental Crops, Grasses, Legumes and Field Crops:

1. Variety Introduction and Trials

Introduction and evaluation of local and introduced materials at the highlands research station. Evaluation and observation should include, but not be limited to, selection for high yields, insect and disease resistance, good phenotypic attributes, quality and other important characteristics.

2. Multiple Cropping and Intercropping

Investigations should be conducted on various combinations of legumes and non-leguminous crops in multiple cropping and/or intercropping schemes with the aim of maximizing yields per unit area and per cropping period or year. Schemes similar to those developed in Taiwan and at the International Rice Research Institute, Philippines, by Dr. R. Bradfield, should be tried together with the various hill and furrow conformations used.

3. Cover Cropping and Green Manuring

Investigations on the use of various legumes such as tropical kudzu, desmodium, clovers, lespedeza, centrosema or other available species for cover crops as well as for green manuring and composting should be carried on. The optimum cutting time or stage for green manuring, comparative efficiency in regeneration of soil fertility and prevention of weed infestation and soil erosion should be noted.

4. Fertilizer Experiments

The use of commercial fertilizers is extremely limited, not only due to scarcity of supply and high cost for the whole country but also due to difficulty of bringing fertilizer materials up to the highland farms. However, to achieve improvement in the living standards of the hilltribes through crop production, limited quantities of some form of commercial fertilizer

are likely to be essential in order to maintain a high level of productivity over the long term on the same fields. The limited use of commercial fertilizers should be investigated especially in the production of high value crops such as onion seeds, for example. The use of compost and various locally available organic materials should also be included in this study.

5. Plant Population and Time of Planting

The best time for planting and optimum plant density or rate of seeding under various conditions should be thoroughly investigated together with alternative methods of nursery or seedling production. Direct seeding may be compared with transplanting. As noted below, special attention must be given to the various pests and diseases that attack young seedlings in the field. Various potting media and soil sterilization methods should also be studied.

6. Irrigation and Soil and Water Management

The rate and frequency of supplemental irrigation and their effects of crop growth and yield should be studied. Effects of irrigation on soil fertility and nutrient movement and dissipation should be included to gain better understanding of soil fertility depletion and regeneration under various irrigation practices or management. Particular attention needs to be given to water management in the highlands to minimize erosion and flooding. When soil is disturbed by cultivation, terracing, irrigation ditches, etc., it is subject to heavy runoff and severe erosion. Attention needs to be given to proper design of fields, terraces, dikes, etc. Simple methods of meeting the design requirements will be needed in the absence of sophisticated instruments and equipment in the highlands.

7. Weed Control

Various cultural and biological methods of controlling weeds should be investigated such as cultivation, ground cover, mulching, etc.

The effects of these methods on production and soil fertility, soil erosion and runoff should be studied. When available and feasible, use of chemicals for weed control may also be included.

8. Disease and Pest Control

The occurrence of incidence of various diseases and pests and their control should be studied. Biological and cultural methods of control should be considered especially in the absence of chemicals for pest control. Cultural methods of disease prevention and control should be thoroughly studied. If available, the use of chemicals and fungicides for disease control should also be studied.

9. Breeding Program

The most important work in an area where insecticides, acaricides, nematocides and fungicides are used in very limited quantities is the manipulation of various germ plasms in the process of breeding to incorporate genetic resistance to insects, mites, nematodes and diseases and at the same time retaining yielding capacity and high quality. As soon as some selections have been made and sufficient knowledge of the pests and diseases prevalent in the area has been attained, an intensive plant breeding program should be initiated. Such a program should include breeding for high yields, high quality and resistance to pests and diseases as well as for other characteristics desirable for the highland area.

10. Harvesting and Post-Harvest Handling

The optimum time for harvesting of each crop should be determined to insure good quality products. This will be particularly important for the highlands which are remote from the market. Proper handling, packaging and storing should receive emphasis in order to maintain high quality produce. For vegetables and ornamental seeds, studies will be needed on methods of harvesting, preparation, packaging, and marketing.

11. Marketing

The success of a production research program is not complete without a good marketing research program. An economic analysis of the market potential of the various crops as well as the availability of a market organization is essential to assure establishment of these crops as viable enterprises for the highlands and for the hilltribes. Marketing studies should also include potentials for domestic as well as export markets and for processed as well as fresh products.

12. Other suggested research work specific to vegetables, ornamentals, legumes, cereals and tobacco is as follows:

(a) Legumes

(1) Inoculation and nitrogen-fixation. Studies on the culture and inoculation requirements of the leguminous crops are recommended and their relation to nitrogen-fixation efficiency for soil fertility regeneration should be studied. Nitrogen-fixation as influenced by various soil and climatic factors, cultural practices, etc., in the highlands should be investigated also.

(2) Flowering and response to photoperiod and temperature. Together with the determination of the optimum time of planting, flowering behavior of legumes and their response to varying day length and temperature have to be studied since these crops are very sensitive to variations in temperature and day length.

(b) Ornamentals

(1) Growing media - Some ornamental crops, especially orchids and anthuriums, require special growing media. The use of various materials, available locally,

for propagation and production of orchids and anthuriums should be studied.

(2) Shading - Orchids and anthuriums also require various degrees of shading, depending on season, elevation, temperature and intensity of solar radiation. Studies using varying degrees of shading should be conducted using locally produced or natural shades as much as possible.

(c) Vegetables

(1) Trellising - Some vegetables such as tomatoes, cucumbers, etc., require some form of support or trellising, especially during the wet season. In areas where soil-born pathogens causing vegetable diseases are prevalent, trellising is important. Studies should be conducted using various forms of support or trellis on production and quality of vegetable crops. The effects of "pinching", pruning and other techniques for inducing better fruiting and flowering should be studied also.

(2) Flowering behavior - Effects of climatic conditions on flowering behavior of vegetable crops, grown mainly for seeds should be studied. The use of natural and artificial pollinators as well as various factors affecting pollen production, viability and transfer should be studied.

(d) Cereals

(1) Rate of seeding - The influence of plant population on production of cereal crops such as upland rice and sorghum is much more pronounced than in paddy rice because of the reduced capacity of upland rice to tiller under limited water supply and the inherently low tillering capacity of sorghum. Studies on the rate of seeding and various row spacings for upland rice and for sorghum should be conducted.

(2) Ratooning - One of the important characteristics of crops belonging to the family Gramineae is their ability to continue to produce tillers after harvest. In the highlands, where a prolonged rainy season is possible, the practice of ratooning, in both upland rice and sorghum should be considered. Studies on ratooning ability of various varieties should be conducted.

(e) Tobacco

(1) Harvesting, drying and curing - Special research on the optimum stage of leaf maturity at harvest should be conducted together with various methods of drying and curing tobacco leaves. This is particularly important in maintaining a high quality product for the local and international market.

(f) Pasture and Forage

(1) Grass - Legume Mixture

Research on the compatibility of various mixtures of grass and legume species for pasture should be studied. Management practices, rotational grazing and varying intensities of grazing should be studied in relation to growth and productivity.

(2) Pasture establishment - To help hill-tribe farmers in the development of their pastures with minimum planting materials, studies on various techniques of pasture establishment including seed pelleting, rate of seeding and use of vegetative cuttings should be conducted.

IV. Five-Year Staffing Plans - Thai Component

In the judgment of the team, the core staff of the Highlands Agricultural Research Station should be Thai personnel. This is necessary if the Highlands Agricultural Research Station is to become a Thai operation at an early date.

The Highlands Agricultural Research Station is to be mission oriented. It is being established to accomplish a useful, practical purpose. The research program of the Station should be a planned program of research based upon an assessment of research priorities.

The success of the Highlands Agricultural Research Station will depend upon the effectiveness with which the resources of the Station are utilized. Key elements are careful planning in accordance with the objectives, goals and mission of the Station, decision-making in selecting high priority work to be undertaken, allocating resources to high priority work, implementing the planned program, continuous evaluation of programs and personnel, and modifying plans as evaluations indicate.

The organizational structure of the Highlands Agricultural Research Station follows from the program plan, the team believes that presenting the organizational chart first will facilitate an understanding not only of the activities and the functions of the Station, which constitutes the program, but also the roles of the key personnel in implementing the program.

The accompanying organizationchart for the Thai component and the staffing plan for key Thai personnel is proposed.

