INTERNATIONAL SOYBEAN RESOURCE BASE

A PROPOSAL

Prepared by the College of Agriculture, University of Illinois for the consideration of the World Consultative Group on Agricultural Research and its Technical Advisory Committee

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The Appendix was not ready for inclusion in this report.

It will be made available shortly.
INTERNATIONAL SOYBEAN RESOURCE BASE

I. SUMMARY

For some time, the Technical Advisory Committee of the Consultative Group has been interested in the potential of soybeans as a source of high-quality, low-cost protein for human nutrition. The TAC has requested that a study be made of ways in which existing competence in soybean improvement, production and utilization could be organized to serve the needs of developing countries, much as is now being done by major international centers (IRRI, CIMMYT, CIP, etc.) for other major food crops.

The proposal presented herewith has developed from this study, and recommends the establishment of an International Soybean Resource Base (INTSOY). The Resource Base would be built around the existing major domestic program in soybeans at the University of Illinois, Urbana-Champaign, and its cooperating agencies, and would specifically develop from the cooperative International Soybean Program at Illinois, in close collaboration with the University of Puerto Rico, Mayaguez Campus. These two institutions are presently engaged in cooperative soybean work, with international orientation, largely under programs supported by USAID.
The need for such a Base arises from major human food shortages in protein and edible fats, which exist in a significant proportion of the world's area and population, and from the unique dual-purpose potential of the soybean (Glycine max) to satisfy existing food needs. Recent field experience in several tropical and subtropical countries has shown that high yields (above 2,500 kg/hectare) can be obtained under favorable conditions with this crop, using the best-adapted present varieties. Since soybeans have approximately 40% well-balanced protein and about 20% utilizable edible fats, this crop obviously can play a major role in overcoming significant shortages of these two important human nutrients, especially in less-developed countries.

At present, actual soybean yields in developing countries average less than half the known potential level cited above, particularly in subtropical and tropical areas. Evidence thus far obtained indicates that a well-adjusted and complete balance of adapted varieties and proper cultural practices is required for soybeans to be successfully grown in tropical and subtropical environments but much of the specific information needed to achieve high yields regularly is not available in most developing areas. Varietal improvement is necessary, to obtain widely-adapted types more tolerant of the production hazards of the tropics, especially for continued production on large acreages. Methods of handling, marketing and storage suitable for the tropics and subtropics must be developed. A basic process is now available for low-cost direct conversion of whole soybeans to human food products, but intensive development of this process and adequate nutritional studies are needed before it can be of maximum utility. Thus, while soybeans have great potential to contribute to world food supplies, the contribution will not be automatic. INTSOY is proposed as an institution to help convert that potential into reality.
The proposed Base is to be developed from the existing AID-funded international soybean program at the University of Illinois and the University of Puerto Rico. Its goal will be to enhance world capacity to supply human food needs for protein and edible fats, especially in the tropics and subtropics, through substantial improvement in soybean production and utilization. An operational principle will be to strengthen the research and production competence of country and regional soybean programs through research, training, communication and technical assistance (outreach) programs.

The Base programs in research, training, communications, and technical assistance will be organized around three substantive problem areas:

1. **Production**: Including supportive work in plant breeding, improved cultural practices, soil fertility, production economics and production engineering.

2. **Protection**: Including identification and control of limiting plant diseases, insect and animal pests, and weeds.

3. **Utilization**: Including storage engineering, food technology, nutrition and marketing economics.

Special emphasis in the production improvement programs will be placed on assembly and computerized referencing of germ plasm collections considered useful in tropical and subtropical programs of soybean breeding. Close liaison will be maintained with the USDA-ARS staff now handling the world germ plasm collection. In plant breeding, particular attention will be given to the formation of breeding populations and gene pools combining favorable agronomic characteristics, high disease and pest resistance, and grain quality best suited for human nutrition. These gene pools will be made available to national and regional breeding programs for development of specific lines. Also, breeding populations will be developed as appropriate to help solve local or regional problems limiting production.
Cultural practice and plant physiology studies will be aimed at finding optimum plant populations and planting dates, and the best crop sequences which include soybeans in cropping systems which will maximize yields and economic returns. Soil fertility problems and the economical supply of adequate Rhizobium inoculation will receive major attention. Production engineering and production economics studies will be carried out in close collaboration with the agronomic work, and will be focused on determining the economic potential for and likely areas of economic production in the tropics and subtropics.

In plant protection studies, virus diseases of soybeans will receive priority attention. These diseases are particularly important in tropical and subtropical areas. Closely related to this problem will be intensive studies of soybean insects, since several of the major virus diseases are insect-borne. Fungal and bacterial diseases, particularly those attacking seeds and seedlings, and nematodes also will be included in the Base programs. For both disease and insect control, special attention will be paid to the use of genetic resistance, through cooperative programs involving plant breeders, pathologists, entomologists and physiologists.