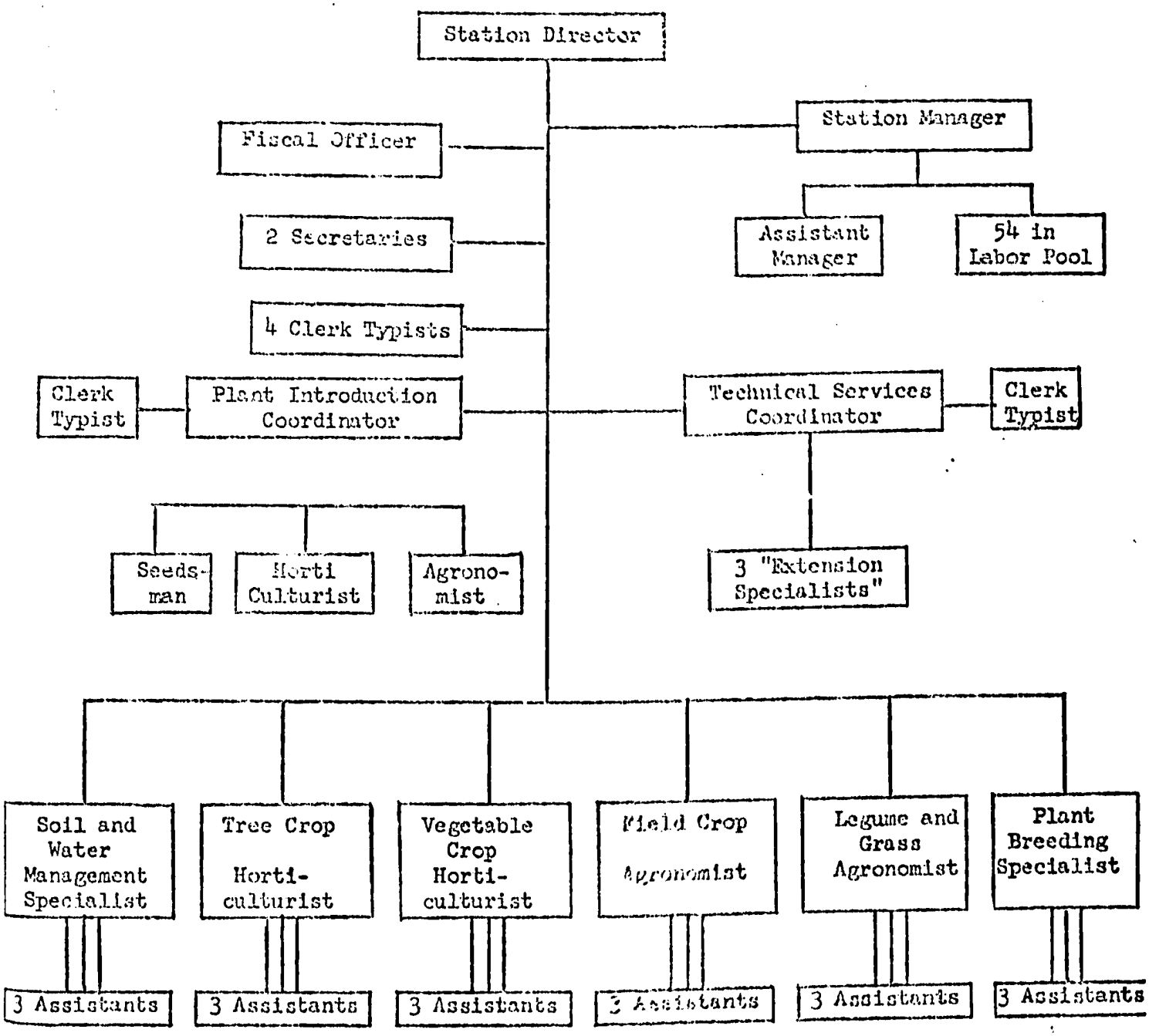
A. Administration

The following administrative staff and procedures are recommended.

1. Station Director (Special Grade)

The principal administrative officer of the Highlands Agricultural Research Station is the Station Director. He will be responsible directly to the Director-General of the Department of Agricultural Technology for:

ORGANIZATION CHART -- THAI [illegible]



a. Selecting and recommending appointment of all Station personnel.

b. Recommending to the Director-General for approval a program of work including specific research projects to be undertaken and a budget.

c. Implementing the approved program of work at the Station.

d. Expenditure of funds allocated to the Station in accordance with an approved budget.

e. Submitting an annual report of progress on the approved program of work including an accounting for the funds.

f. Maintaining liaison with NADC and other research stations.

Qualifications of the Station Director:

The Station Director should have creditable research experience. Although in the position of Station Director he will not be primarily a researcher, he must know and understand research procedures and he must be able to evaluate and make judgments about the research of his staff. He must have management or administrative capability. This is his primary responsibility.

The Station Director should have five positions on his staff.

a. A Fiscal Officer

b. A Station Manager

c. An Assistant Station Manager

d. Four Clerk Typists

e. Two Secretaries

2. Fiscal Officer (Grade 3)

The Fiscal Officer should have previous training and experience in accounting and fiscal management procedures. His principal responsibilities will be:

a. To assist the Station Director in preparing the annual budget to be recommended to the Director-General for approval prior to the beginning of the fiscal year.

b. Maintaining records of receipts and expenditures during the year.

c. Preparing an annual financial report after the close of each fiscal year.

d. At the request of the Director-General or the Station Director, to make special analyses and reports to facilitate administrative decision making.

e. To maintain an inventory of supplies and equipment.

3. Station Manager (Grade 3)

The Station Manager should have previous training and experience in supervising workers and in maintaining and operating facilities.

His principal responsibilities will be:

a. To maintain the physical facilities of the Station including buildings, roads, the water supply, etc.

b. Upon request of Research Leaders, to assign workers and field equipment of specific tasks in implementing the program.

4. Assistant Station Manager (Grade 4)

The Assistant Station Manager will be assigned to the Station Manager to lighten his workload. For example, the Station Manager might give primary responsibility to the Assistant Manager for maintaining physical facilities or the repair, maintenance and fabrication of farm machinery and equipment or both, depending on workload.

5. Secretaries

Typing correspondence and reports, filing materials and office assistance will be necessary in the offices of the Station Director, the Fiscal Officer, the Station Manager and the research leaders.

B. Station Program Support Services

Two units need to be attached to the Station if the mission of the Station is to be accomplished. Although not research units in themselves, these units support the total program of the Station. One of these units is the Plant Introduction Unit and the other is the Technical Services Unit. Each of these units should be responsible to the Station Director.

1. Plant Introduction Unit

During the first five years of the plant introduction program it is recommended that primary emphasis be placed on the major crops to be researched at the station. Miscellaneous crops that are believed to have potential, as additional new crops, should also be evaluated, but with a lesser degree of intensity.

Initially, emphasis should be placed on obtaining collections of all strains and lines that are presently available in Thailand for testing at the station. Simultaneously a thorough domestic exploration should be made within Thailand and surrounding countries for collections of wild or semi-domesticated species that may be of importance to highland agriculture. The

initial domestic explorations should be conducted throughout the highlands country since many of these may have undergone a "survival of the fittest" evolutionary period.

Exceptions to initially confine the collections to Thailand would be when it is already known that local lines are subject to serious disease or insect damage. An example of this might be susceptibility of local lines of coffee to rust. In such cases immediate steps should be taken to obtain coffee lines with resistance to one or more races of rust. One source for such material would be the Miami Plant Introduction Station at Miami, Florida. Naturally, if germ plasm of other crops is not available, then immediate introduction of exotic materials should be initiated.

In order to keep an accurate record of all material obtained and collected an introduction number should be assigned to each line. Each number should be unique and never duplicated again. The numbers must be assigned sequentially and chronologically to the next plant introduction entering the system. If it already has an introduction number from another country, then a Thailand number should also be assigned for cross reference. It is suggested that the Plant Introduction Section of the Highland Agricultural Research Station assign and keep a record of the Thailand Accession numbers. Three items of information must be provided for each accession line: 1) the unique accession number, 2) scientific name 3) source from which the plant was obtained. This information would be combined with the plant collector's notes and would be included in the official plant inventory handled by the Highlands Plant Introduction Section.

The Plant Introduction Section of the Highlands Agricultural Research Station, should be assigned the responsibility of being the central focal source for collecting, increasing, maintaining, evaluating and distributing all new sources of germ plasm for all agencies in the highlands of Thailand.

Ideally all requests for accessions, by all agencies, should be made to the Highlands Plant Introduction Section. In those cases where scientists obtain new plant material by exploration or by requesting from some other country on an individual basis it is important that a portion of the material be provided to the Plant Introduction Section and the accession number assigned. Cooperation is essential, otherwise the system will not be effective or functional. See Appendix II for suggested procedures for operating a Plant Introduction Station.

Staffing of the Plant Introduction Section should consist of a program leader (pathologist), agronomist, horticulturist, seedsman, secretary and field workers.

a. Program Leader (Pathologist, Grade 1)

This individual should have a Ph. D. or at least an MS with considerable experience. He should have a very broad knowledge of plant diseases in order to identify both agronomic and horticultural diseases that may occur in the plant introduction material. In addition to supervising the activities of the Highland Plant Introduction Section, this individual should have the capability to coordinate the evaluations of plant introductions, not only for the Highlands Agricultural Research Station, but for all agencies throughout the Highlands agricultural area working with plant introduction materials.

b. Agronomist (Grade 3)

The agronomist should have an MS degree with an extremely broad knowledge of agronomic crops. This is very important since he will be working with many crops instead of a few. He should be capable of maintaining, increasing and evaluating a large number of agronomic species.

c. Horticulturist (Grade 3)

Same qualifications as the agronomist except in the field of horticulture.

d. Seedsman (Grade 4)

It is recommended that this individual be a graduate of an agricultural vocational technical school. He should have some knowledge of crops and seed and especially competent in maintaining accurate records. He should have the capability to supervise the harvesting, threshing, cleaning and storage of seed samples.

e. Clerk Typist

Ability to type, file and maintain records accurately.

2. Technical Services Unit

a. Technical Services Coordinator

It is recommended that the Station include in its staffing plan a position responsible for the delivery of "technical services". He should be appointed in year two. The person in the position of Coordinator of Technical Services would have the following responsibilities:

1) He should have a full understanding of the economic, social and political setting within which the hilltribe farmers operate and within which the "extension" workers in other agencies operate.

2) He would acquire full knowledge and understanding of all the biological and economic components required for a successful "package" of technology and should put together the recommended "package" of technology.

3) He would be a specialist in the ability to transmit this knowledge to "extension" workers in a form they in turn could use in advising farmers.

4) He would be able to establish, and advise others to establish, demonstrations where farmers could observe the package of technology in operations.

5) He would, from time-to-time, monitor such demonstrations to see that they are properly conducted.

6) He would report back to appropriate researchers his observations with respect to crop response to the technological package at different locations operating under varying conditions.

7) He would assist "extension" workers in organizing and conducting field days and other special events to promote the use of the best known systems and practices in crop production by the highlands farmers.

b. Technical Services Assistants (3 Grade 3 Officers)

To reach the "extension" workers in various geographical locations, the Technical Services Coordinator will need assistants to carry the educational program based on results of research at the Highlands Agricultural Research Station. Three such assistants are recommendded and they should be appointed in year three.

The Technical Services Assistant should be able to fully understand the various components of the recommended packages of technology. They should be able to communicate these components to "extension" workers and to farmers. They should be able to conduct training programs for "extension" workers and to set up and monitor demonstrations in villages. They should

be prepared to travel extensively over the highlands and be away from the Station much of the time.

c. Clerk - Typist

Ability to prepare educational materials from the Technical Services Unit.

C. Research Program Leaders (Grade 1)

Each Research Leader will be responsible for planning and executing specific research projects that contribute to the accomplishment of the research program that has been approved by the Station Director and the Director-General of the Department of Agricultural Technology. No research project may be initiated until the project outline has been approved by the Station Director and an allocation of resources for the project has been approved. A single research project may involve one or more project leaders.

A project outline is a written statement bearing a title, a statement of the objectives of the project, the research procedure to be followed, the nature of the data or information to be collected, the statistical or analytical methods to be used, the expected usefulness of the results, the resources required to execute the project and the date when the project will be completed or reviewed for termination, extension or revision.

At the end of each fiscal year the Research Leader (or Leaders) will prepare a written report on the progress of the project in accomplishing the objectives. On the date the project is completed or reviewed for termination, extension or revision, a comprehensive report on the work under the project will be prepared.

Research Leaders should have demonstrated capability, through training or experience, to conduct productive research in some specialized field. More specific qualifications for each of the research program leaders is given in a later section.

Each Research Leader may be responsible for one to three or four projects. He may have assigned to him one or more Grade 3 officers to assist in executing the projects. He may request of the Station Manager the necessary laborers, supplies and equipment to properly execute the project.

1. Horticulturist (Fruit Tree Crops)

The Thailand tree-crop horticulturist should have Ph. D. degree training in pomology. He will be expected to have experience in tropical and sub-tropical fruits with some experience in coffee desirable but not a prerequisite. The specialist should have had at least three years experience in horticultural research, capable of planning, designing and conducting experimental work involving tree fruits.

He should efficiently supervise, direct and advise three officers of Grade 3 level assigned to the major groups of crops to be researched.

He will be expected to thoroughly survey existing horticultural practices, varieties and problems of production in the highlands; assist in and supervise a nationwide collection of tree crops, coffee-tea germ plasm for establishment at the research site; administer, coordinate and integrate horticulture research programs with other departments; assemble a broad range of horticultural literature for the library to be readily available to the staff; be able to draft and prepare reports for presentation at seminars, conferences, both national and international; to supervise the upgrading and training of staff to keep them abreast of developments in horticultural research, particularly that involving highlands research.

2. Horticulturist (Vegetables and Ornamental)

This specialist should have Ph.D. or a minimum of Master of Science training in vegetable production with some training in ornamentals preferred. He should have had research experience in vegetable production, capable of planning and

designing a research program for the wide range of vegetables grown in the highlands, to include production and marketing problems.

The specialist will be expected to plan, supervise and implement a research program on vegetables and seed production; assemble and train staff; and administer the entire vegetable research program in the highlands.

The specialist should cooperate with the Plant Introduction Horticulturist in planning his program and should personally engage in the collection and seed increase program for vegetable germ plasm in Thailand. In this way he would become thoroughly familiar with highland vegetable culture. He should actively engage in training and upgrading the knowledge of staff in vegetable and seed production through short courses, attendance at seminars and field training.

3. Agronomist (Field Crops)

This position will work on researches involving production and management of field crops such as rice, corn, sorghum and tobacco. In addition, he will be involved in evaluating other field crops introduced for testing in the research center. He will work with the U.S. agronomist in preparing and implementing a working research program for field crops. He will supervise and coordinate Grade 3 Agronomists working with specific field crops and specific fields of research.

Preferably, this position should have a Ph. D. or a M.S. degree with five or more years of experience in production and management research. Some experience in research administration will be valuable.

4. Agronomist - (Pasture and Legumes)

This position will be involved in preparing and implementing a research program on various grass and legume production and management problems. He will be working with the U.S. agronomist and will supervise and coordinate Grade 3 agronomists working on specific researches on pastures and forages.

Preferably, this position should have a Ph. D. or MS degree with five or more years of experience in pasture research. Some experience in research administration will be valuable.

5. Soil and Water Management Specialist

This position will carry out experiments on irrigation, soil and water management, land preparation and soil conservation. This position will also supervise and coordinate activities of third grade researchers working on specific soil and water management experiments.

This position, in cooperation with research horticulturists and agronomists may work on studies involving multiple or rotation cropping and cover cropping in relation to soil erosion control.

The Soil and Water Management Specialist should have at least a Master's degree with five years experience or preferably a Ph. D., in soil science or agronomy with background in soil chemistry, and soil physics. Some working experience in crop production and management would be valuable.

6. Plant Breeding Program

It is estimated that by the beginning of the third or fourth year problems will begin to emerge requiring the specific expertise of plant breeders. Such needs as increased yields, disease resistance, insect resistance, date of maturity, quality factors, seed shattering, date of flowering, fruit setting, etc., will probably emerge.

It is difficult in the early planning stages to determine the specific crops for which a plant breeding program will be required. Therefore the team is suggesting a broad general approach to this problem.

a. Project Leader - Grade 1

It is essential that this individual have a Ph. D., with considerable experience and a comprehensive understanding of genetics and of the breeding methodologies and techniques covering a broad range of crops. He should also be well trained in statistics and experimental designs.

b. Specialized Plant Breeders - Grade 2

As the research program develops the specific crops to be worked upon can be identified. It is anticipated that two and perhaps three additional men will be required. The first two will probably be needed in field crops and vegetables. At a later date a fruit breeder may be required. These individuals should have M.S. degrees in plant breeding, preferably with some experience. If possible, their training should be in the specific classes of crops in which the breeding work will be conducted.

D. Grade 3 Officers

Since each Research Leader will have responsibility for from one to three projects, he will need the support of one or more properly trained technicians to carry out the detailed work under his project or projects. The range of jobs to be undertaken by support technicians may vary widely depending on the nature of the research. This may include such activities as planting, budding, grafting, making precise measurements of chemicals, accurately recording weights of products, operating sophisticated scientific equipment, etc. Graduation from a university, college or technical school generally would be required. For purposes of planning, a target figure of 18 Grade 3 Officers is suggested (3 per Research Program Leader). Some specific examples of Grade 3 Officers follow. They should have at least a Bachelor's degree in Horticulture, Agronomy, Soil Science or Agricultural Engineering, as appropriate.

1. Rice Agronomist - Grade 3

Working under the supervision of the Grade 1 Field Crop Agronomist, this position will work on the various researches on rice production such as soil and water management, pest and disease control, soil fertility, multiple cropping, and plant breeding, etc. He must be capable of acquiring a working knowledge of field and laboratory research, making field evaluations and measurements and collecting and recording accurate field and laboratory data. This position will also supervise laborers working with specific field and/or laboratory research. This position should have a bachelor's degree with a major in agronomy preferably with some background in horticulture, botany, soil science or plant breeding.

2. Corn Agronomist -Grade 3

This position will work on the various researches on corn production. This position will perform duties similar to the rice agronomist; supervising laborers working on specific field and laboratory research. This position should have a bachelor's degree in agronomy or horticulture with a background in botany, soil science and plant breeding. A working knowledge of statistics and data analysis will be valuable.

3. Sorghum Agronomist - Grade 3

This position will work on the various researches on sorghum production, management and breeding, working directly under a first grade agronomist. He will be performing duties similar to the rice and corn agronomists. This position should have a bachelor's degree in agronomy with some background in botany, soil science and plant breeding. A working knowledge of statistics and data analysis will be valuable.

4. Grass and Legume Agronomist - Grade 3

This position will work on various researches on grass and legume production for pasture and forage, working directly under a first grade agronomist. He will be performing duties similar to the rice, corn and sorghum agronomists. This position should have a bachelor's degree in agronomy with backgrounds in both plant and animal sciences.

5. Three Soil and Water Management Specialists - Grade 3

These positions will be coordinated by the Soil and Water Management Specialist, Grade 1, and will be directly involved in the implementation of irrigation and soil management studies. They should be capable of performing accurate data measurements and collection. They should have some background in soil physics and soil chemistry. A strong background in agricultural engineering is valuable but not a prerequisite for these positions.

E. Laborers

Maintenance of buildings and grounds, controlling weeds and brush, tilling the soil, terracing and benching land, operating farm machinery, etc., are tasks that are essential to operating a research station. The level of formal education required is minimal. The number of laborers required will depend upon the size of the station and the terrain, the nature, size and extent of the research program. The number should be kept flexible. Experience will be the best guide to the number to be employed. For purposes of planning, a target figure of 55 is suggested.

V. Five Year Program and Staffing Plan -- U.S. Component

The team is recommending that the core research staff of the Highlands Research Station will be Thai personnel. Only a limited number of long-term U.S. personnel is recommended with considerable reliance placed upon short-term (30 to 90 days) consultants. The principal roles of U.S. personnel should be:

1. To provide maximum assistance to Thai personnel as they inaugurate their programs.

2. To monitor progress as the programs evolve and offer whatever advice and consultation they or the Thai staff feel would be helpful.

3. To provide on-the-job training to Thai personnel as needs are identified or agreed to.

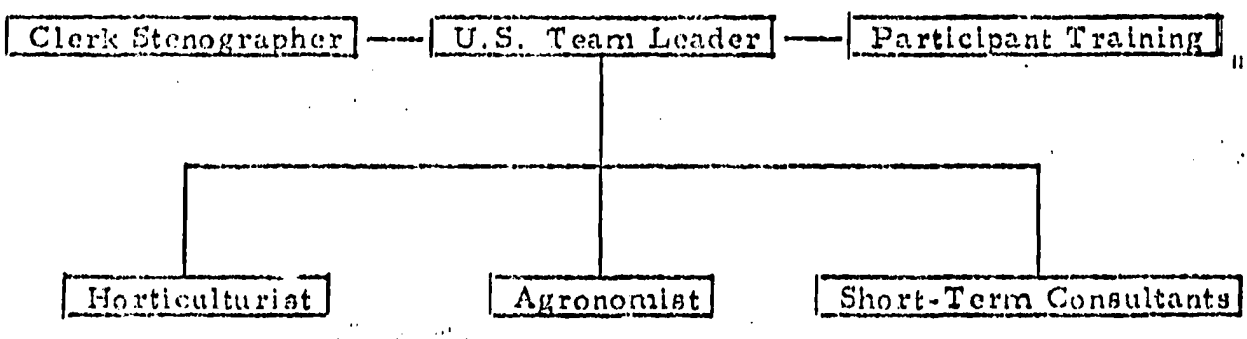
4. To recommend short-term consultants for specific tasks as needs are identified.

5. To recommend Thai personnel for participant training.

A. Organization and Staffing Plan -- U.S. Component

The accompanying organization chart for the U.S. component and the staffing plan for key U.S. personnel is proposed.