Utilization studies will emphasize human food uses of whole soybeans and products derived therefrom. Existing technology for the direct food use of whole soybeans will be expanded by study of specific country and area requirements. Exploitation of simple, low-cost processes to produce foods suited to the food habits of particular populations will be sought, to broaden the potential base for food utilization of the crop. Nutritional studies, including bioassay and human diet trials, will be conducted. Cooperation with existing nutritional research centers in developing areas will be established and utilized to maximize the effectiveness of the Base programs. Special attention will be paid, in plant breeding programs of
the Base, to development of types with the highest possible nutritional value and usefulness. The economic problems in marketing soybeans and soybean products will also receive early attention by the Resource Base, as required.

The Base will operate a network of training and communications systems to provide linkages for strengthening regional and country soybean programs. These systems will include (1) training and communications; (2) linkage relays; and (3) technical assistance (outreach) teams, as required.

The Base will organize conferences and workshops related to soybeans, with as many of these as is practical to be held in tropical and developing areas. The linkage and communications activities will include the operation of a computerized soybean information storage and retrieval system. This will be expanded from existing specialized systems on soybean germ plasm, soybean-related insects and related topics.

Training activities will stress short-term, practical in-service training of soybean research and development staff from developing countries. As soon as possible a large component of this training will be in Puerto Rico, and some will be at relay stations or other sites in developing countries. More extensive, formal graduate training at the University of Illinois and the University of Puerto Rico also will be available in Base programs. A limited number of post-doctoral research training programs will be supported.

Special linkage relay station operations are planned in conjunction with cooperating international crop research centers such as IITA, CIAT, IRRI, ICRISAT, and CIMMYT. These will involve small teams of appropriate Resource Base scientists at the cooperating International Center or Institute, working with the crop as it fits into local or regional cropping
patterns. The linkage teams would be funded through contractual arrangements, retaining their Base affiliation but operating as an integral part of the International Center research programs. This arrangement would facilitate focusing of special Base competence and resources related to soybeans, on regional and area problems of special concern to the respective Centers.

Technical assistance (outreach) programs will be jointly developed with interested donor agencies and cooperating countries. Typically, such a team would be practically-oriented, and would consist of one or a few Base staff members, and a small number of short-term consultants, to provide guidance and technical assistance aimed at rapid enhancement of local country competence in soybean research and development.

The Resource Base will be guided in its policies and long-range program planning by an International Advisory Board. This Board will consist of 12 to 15 members, broadly representing interested agencies and cooperating groups. The internal structure of the Base will include a directorate, headquartered at Urbana, Illinois, with an associate director and part of the staff located at Mayaguez, Puerto Rico. Three major subject-matter groups and the training/communications function will each be under technical leadership of a Coordinator. Relay and technical assistance programs will be coordinated by appropriate staff of the directorate.

A portion of the activities of the Resource Base will be brought into operation in 1973-74, utilizing a USAID-funded contract and 211(d) programs with a first-year annual budget of approximately $400,000. The total core budget needed to meet 1974-75 staffing and operational plans is approximately $700,000 of which approximately $500,000 is expected to be available from USAID contract and 211(d) programs. The 211(d) programs will provide approximately $100,000 additional for training functions in 1974-75.
Additional costs for training, relay, and technical assistance operations will depend on the scale of such operations. Costs are estimated roughly at $85,000 per relay station, an average of $75,000 for each technical assistance activity, and a total of $70,000 for training functions over and above the 211(d) operations for 1974-75.

When the Resource Base develops its full program, annual core costs are estimated to be on the order of $1,000,000. Training activities will increase in scale as the Base becomes fully operational. A total training budget of about $400,000 is a reasonable estimate considering the likely scale of core staffing, and the expected training needs. Linkage relay station and technical assistance support costs should remain approximately as indicated above per site. As the Base reaches full staffing, its capabilities to staff relay and outreach programs will increase.

Many of the facilities required initially for Base operations can be made available on a shared-cost basis from existing installations at Urbana, Mayaguez, and field stations in Puerto Rico. Provision could be made through lease or rental arrangements for additional office and laboratory, as the program develops. However, some future capital outlay probably would provide a more economical and practical solution to the space needs which will be created by anticipated program expansion.
II. SECTOR AND NEEDS TO BE SERVED BY THE RESOURCE BASE

A. Importance and Present Production Level of Soybeans

The proposed Resource Base will concentrate on the genus Glycine (the soybean and its near botanical relatives). While having a worldwide operational scope, it will particularly emphasize work with this crop in tropical and subtropical areas where there is a chronic shortage of protein and edible fats.