ORGANIZATION CHART -- U.S. COMPONENT



1. U.S. Team Leader (Counterpart to the Thai Station Director)

As soon as possible after the Highlands Research Station is approved, and well before actual research is underway, the U.S. Team Leader should be recruited and on the job. The Team Leader should be an experienced research administrator from the Agricultural Research Service of USDA or from a State Agricultural Experiment Station.

The Team Leader should have a minimum of five years experience as a research administrator. Previous foreign experience in the tropics or subtropics would be highly desirable.

The Team Leader should:

a. Assist in planning the research facilities.

b. Assist in developing the research plan.

c. Assist in developing, reviewing and recommending approval of specific research projects.

d. Participate in budget requests.

e. Participate in program and personnel evaluation.

f. Participate in recommending and selecting the U.S. Horticulturist and the U.S. Agronomist.

g. Receive requests for and recommend short-term consultants.

h. Receive requests for and recommend Thai personnel for participant training.

i. Handle the necessary fiscal and personnel matters required by USOM.

2. Clerk-Stenographer

One Thai clerk-stenographer should be assigned to the Team Leader to handle correspondence, filing, etc., for the U.S. Team.

3. U.S. Horticulturist and U.S. Agronomist

As soon as possible after the Highlands Research Station is approved, and even before site preparation or building construction is started, a U.S. Horticulturist and a U.S. Agronomist should be employed and on duty. Each should consult with Thai counterparts employed by the Highlands Station to firm up the nature of the research plans in their respective fields. Each should participate in the research for knowledge about the crops and soils problems identified for concentrated research and the "bottlenecks" to be researched. Each should assist their Thai counterparts in formulating their research projects to be submitted to the Station Director for approval. Each should assist their Thai counterparts in getting the research underway and each should monitor the progress of research in their respective fields, offering assistance that will expedite the research programs. Each should offer on-the-job training as appropriate for Thai personnel.

Qualifications

(a) A Ph. D. and minimum of ten years of productive research in their respective fields would be required.

(b) Previous foreign experience would be desirable.

(c) Since each of these two individuals will be concerned with a wide range of crops and disciplines, a broad range of interests and experience would be highly desirable.

4. Short-Term Staff

1. With limited U.S. permanent staff at the Highlands Research Station, heavy reliance will be placed on short-term consultants. Generally, these will be from disciplines not represented by longer-term U.S. staff and may include personnel with specialized talent for specific assignments.

2. The number and qualifications of short-term U.S. staff cannot be specified in advance. In general, the principal qualification would be recognized expertise in the required field of specialization. The number of short-term consultants should be controlled by budgetary allocations. For purpose of planning, 20 man-months of consultant services per year is suggested.

3. Specific requests for consultants services will need to await further development of the research program. However, the following needs will likely occur.

   a. Marketing Consultant - year 1, 3 months, to join with a Thai economist in making an assessment of market potentials and price expectations for each crop being considered for research at the Highlands Research Station.

   b. Plant Introduction Consultant - year 1, 6 months, to help establish the Plant Introduction Unit at the Highlands Research Station. One of the four U.S. Regional Plant Introduction Station Coordinators or a member of one of their staff assistants would be recommended for this assignment.

   c. Production Economics Consultant - year 1, 3 months, and year 4, 6 months. In year 1, he would develop a format to specify data requirements from Crops Researchers in order to accumulate data for making cost-of-production estimates. In year 4, cost-of-production estimates would be made and provision made for collecting data on highland farms. This would provide estimates of actual farm cost of production.

   d. Plant Breeding Consultants - year 3 and 4, 3 to 9 months. For those crops emerging from observations and experiments where plant breeding is needed, the need for some specialized talent is anticipated.

   e. Farm Management Consultant - year 4, 3 months and year 5, 3 months. With data from the Cost-of-Production Consultant and from the Crop Production Researchers, the preparation of packages of technology can be developed by Farm Management Consultant.

   f. Coffee Consultant - year 2, 2 months. After the collections of local coffee plantings are established and field trials are about to be laid out, it would be desirable to bring in a short-time Coffee Consultant for a two month assignment. His duties could be to assist in program planning, selection, and preparing details of the experiments on coffee.

g. Plant Pathology Consultant - year 4, 2 months. A Plant Pathologist should be called in to diagnose disease problems, identify pathogens and recommend control measures.

h. Tree Crop Breeding Consultant - year 4 to 7, 3 months each. If a plant breeder is not already available to assure progress toward finding adapted apple and pear varieties, a Tree Crop Breeder should be called in to train staff and plan a breeding program for these fruits.

5. Participant Training for Selected Thai Staff

1. Due to the limited availability of well-trained Thai Research personnel qualified for research in the highlands, the program should include provision for formal training of selected individuals on the highlands staff, particularly those in Grades 2, 3, and 4, who demonstrate capacity for intellectual growth. Selection should be based on (a) the potential of the individual to improve his competence and (b) the need for the expertise in the research program in the highlands.

2. Such advanced training might take place at any one of three categories of institutions: (a) Thai universities; (b) U.S. universities; or (c) third-country universities. The particular institution selected should be determined by the need and the quality of the program.

3. The number of such trainees cannot be determined in advance but should be controlled by budgetary allocations. For purposes of planning, 3 participants per year beginning in year two are suggested.

VI. Liaison with Other Research Development Programs

A. Disseminating the Results of Research

The results of research at the highlands will be of interest and value to other research and development agencies in the northern region, in other regions of Thailand and other highland areas of the world. Among the agencies in the northern region of Thailand are the station at Tak province, the Uplands Rice Station, the Mae Jo Station, Chiang Mai University, the King's Project, and the Northern Region Agricultural Development Center. Likewise, the observations, research results and information gained by these other stations and agencies will be of interest and value to the highlands station.

Research programs can be expedited and progress can be enhanced if researchers and research administrators can be in personal contact with interested counterparts in the region, in the nation and in the tropical and subtropical zones of the globe.

B. Research Interchange in the Northern Region

The team strongly recommends that the Northern Agricultural Development Center take positive steps to schedule five or six, one or two day regional conferences and seminars each year to be attended by research administrators and/or researchers in areas of common interest (for example, soybean researchers or tree crop horticulturists). Exchange of research data, methodologies-observations, etc., can be very helpful to participants in their research programs. The Highlands Station budget should include an item for travel and per diem for highlands researchers and administrators to participate in such seminars and conferences. Some of these seminars and conferences should be held at the Highlands Station and others at other research locations in the northern region. Due to the relatively isolated location of the Highlands Station, it is of particular importance that the research there be made known to others and especially that researchers at the highlands go to other locations to observe the research work there.

C. National Research Interchange

In expanding to the national scene, it is recommended that the Highlands Station Research Leaders participate in the annual conference of the Department of Agricultural Technology at which

formal papers on topics of general scientific interest will be presented and discussed. One or two representatives of the highlands station should attend each conference. A budget item for travel and subsistence for participants should be included.

D. International Research Interchange

Occasionally there may be international conferences where participation by Highlands Station personnel would be advantageous. Participation should be strongly justified and approved in advance by the Station Director and the Director-General of the Department of Agricultural Technology. A budget item should be included for such participation.

E. A Research Library

A common means of disseminating significant research information is through the publication of books, printed pamphlets, scientific journals, mimeographed papers, etc. The Highlands Station should receive relevant published materials from selected research agencies throughout the world. Due to the geographic isolation of the Highlands Station, it will be important to develop a library with significant scientific books and journals appropriate to the research at the Highlands Station. A budgetary item should be included for these materials.

F. Publication of Research Results at the Highlands Station

Researchers at the Highlands Station should also prepare manuscripts reporting the significant results of their research for submission to recognized scientific journals or for mimeographing or printing and distribution in the region and nation. Such manuscripts must be carefully prepared, reviewed by colleagues for merit and edited carefully prior to submission for publication. The Northern Agricultural Development Center might mimeograph and distribute papers of regional interest including papers presented at regional conferences and seminars. The Department of Agricultural Technology might print pamphlets on subjects of national interest, including papers presented at the national conference. A budgeted item in the Highlands Station might be provided to pay the cost of publishing the results of research at the Highlands Research Station. This information would be of particular value to the technical services coordinator, his assistants and "extension" workers in the Highlands region.

VII. Budgets

A. Site Preparation

Site preparation will include a hard-surfaced road into the site and up to the location of the office-laboratory building. Additional roads within the Station to connect the office-laboratory building with other buildings and the various experimental fields will be needed. These roads need not be hard-surfaced but should be graded and well drained. Perimeter fencing of the entire site with gates and locks will be needed for security and protection. Extension of utilities into the site including water from the source of supply into the site, electricity (if available), telephone will be needed, etc. Site preparation would also include levelling of building sites and some of the field plot areas.

Until the site is actually located and surveyed, no estimate of costs can be made.

Actual field plan and layout of permanent facilities, irrigation and water supply will require the expertise of professional engineers, architects, planners and surveyors. The appropriate office of the Royal Thai Government should be called upon to provide this support. The appropriate government office should also be called upon to construct the buildings, roads, etc., unless a private construction company is contracted to perform the job.

B. Permanent Station Facilities

The type, number and size of permanent facilities given below should be used only as a guide. The actual cost of construction will depend on current prices of labor and materials. Specific floor plans and specifications will also depend on final needs as assessed by the Research Director and professional staff.

The recommended floor area for the office-laboratory building is 1,200 square meters. This should provide office space for the director, fiscal officer, station manager, one U.S. team leader, two U.S. scientists, seven first grade, one second grade and 23 third grade Thai scientists, four clerk typists and five secretaries. The building is also estimated to have sufficient room for a conference room, library, storage or supply room and seven laboratories.

As more funds become available and the need for more office and laboratory space arises, construction of an annex office-laboratory building may be justified.

The seed storage facility will be used mainly for storing planting materials and for maintaining germ plasm collections. A separate seed storage room with controlled temperature and relative humidity is recommended for the germ plasm collections of the plant introduction section. This building will also have sufficient room for a seed laboratory for weighing, treating and packaging seeds for planting and for shipment.

Other recommended facilities are the screen house for isolating new acquisitions; greenhouse for plant propagation and nursery during the cold season; lath houses for hardening rooted materials; propagation chamber for rooting cuttings; soil sterilization and potting facilities for steam sterilizing or fumigating soil and other growing media; machinery storage for protection of farm vehicles and equipment; farm shop for repair and maintenance work; and a chemical storage building for fertilizers and pesticides. Additional buildings may also be for other purposes if there is sufficient need and if funds are available.

Permanent Facilities

Function	Type of Construction	Floor Area m^2	No.	Cost Baht	Total Cost
1. Office Laboratory	Reinforced concrete	1,200	1	1,800,000	1,800,000
2. Seed Storage	Reinforced concrete	100	1	120,000	120,000
3. Screen house	Wood frame	140	1	112,000	112,000
4. Green house	Metal or Wood frame	100	1	100,000	100,000
5. Lath house	Wood frame	100	2	70,000	140,000
6. Propagation House	Wood frame	10	5	2,000	10,000

Function	Type of Construction	Floor Area m^2	No.	Cost Baht	Total Cost
7. Soil sterilization and potting	Wood frame	100	1	70,000	70,000
8. Machinery Storage	Lean-to wood frame	240	1	144,000	144,000
9. Farm shop	Wood frame	100	1	80,000	80,000
10. Chemical Storage	Wood frame	100	1	80,000	80,000
11. Field Laboratory	Wood frame	100	1	80,000	80,000
					2,736,000

C. Housing

How much housing to provide for staff on the Station needs to be considered. Several alternatives are possible.

Alternative 1: Some minimum housing needs to be provided on the station for security measures, emergency situation and for the convenience of the entire staff. This probably should include housing for the Station Manager and for five skilled laborers and their families. This would be the least cost alternative.

Type of Construction	No. of Stories	Area M^2	No.	Cost ฿ Each	Total Baht
Second Grade Officers-Frame	1	96	1	96,000	96,000
Laborers Housing 5 family unit frame	1	300	1	480,000	480,000
TOTAL					576,000

The remaining Thai personnel and U.S. personnel would be provided a housing allowance and would reside in or near an existing community where schools, markets, etc., are available. Daily transportation by shuttle bus might be provided. No estimate of cost of housing allowances or a shuttle bus has been made.

Alternative 2: This alternative would provide housing, in addition to that provided in alternative 1, for the Station Director and all the Thai Grade 1, 2, and 3 personnel and their families. Housing would not be constructed for U.S. personnel since they would phase out of the program in year 5, 6, or 7.

Type of Construction	No. of Stories	Area M^2	No.	Cost ฿ Each	Total Cost ฿
Station Director Frame	2	200	1	240,000	240,000
First Grade Officers-Frame	2	120	7	150,000	1,050,000
Third Grade Officers	1	84	23	84,000	1,932,000
					3,222,000
Plus Alternative 1					576,000
TOTAL					3,798,000

U.S. personnel would be provided housing allowance and would commute to the Station in vehicles provided by the project.

Alternative 3: This alternative would provide all the housing in alternatives 1 and 2 and in addition would provide housing for the U.S. staff including housing accommodations for a maximum of 3 short-term consultants or one team.

Type of Construction	No. of Stories	Area M^2	No.	Cost ฿	Total Cost ฿
U.S. Team Leader and U.S. Scientists	2	200	3	240,000	720,000
Consultants Housing	1	84	3	94,000	252,000
					972,000
Plus Alternatives 1 and 2					3,798,000
TOTAL					4,770,000

This is the figure that is carried forward to the summary.

D. Farm Equipment

An inventory of farm machinery is required to start land preparation for field plot experimentation. Emphasis is put on minimum machine requirements and then to provide sufficient hand tools to support the hand labor available. Specialized machinery, accessories or attachments may be purchased as needs are ascertained and funds made available after the purchase of the initial equipment. Again, the list given below should be used as a guide in procuring farm machinery.

	Type	Number	Estimated Cost	Total Cost
1.	Tractor, 4 wheels 60-70 HP, Diesel	1	$ 12,000	$ 12,000
2.	Tractor, 4 wheels 30-35 HP. Diesel	1	8,000	8,000
3.	Rototillers, 2 wheels	4	600	2,400
4.	Reversible Disc Plow 3 Discs, 18-20"	2	500	1,000
5.	Reversible Moldboard Plow 2 bottom, 14"	1	600	600
6.	Tandem Disc Harrow, 7 ft.	1	500	500
7.	Spike Tooth Harrow 2-5 ft. sections	1	500	500
8.	Grain Drill, 10 ft.	1	1,200	1,200
9.	Cone Planter, Planet Jr. 1 row, Push type	4	100	400
10.	Rotovators, PTO, 62"	1	1,700	1,700
11.	Shredder, PTO, 4 ft.	1	2,000	2,000

	Type	Number	Estimated Cost	Total Cost
12.	Clipper Seed Cleaner	2	500	1,000
13.	Small Plot Head Thresher, Vogel type	2	1,500	3,000
14.	Steam Sterilizer	1	500	500
15.	Mist Blower	4	200	800
16.	Knapsack Sprayer	10	50	500
17.	North Dakota Seed Cleaner	1	600	600
18.	Irrigation Pump 200 GPM, Diesel	2	5,000	10,000
19.	Irrigation Pipe 4"	2,500 ft.	3/ft.	7,500
20.	AC Diesel Powered Generator, 500 Kva	1	15,000	15,000
21.	Land plane	1	1,000	1,000
22.	Miscellaneous Farm Equipment and Hand tools			40,000
	TOTAL			$ 110,200

E. Vehicles

Vehicles should be provided for professional staff mobility and for transporting field equipment and personnel. A minimum inventory is recommended until additional funds are available. It is recommended that the Station Director, Station Manager, Assistant Manager, U.S. Team Leader and two U.S. Scientists be provided with vehicles. The Station Manager and Assistant Manager should have four-wheel drive 1/2 ton truck or comparable vehicles.

	Type	Number	Estimated Cost	Total Cost
1.	Car, 4-door sedan	4	4,000	16,000
2.	Truck, 1/2 ton, 4-wheel drive	4	5,000	20,000
3.	Station Wagon 4-wheel drive	1	6,000	6,000
4.	Truck, 1 1/2 - 2 ton 5 shift, Diesel	1	8,000	8,000
	TOTAL			$ 50,000

F. Laboratory Equipment

The degree of sophistication in the selection of laboratory equipment depends on the final research projects to be conducted and specific training and interests of the researchers. The list provided should only serve as a guide, especially during the initial stages of development of the Highland Agricultural Research Station. Additional equipment and supplies including reagents and glasswares can be obtained as the need is ascertained.

	First Year Equipment	No.	Estimated Cost	Total Cost
1.	Balance, Mettler, Top loading, P-1000	3	$ 650	$ 1,950
2.	Balance, Analytical, Mettler H20T	1	1,200	1,200
3.	Distilling Apparatus, Barnstead, 10 gal./hr.	1	1,900	1,900
4.	pH Meter, Expand-O-Matic	1	500	500
5.	Drying Ovens	2	100	200

	First Year Equipment	No.	Estimated Cost	Total Cost
6.	Force-draft ovens	2	500	1,000
7.	Stereo Microscope	2	200	400
8.	Compound Microscope	2	500	1,000
9.	Seed cleaning sieves	2 sets	200	400
10.	Seed germinator	1	4,000	4,000
11.	Seed Moisture Tester	1	600	600
12.	Anemometer	2	150	300
13.	Rain gauges	2	25	50
14.	Hygrothermographs	4	200	800
15.	Solarimeter	2	150	300
16.	Refractometer	2	200	400
17.	Miscellaneous laboratory equipment (furnace, dehumidifier, etc.)			15,000
	TOTAL			$ 30,000

	Year 2	Year 3	Year 4	Year 5	Total
Miscellaneous Laboratory Equipment	$10,000	$10,000	$10,000	$10,000	$40,000

TOTAL LABORATORY EQUIPMENT BUDGET (5 Years) $70,000

G. Office Equipment and Furniture

An initial inventory of office equipment is needed as soon as support staff are hired such as the secretaries and clerks. Desks, chairs and file cabinets for professional staff will also be needed as soon as the office-laboratory building is constructed.

Again, the list provided should be used as a guide only and more furniture and equipment should be procured as needs are determined.

	Equipment	No.	Estimated Cost	Total Cost
1.	Typewriter, Electric	9	$ 600	$ 5,400
2.	Desk Calculator	2	800	1,600
3.	Adding Machine, Business	6	500	3,000
4.	Executive Desks, Wood	2	200	400
5.	Executive Chairs	2	200	400
6.	Secretarial Desks, Steel	10	160	1,600
7.	Secretarial Chairs	10	40	400
8.	Professional Desks, Steel	40	160	6,400
9.	Professional Chairs	40	40	1,600
10.	Library table, wood	1	150	150
11.	Library chairs	12	20	240
12.	Conference Table	2	150	300
13.	Conference chairs	24	20	480
14.	Office chairs	100	20	2,000
15.	File cabinet	50	150	7,500
16.	Miscellaneous Office Equipment			18,530
	TOTAL			$ 50,000

H. Thai Personnel Budget

	Grade	No.	Baht 1st Year	2nd Year	3rd Year	4th Year	5th Year
1. Station Director's Office							
Director	Spec.	1	62100	82500	107400	107400	107400
Clerk Stenographer	4	4	36000	45440	58560	58560	58560
Secretary	4	2	18000	22720	29280	29280	29280
Fiscal Officer	3	1	13800	18600	25200	25200	25200
Station Manager	3	1	13800	18600	25200	25200	25200
Assistant Manager	4	1	9000	11360	14640	14640	14640
Subtotal			152700	199220	260280	260280	260280
2. Plant Introduction Sect.							
Coordinator (Pathologist)	1	1	41400	55200	73800	73800	73800
Asst. Horticulturist	3	1	13800	18600	25200	25200	25200
Asst. Agronomist	3	1	13800	18600	25200	25200	25200
Seedman	4	1	9000	11360	14640	14640	14640
Clerk Typist	4	1	9000	11360	14640	14640	14640
Subtotal			87000	115120	153480	153480	153480
3. Research Project Leader							
Horticulturist	1	2	82080	110400	147600	147600	147600
Agronomist	1	2	82080	110400	147600	147600	147600
Soil & Water Mgt. Spec.	1	1	41040	55200	73800	73800	73800
Plant Breeder	1	1	-	-	41400	55200	73800
Subtotal			205560	276000	410400	424200	442800
4. Research Assistants							
Asst. Horticulturist	3	6	82800	111600	151200	151200	151200
Asst. Agronomist	3	6	82800	111600	151200	151200	151200
Asst. Soil & Water Mgt Specialist	3	3	41400	55800	75600	75600	75600
Asst. Plant Breeder	3	3	-	-	41400	55800	75600
Subtotal			207000	279000	419400	433800	453600
5. Technical Service Office							
Coordinator	2	1	-	22320	30240	41040	41040
Assistants	3	3	-	-	41400	55800	75600
Clerk Typist	4	1	-	9000	11360	14640	14640
Subtotal			-	31320	83000	111480	131280
6. Field Staff							
Driver		6	50400	54000	57600	57600	57600
Tractor Operators		4	36000	45440	58560	58560	58560
Skilled Laborers		20	144000	156000	168000	168000	168000
Unskilled Laborers		25	135000	150000	165000	165000	165000
Subtotal			365400	405440	449160	449160	449160
Grand Total			*1017660	1306100	1775720	1832400	1890600

*Expenditures for salaries and wages for the first year will undoubtedly be less than budgeted. Some personnel will not be needed the first year. Also it is doubtful if the full complement of people could be recruited and on the job during the full year. For want of a better figure, one-half of the total for year 1 is carried forward to the summary (฿ 508,830)

I. U. S. Personnel Budget

	No.	Year 1	2	3	4	5
		$	$	$	$	$
Team Leader	1	30000	31800	33708	35730	37874
Horticulturist	1	30000	31800	33708	35730	37874
Agronomist	1	30000	31800	33708	35730	37874
Consultants, @$3000/man-month, 20 man-month/year		60000	60000	60000	60000	60000
Secretary, Grade 4	1	450	568	732	732	732
Subtotal $		150450	155968	161856	167922	174354
J. Participant Training						
Degree Training @$9600/trainee/yr.	3/yr	28800	57600	57600	57600	28800
Non-degree Training @$8000/trainee/year	3/yr	24000	24000	24000	24000	24000
Subtotal $		52800	81600	81600	81600	52800
Grand Total $		203250	237568	243456	249522	227154

K. Current Expenses

Provision needs to be made for supplies such as fertilizer, pesticides, seeds, petroleum products, office supplies, etc.; services such as utilities, postage, repair work, etc.; library books, subscriptions and scientific journals; for travel and per diem; and for additional scientific equipment. Expenditures for supplies will be high the first year to build inventories and then should level off to maintain a working level in the inventory. The library will require a substantial amount for acquisitions and then level off to a continuing rate of expenditures for new acquisitions and for continuing subscriptions. Travel and per diem may be high the first year as scientists travel to acquire expertise and knowledge about crops they will be working with and to collect planting material. Thereafter, travel costs will level off to attend conferences, seminars, and meetings. Services probably will be lower the first year since not all utilities will be utilized up to normal during that year. In following years, costs of services will be higher but should not increase significantly over the years. Purchase of some scientific equipment needs to await decisions by the individual scientists as their research program develops.

L. Budget Summary

1. Royal Thai Government (Baht)

a. Capital costs, years 1 and 2

1.	Site Preparation	(Not estimated)
2.	Station Facilities	฿ 2,736,000
3.	Housing	฿ 4,770,000
	TOTAL	฿ 7,506,000

b. Operating Costs

Operating Costs	Year 1	Year 2	Year 3	Year 4	Year 5
a. Personnel	508,830	1,306,100	1,775,720	1,832,400	1,890,600
b. Supplies	300,000	100,000	100,000	100,000	100,000
c. Services	10,000	20,000	20,000	20,000	20,000
d. Library	50,000	10,000	10,000	10,000	10,000
e. Travel	60,000	30,000	30,000	30,000	30,000
TOTAL	928,830	1,466,100	1,935,720	1,992,400	2,050,600

Total 5 Year Thai Cost (Baht) ฿ 15,879,650

2. U.S. Government (Dollars)

a. Capital Costs, Years 1 and 2

1)	Farm Equipment	110,200
2)	Vehicles	50,000
3)	Laboratory Equipment	30,000
4)	Office Equipment & Furn.	50,000
	TOTAL	240,200

b. Operating Costs (Dollars)

Operating Costs	Year 1	Year 2	Year 3	Year 4	Year 5
a. Personnel	90,450	95,968	101,856	107,922	114,354
b. Consultants	60,000	60,000	60,000	60,000	60,000
c. Training	52,800	81,600	81,600	81,600	52,800
d. International Travel	6,000	6,000	6,000	6,000	6,000
e. Additional Equipment	-	-	10,000	10,000	10,000
TOTAL	209,250	243,568	259,456	265,522	243,154

Total 5-Year Dollar Cost (Dollars) $1,461,150

Two final notes on the budget:

1. The cost estimates are based on very incomplete information. Cost of site preparation was not estimated. The team hopes the information on the categories of expenditures and the kinds of things that will be needed will be helpful but the magnitudes of the figures will need very careful consideration and substantial revision.

2. The item for housing is one of the most costly items in the budget. The most costly housing alternative was used in the budget summary. The capital cost could be reduced by some four million baht if the least costly alternatives were used. This would require some additional operating costs such as housing allowances and a bus shuttle system but might well be considered as a less costly alternative.

APPENDIX I

Secondary and Miscellaneous Crops which might be considered for testing and evaluation:

A. Fruits:

1. Guava
2. Citrus (tangerines, kumquats)
3. Cherimoya
4. Loquat
5. Persimmon
6. Purple Granadilla
7. Kiwi
8. Tropical Gooseberries
9. Raspberries
10. Strawberries
11. Isabella Grapes
12. Plantain
13. Sapodilla
14. Sugar Apples

B. Essential Oils

1. Tung
2. Cinnamon
3. Citronella
4. Peppermint
5. Lemon grass
6. Patchouli
7. Sandalwood oil
8. Coriander
9. Camphor
10. Anise oil
11. Basil

C. Drugs and Medicinal Plants

1. Papaver bracteatum
2. Croton oil (Croton tiglium)
3. Sarsaparilla
4. Wormwood
5. Balm

6. Bael tree
7. Belladonna
8. Digitalis

D. Spices

1. Caraway
2. Cardamon
3. Celery
4. Jasmine
5. Mignonette
6. Saffron
7. Savory
8. Tumeric
9. Allspice
10. Bay Tree
11. Cassia Bark
12. Cinnamon
13. Clove
14. Ginger
15. Galabash Nutmeg

E. Herbs

1. Acalpyha indica
2. Amarantus gangeticus and polygonoides
3. Lavender
4. Cassia auriculata
5. Lemon grass
6. Mustard
7. Marjoram
8. Parsley
9. Rosemary
10. Sage
11. Cumin
12. Fennel
13. Fenugreek
14. Chervil
15. Tarragon
16. Thyme

SUGGESTED PROCEDURE FOR HIGHLANDS STATION, PLANT INTRODUCTION SECTION

Since each collection of new germ plasm is limited in quantity, it must be increased to provide adequate working stocks to meet the demands of plant breeders and other research workers. When an introduction has been increased, it is essential that it be maintained, either as vegetatively reproduced stock or as viable seed.

New introductions of germ plasm are of greater value to plant breeders and other research scientists after the stocks have been characterized and evaluated by screening for various desirable or undesirable properties and this information is made available. Therefore, the introduction, multiplication, maintenance and evaluation of plant germ plasm are all necessary activities and would be the primary responsibility of the Plant Introduction Section of the Highlands Station.

It is emphasized that the Plant Introduction Section would not conduct plant breeding programs, but would provide plant breeders and other researchers with germ plasm materials, evaluated and documented with as much information as possible. Additional documentation and evaluation will be required of the plant breeder and other scientists.

I. EXPLORATION

A. Preparation

1. Request should come from scientists at the Highlands Research Station, other research stations and perhaps other agencies including Forestry, Extension and Universities. Request should come to program leader (Pathologist). If the program leader approves (or perhaps a committee should be appointed to review exploration requests) it should be recommended to the Department of Agricultural Technology for approval and for funding if foreign travel is involved.

2. If foreign travel is involved, the Department of Agricultural Technology could set up contacts, arrange transportation, passports, etc. Considerable correspondence would probably result.

B. Collection

1. Often accomplished via exchange of letters and/or plant material. Collection made by local plantsmen and sent to Thailand.

2. Collected by Thailand scientists who are specialists in various fields. An example of a sheet that collectors could use for notations on each collection is shown in Chart No. 1.

CHART NO. 1

Latin Name: _____
Local Name: _____
Locality Data: _____

Plant Description: _____

Special notes: _____

Wild? _____
Cultivated? _____

Collector: _____ Date: _____

THAILAND DEPARTMENT OF AGRICULTURE

Form Number _____

II. QUARANTINE:

The Plant Protection and Quarantine Center is located at Bangkok. This should be the main entry point where all plant introductions are sent for standard methyl bromide treatment, and visual inspection for contamination with pests of all sorts (insects, mites, nematodes, disease organisms, etc.). If a taxonomist is available

the plant introduction should be identified as to species. The material should then be sent to the Highlands Plant Introduction Section and the information, as illustrated in Chart No. 2 assigned to the new accession. This should be combined with any information that accompanies the introduced material as shown in Chart No. 1. Some material such as the stone fruits, etc., should require a post entry quarantine where each introduction undergoes extensive screening such as indexing for viruses, etc. This could require two or more years.

CHART NO. 2

1. Assignment of accession number: _____

2. Scientific name: _____

3. Source of Collection: _____

4. Collector's name: _____

III. OFFICE FUNCTIONS (PRIMARY SEED MATERIAL)

A. Incoming Seed

1. The seed packets should be stamped with date of arrival.

2. Each accession number and perhaps a numerical station number for cross reference should be entered in the incoming seed ledger.

3. A 3-part index card should be typed for each plant introduction and filed as follows:

a. Original - numerical file in office
b. Second copy - genus and species file in office
c. Third copy - file in seed house where all seed is stored. An example of this card is illustrated in Chart No. 3.

CHART NO. 3

Genus _____ Species _____ Accession No. _____

Station No. _____ Source _____

Reporter or collector: _____

Institution: _____ Date: _____

Description and special value: _____

_____

_____

B. Outgoing Seed

1. Requests for seed should be stamped the day received and logged into a correspondence log. The seed order is given to the project leader, and then to the agronomist or horticulturist depending upon the type of seed requested. Scientist notes accessions for seedsworker to send out and return correspondence to secretary. Then a copy of the request is given to seedsworker to fill.

2. Seedsworker fills request from storage in the seedhouse and gives seed to secretary who types shipping documents and forwards seed to the requestor (See Chart No. 4.).

3. Shipping document

The shipping documents should be distributed as follows:

a. Seed sent to cooperators within Thailand - original copy with seed to scientists making request; second copy to plant introduction file; third copy for the agronomist or horticulturist at Plant Introduction Station.

b. Seed sent to foreign countries - essentially the same as above, plus any regulation that Thailand may have on exporting material.

4. Original letter requesting seed marked with date seed sent and then filed. Date seed sent logged in correspondence log.

CHART NO. 4

SHIPPING DOCUMENT

Shipping Station	Shipped by	Date Weight
Accession	Species Name	Source of Original Collection
_____	_____	
_____	_____	
_____	_____	
_____	_____	
_____	_____	
_____	_____	

Supplemental information on above species _____

_____

THAILAND DEPARTMENT OF AGRICULTURE

Form No. Plant materials shipping invoice Receiver

IV. MULTIPLICATION

A. Seed Increase

1. Seedhouse preparation:

New incoming seed should first go to the seedsworker together with the record file prepared by the secretary and both are taken to the seedhouse where a planting packet (with pertinent labeling) is made to increase the new line. Most material will be planted in the field at the normal planting date. If the seeds are in critical supply and the weather or time of year is a problem they may be increased in the greenhouse. Either pint cans with a screw-type lid or heavy duty 5" by 9" seed envelopes can be used for storage of the increased seed of a new line (see Chart No. 5). The can or envelope should be labeled with the accession number and scientific name and source. The remaining seed should be kept in the original packet for further seed increase as needed. The information from the packet should also be recorded on the seedhouse inventory list. The line then goes to the greenhouse, lath house or field, for seed increase. During the growing season notes should be taken for the inventories. After the material is harvested the seed is placed in cold storage in the can or envelope previously assigned. Extra envelopes properly labeled can be used if there is excess seed. Periodically all material is checked for low germination and/or low seed supply. When either occurs, the material is again planted in the field for increase. Normally there should be sufficient seed available of each plant accession so that the recipient can plant a 20 foot row. The seed can be sent in stamped coin envelopes (See Chart No. 6), along with other pertinent data available on the accession, similar to Chart No. 7.

CHART NO. 5

Accession number _____

Scientific name _____

Source _____

Year of increase _____ % germination _____

Year of reincrease _____ % germination _____

CHART NO. 6

Highlands Plant Introduction Section

Accession No. _____

Genus _____

Specie _____

Source _____

Report performance to the project leader
of the Highlands Plant Introduction Section.

2. Field Operations

Plant introductions that are not direct seeded may be planted in the greenhouse in the winter, transferred to the lath house to harden off, and then transplanted to the field. For field crops about 20 plants are transplanted, spaced about 1 foot apart, in row settings convenient for either hand or machine cultivation. Transplanting may be done by hand or if the terrain is suitable a small 10 H. P. tractor (lawn type) can be adapted for use in transplanting. Most field crops may be direct seeded in 20 foot rows. The

usual weeding, irrigation, fertilization, note taking, harvesting, etc., follow. The note taking on the accessions will vary depending upon the species being evaluated. All material evaluated by the Plant Introduction Section plus all cooperating agencies should collect this information. An example for beans is illustrated in Chart No. 7.

CHART NO. 7

BEAN PERFORMANCE NOTES

Highlands Plant Introduction Section

Scientific Name _____ Accession No. _____

Origin _____ Cross Reference No. _____

Plant Date _____ Station and Reporter _____

Plant:

Habit: det, indet, delayed. Size: l, m, s,
Foliage*: leaf size _____, internode length _____
Uprightness* _____ Branching* _____ Stem Color: Green, pink, purple

Flowers: Date: _____ Color: White, pink, lavender, purple
Concentration* _____ Racemes* _____

Pods: Date: _____ Concentration* _____ Length(inches) _____
Constriction* _____ Straightness* _____ Wall*thickness _____
Beak* _____ Strings + or - (plus or minus) Color: mottled, green (l, m, d)
Maturity (date) _____ Type (check one) snap_____ wax green shell _____

Seeds: White, red, tan, brown, purple, black; mottled; streaked: flecked, light, dark; size _____

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Diseases:	Susceptible to:	% infection	% dead
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

Insects: _____

Remarks: _____

* Score 1 to 5 with 1 as least or poorest

Harvesting, Drying, Cleaning and Processing: Steps performed after each plant accession has been established and identified by staking and a field record book developed for the field.

a. Harvesting may be determined by maturity of plants and seed, moisture in plants and seed, and amount of dehiscence. This can be accomplished by observation.

b. Methods of harvest -- The majority of the material can be cut with a hand sickle or Jeri mower, and put in a paper bag ranging from 1 - 50 pounds. If the accession is too bulky to put in paper bags, then plants can be cut, let dry in the field and threshed with a Vogel thresher. A method that is often used on small quantities and lines that shatter easily is to simply rub the seed in a pan. It might be feasible to collect small vegetable seed using a portable vacuum cleaner which was originally designed to collect insects.

c. After harvesting, all material should be put in a drying room to enhance threshing and to reduce seed moisture to a level which will be most

advantageous for maximum seed longevity in cold storage.

d. Threshing and cleaning -- Most of the accessions can be threshed by a Vogel thresher. Seed can be further cleaned by the use of hand sieves. Larger quantities of seed may be run through a "Clipper" cleaner. Small quantities of seed and other troublesome accessions may necessitate rubbing by hand or over a rubber strip or dehiscing by hand. The final seed cleaning procedure is using the North Dakota Seed Blower. This machine is a pneumatic separator using a controlled air quantity running through an inverted U-shaped plastic tube. The seed is separated from non-seed material on the basis of specific gravity. After cleaning the seed is taken to the cold storage room for permanent storage.

V. MAINTENANCE

The main objective here is to limit the number of expensive replantings needed to keep the germ plasm true to type and in a good viable condition. To keep the seed in a viable condition a low humidity cold storage room is required. A "rule-of thumb" is the sum of the figures for relative humidity and temperature to be under 100, preferably with the RH on the low side, i.e. 40°F and 30% RH (= total of 70).

When the seed containers previously described are full this can be assumed to be the "working stock levels for storage". The unique accession numbers, scientific plant name and source from which obtained are written on each can, seed envelope, field stake, etc. and this must be duplicated with great accuracy.

Many crops will remain viable for many years under these conditions, a limited number for only a few years and a few such as lettuce and onions are quite short-lived and require deep freezing or other methods of maintenance. Perennials may be kept continually growing in the field and fresh seed obtained as needed.

In the field, plants should be sprayed to keep out insects and such methods as sib pollination by hand, covering the inflorescense with bags, isolation or whatever is required to keep the plant introduction true to type. Whatever method is used the introduction should be maintained with all its variability and not selected for specific types. It is essential to keep a broad base of germ plasm so researchers can make their own selections to fill their various needs.

All information obtained on the characteristics and performance of individual plant introductions should be recorded and placed in an inventory. These should be printed and circulated to research workers. A fast data retrieval system should be devised if the station is to be of service in meeting the needs of researchers.

VI. VEGETATIVELY PROPAGATED MATERIAL

A. Incoming Propagated Material

1. All materials should come through the quarantine station for treatment, usually with malathion, and then sent to the Highland Station as quickly as possible since vegetative plant material is perishable.

2. Identify in an accession book with Highland Station accession number and list in the appropriate filing systems.

3. An accession number should be assigned even if the material does not survive. This is useful information.

B. Establishment and Maintenance

1. Depending upon the need and Thailand Government regulations for material collected from other countries, two quarantine categories may be required.

   a. Post-entry quarantine of permissible plant materials.
   b. Quarantine of prohibited materials.

Although most plants will probably enter under the post-entry quarantine program, some species may be required to pass through more intensive investigations. These quarantine measures may be handled by the Plant Quarantine Station or the Highland Plant Introduction Section, depending upon existing regulations. Screen-houses and isolation areas will be required. In any event no propagated material should be distributed to the various experiment stations, universities, growers agencies, etc., until it is certain that the material is free of exotic injurious insects, diseases or viruses. Time required may vary from six to twelve months.

2. New plant material that is to be potted requires sterilized soil. This can be done with a portable steam sterilizer by placing the soil under plastic and injecting steam. The establishment of incoming plant material may require a greenhouse with controlled humidity and temperature using intermittent and/or constant mist systems. This will depend upon the plant species. Some species may be established in a lath house.

3. After establishment in the greenhouse the material should be moved to a lath house, with various degrees of shading, for additional growth and an initial hardening process. Saran cloth may be used over the top of the lath house to provide from 15% to 90% shading. It is also important to maintain rootstocks on which introduced material can be budded or grafted. Many of the propagated vegetative cuttings will not root, therefore, rootstocks must be maintained.

4. After sufficient growth of the various species has been obtained the material can be moved from the lath house to a hardening area in the sun. This is generally required for increased survival since the lath house is partially shaded. The material should be kept in containers throughout this entire process.

5. After the material has undergone a sufficient hardening process, it is transplanted to the field. Normally, because of the small quantity of material originally received, the usual procedure is to plant three trees of each introduction in the field and keep an equal number in the lath house or hardening area so that if any of the material dies in the field it can be replaced.

6. For the material planted in the field a field book should be maintained showing the field design and identifying the field, block, row and placement within the row of each accession. In addition, each plant should be tagged with its unique accession number.

7. Throughout the growing and evaluation process complete notes should be maintained on pre-determined cards providing information or morphological characteristics, growth habit, size and shape of fruit, disease and insect susceptability, etc.

C. Outgoing Plant Material

1. Propagations should be obtained from the field-established material.

2. Depending upon the species, some of the material should be rooted prior to shipment. The rooted material can be wrapped in sterilized sphagnum for shipment. Those not requiring rooting, but can be shipped as vegetative cuttings, wrapped in sterilized sphagnum and placed in plastic bags.

3. Particular care should be taken to include the accession number and other collected data pertaining to the material, and also to keep pertinent station inventory records of outgoing material. Instructions should be sent to the receiving station detailing the information that the Highlands Station would like to receive pertaining to the performance of the material at other locations.

TEAM'S ITINERARY

AUGUST 30

The Team met with Dr. Fletcher Riggs, Assistant Director, Office of Agriculture, USOM/Thailand, and Dr. Bhakdi Lusanandana, Director-General, Department of Agricultural Technology, Thailand, to discuss goals and objectives of the mission.

SEPTEMBER 3

Team left for Chiang Mai via RTG vehicles accompanied by Mr. Pairoj Polprasid, Mr. Manope Pavakul, and Mr. Thanoo of the Department of Agricultural Technology. On the way to Chiang Mai, the Team stopped by Doi Musser Experiment Station. The station, situated in Tak Province with an elevation of 1,100 M and an average rainfall of 2,500 mm covers an area of about 2,000 rais. Mr. Inson Klongkangorn, Station Chief, accompanied the Team on a tour of the station and explained the various works going on in subtropical fruit tree research. Other work included feasibility studies on the production of various vegetables for seed.

SEPTEMBER 4

The Team met with Dr. Wallace E. Manis, Project Manager, U.S.D.A., accompanied by Mr. Sunan Laongsri, Station Chief, Mae Jo Agricultural Experiment Station, Mr. Pairoj Polprasid and Mr. Manope Pavakul.

Mr. Manis briefed the Team on the various crop substitution projects funded by U.S.D.A./ARS and the United Nations Program for Drug Abuse Control in Thailand. The Team proceeded to Chang Khian Highland Agricultural Extension Training Centre and Field Crop Development Station where a training program is underway for 22 trainees from five hilltribes. The station manager, Mr. Jitti Pinthong, showed the Team members the research in progress at the station.

A brief stop was made at the Buakha Station where the Team was met by Dr. Pavin Punsri, Project Leader for Fruit Crop Research of Kasetsart University, and Prince Bhisadej, Director of His Majesty's Project of Agricultural Assistance to the Hilltribes. A tour of the tree plantings and research at the Station was made under the leadership of Dr. Pavin. Next stop was at Nong

Hoi Village, one of the King's satellite villages where various crops are being tried for local production. The Team proceeded to the experimental coffee plantings being conducted by Mr. Sunan Laongsri.

SEPTEMBER 5

Starting at 0700, the Team was taken by Mr. Pairoj, and Mr. Manope on a tour of the fresh produce market of Chiang Mai where the Team members had a chance to observe local marketing practices and fruits and vegetables in season. Again, accompanied by Mr. Pairoj, Mr. Manope, Mr. Thanoo and Mr. Sunan, the Team went to the proposed Doi Inthanon Research Station site. The site, about 96 Km. from Chiang Mai, has an elevation beginning at about 1,500 M and is located just above the Siriphom Falls. An observation of the site was made after a strenuous climb of almost two hours to the crest above the falls. On the way back to Chiang Mai, the Team stopped by Sanpatong Rice Experiment Station and Dr. Vitoon briefed the members on the various rice improvement projects in progress at the station.

SEPTEMBER 6

The Team went to Mae Jo Agricultural Research Station and visited with Mr. Sunan Laongsri who showed the members the soybean, mung bean and coffee research in progress. Mr. Sunan also briefed the Team on other training and research programs of the station.

Next stop was the temporary headquarters of the Northern Region Agricultural Development Center (NADC) at Chiang Mai. Dr. Krui Punyasingh Director of NADC and Mr. Vieldman, Project Manager for NADC, met the Team and Mr. Vieldman gave a brief presentation on the role of NADC in coordinating agricultural research and extension for Northern Thailand.

The Team returned to Bangkok by plane and met with Dr. Fletcher Riggs and Dr. Bhakdi late in the afternoon. Dr. C.P. Wilson, the Team Leader, reported on the trip to Chiang Mai and also discussed some questions pertaining to the Team's assignment in Thailand.

SEPTEMBER 9	Team met with Dr. Bhakdi and Dr. C.P. Wilson presented an outline of the report that will be made by the Team in connection with the establishment of the Highland Agricultural Research Station.
SEPTEMBER 12	Team met with Mr. Adul Warawisthuwong, Plant Quarantine. Mr. Adul discussed his work in plant and material control in Thailand, which includes enforcing plant quarantine rules and regulations for incoming and outgoing plant materials and controlling accuracy of labeling agricultural chemicals for sale in Thailand. The Team met with Dr. Pavin at Kasetsart University and discussed various problems and researches that should be conducted at the Highland Agricultural Research Station. Dr. Pavin also discussed with the Team his work in improving fruit production, processing and marketing in Thailand.
SEPTEMBER 15	Team left Bangkok for Chiang Mai by plane.
SEPTEMBER 16	Team met Mr. W.E. Manis, Mr. R. Mann and Prince Bhisadej at the UNPDAC Headquarters. An arrangement for a helicopter trip to Doi Inthanon and Ang Khang Research Station was made with Prince Bhisadej for September 18, 1974. Dr. Marvin Wilson met with Mr. Manis and discussed problems related to plant introduction. Dr. C.P. Wilson met with Dr. A.R. Thodey of the Ford Foundation while Dr. R. de la Pena and Mr. C.A. Duncan went with Mr. Manope to Mae Jo Agricultural Research Station.
SEPTEMBER 17	The Team, accompanied by Mr. Manope, visited Fang Research Station. The station located in Northern Chiang Mai is used mainly for vegetable and fruit research.
SEPTEMBER 18	Accompanied by Prince Bhisadej, the Team went by helicopter to view the proposed site at Doi Inthanon then proceeded to Ang Khang Research Station. Prince Bhisadej discussed the goals and objectives of Ang Khang Research Station and showed the Team the research in progress.

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SEPTEMBER 20	Dr. C.P. Wilson attended a conference called by the U.S. Embassy to discuss prospects for opium production in the coming year. The conference was also attended by representatives of A.I.D., U.S.D.A., U.N., King's Project, Missionaries and officials of the Royal Thai Government. Dr. M.L. Wilson, Dr. R.S. de la Pena and Mr. C.A. Duncan went with Mr. Garry Oughton of the Tribal Research Center, Chiang Mai University, and Mr. Manope to the UNPDAC research station at Chang Khian. Mr. Oughton discussed with the team members the various soil and climatic characteristics of the hilltribe farms where opium is grown and showed some possible alternative sites for the Highland Agricultural Research Station.
SEPTEMBER 22	Left Chiang Mai for Bangkok by plane.
SEPTEMBER 26	Team met with USOM staff, headed by Mr. Roger Ernst, Director, USOM/Thailand, Mr. Guy Havilland, U.S. Agricultural Attache, Thailand, and Dr. Fletcher Riggs. Dr. C.P. Wilson made presentation on the report that the team was working on. Others present were Mr. F. William Small, Mr. Jon Sperling and Mr. Charles Rheingans.
SEPTEMBER 27	Dr. C.P. Wilson, Team Leader, accompanied by Dr. Fletcher Riggs and Mr. F. William Small, met with Mr. Pairoj and Mr. Manope of the Department of Agricultural Technology to discuss the report being prepared by the team.
SEPTEMBER 28-OCTOBER 1	Team prepared draft of report. On October 2 Dr. C.P. Wilson presented an oral report to the Deputy Chief of Mission and his staff and also to the Income Substitution Subcommittee.

APPENDIX IV

Biographical Data for Team Members

Dr. C. Peairs Wilson

Team Leader, B.S. and M.S. Kansas State University, 1938 and 1940 respectively; Ph D. University of California, Berkeley 1958. Instructor to Professor of Agricultural Economics, Kansas State University 1938 - 1952. Assistant Director of Kansas Agricultural Experiment Station, 1952 - 1965. Also, Director of Resident Instruction in Agriculture, Kansas State University, 1956 - 1963. Dean, College of Tropical Agriculture, Director, Hawaii Agricultural Equipment Station and Director, Hawaii Cooperative Extension Service, 1965 to date.

Assisted in administering Kansas State University AID, India Contract, 1956 - 1965 and University of Hawaii, AID, Kasetsart University Contract, 1965 - 1966. Executive visit to India, June, July 1957. Consultant for Ford Foundation to Brazil, October, November 1963; Consultant for East-West Center to Taiwan, the Philippines, Malaysia, Thailand and India, June, July 1966. Site Visit to South Vietnam to consider possible University of Hawaii - AID Contract, March - April, 1971; Consultant for Ford Foundation to Kenya, October - November 1972.

Dr. Marvin L. Wilson

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B.S. University of Philippines at Los Banos 1958, M.S. University of Hawaii, 1965 and Ph. D. University of Hawaii, 1967. Research Assistant, University of the Philippines 1958 - 1960. Assistant in Plant Physiology 1960 - 1965 and Jr. Soil Scientist 1965 - 1967 at the University of Hawaii. Assistant Agronomist 1967 to present, Hawaii Agricultural Experiment Station, College of Tropical Agriculture, University of Hawaii. Rice Training Officer, University of Hawaii 1968 - 1972. Director, Office of Economic Development, County of Kauai, 1973 - 1974.

Mr. Charles A. Duncan

B.S. and M.S., University of Illinois, 1938 and 1949 respectively. 1941 - 1947, Armed Forces; 1947 - 1948, Agriculture Advisor, U.S. Military Government in Korea, Seoul, Korea; 1949 - 1954, Research Horticulturist, Guam Agriculture Experiment Station, Mangilao, Guam, Marianas Islands; 1954 - 1957, Horticulture advisor, United States Civil Administration in Ryukyus, Okinawa, Ryukyu Islands; 1957 - 1962, Soils and Crops, Research Advisor, USOM Korea; 1962 - 1968, Horticulture and Rice Research advisor, USOM Nigeria; 1968 - 1969, USOM Area Advisor, Iloilo, Philippine Islands; 1969 - 1974, Horticulture Research Advisor, USOM Afghanistan; 1974, Horticulture Advisor, Technical Assistance Bureau, Crops Production Section, Agency for International Development, Washington, D.C. [illegible] - June 13, 1974, USOM Laos - planned a tropical fruit and [illegible] alternative - Crop Improvement program.