The soybean offers unique promise as a source of both protein and fats for human nutrition. The high protein content (36 to 40 percent) with excellent amino acid balance gives the soybean great nutritive advantages over most other oilseeds and vegetable legumes. For example, the protein content of most dry beans and other grain legumes is in the range from 22 to 28 percent; these seeds also have low levels of fat. The peanut, while high in fat, has only about 25 percent protein, and this protein is not as well balanced in its amino acid content as soybean protein. Moreover, the yield levels of soybeans when properly grown are distinctly above those of the peanut and most of the usual grain legumes. This gives a potential economic advantage to soybean products which could be very significant.

Soybean production presently is concentrated in a few major areas, almost entirely located in temperate latitudes. Of the total world production (estimated at about 43.5 million metric tons in 1972), about 75 percent is produced in North America and 17 percent in Mainland China. Other major producing areas include Brazil, the U.S.S.R., and Indonesia. Virtually the entire U.S. production, and much of the supply produced in Brazil, the U.S.S.R., and similar countries, is processed for oil. The residual meal is then used principally for livestock feeding, although it has a major additional utility as an industrial product, and can be used as a source of protein for human consumption.
### World Soybean Acreage, Production and Yields, 1971

<table>
<thead>
<tr>
<th>Western Hemisphere</th>
<th>Acreage (1,000 hectares)</th>
<th>Production (1,000 metric tons)</th>
<th>Yield (g/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Argentina</strong></td>
<td>27</td>
<td>59</td>
<td>21.8</td>
</tr>
<tr>
<td><strong>Brazil</strong></td>
<td>1,850</td>
<td>2,100</td>
<td>11.4</td>
</tr>
<tr>
<td><strong>Canada</strong></td>
<td>146</td>
<td>274</td>
<td>18.8</td>
</tr>
<tr>
<td><strong>Colombia</strong></td>
<td>66</td>
<td>120</td>
<td>18.2</td>
</tr>
<tr>
<td><strong>Mexico</strong></td>
<td>120</td>
<td>240</td>
<td>20.0</td>
</tr>
<tr>
<td><strong>Paraguay</strong></td>
<td>45</td>
<td>60</td>
<td>13.3</td>
</tr>
<tr>
<td><strong>United States</strong></td>
<td>17,176</td>
<td>31,825</td>
<td>18.5</td>
</tr>
<tr>
<td><strong>Africa</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All countries</td>
<td>53</td>
<td>30</td>
<td>5.7</td>
</tr>
<tr>
<td><strong>Europe/Asia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>China (People's Republic)</strong></td>
<td>8,100</td>
<td>6,900</td>
<td>8.5</td>
</tr>
<tr>
<td><strong>Indonesia</strong></td>
<td>700</td>
<td>390</td>
<td>5.6</td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>100</td>
<td>125</td>
<td>12.5</td>
</tr>
<tr>
<td><strong>Romania</strong></td>
<td>120</td>
<td>150</td>
<td>12.5</td>
</tr>
<tr>
<td><strong>South Korea</strong></td>
<td>295</td>
<td>230</td>
<td>7.8</td>
</tr>
<tr>
<td><strong>Taiwan</strong></td>
<td>45</td>
<td>70</td>
<td>15.6</td>
</tr>
<tr>
<td><strong>Thailand</strong></td>
<td>75</td>
<td>70</td>
<td>9.2</td>
</tr>
<tr>
<td><strong>U.S.S.R.</strong></td>
<td>890</td>
<td>605</td>
<td>6.8</td>
</tr>
<tr>
<td><strong>All Others</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>30,178</td>
<td>43,590</td>
<td>14.4</td>
</tr>
</tbody>
</table>
Recent developments in Brazil, Colombia, Mexico, and India indicate a much greater potential for soybean productivity in subtropical and equatorial areas than had previously been thought possible. Utilization of improved varieties and better cultural techniques—especially the provision of adequate inoculation and mineral fertilization—has given dramatic yield increases on a farm scale.

More recently, exploratory studies in low-altitude equatorial areas have shown that even with varieties now available, yield levels of 2,500 to 3,000 kg/hectare are possible. Trials organized under the University of Illinois' PIRIDS (INTSOY) program and conducted in Costa Rica, Indonesia, Ecuador and Nigeria all have reached or exceeded 3,000 kg/hectare in experimental plots.

B. Essential Requirements for Improved Soybean Production in Developing Countries

1. It is clear that successful soybean cultivation in the tropics and low-latitude subtropics, in particular, requires a well-adjusted and complete balance of the proper varieties and cultural practices. If any one major factor is lacking, yield levels are likely to be unsatisfactory. The essential factors appear to include:

   a. Varieties capable of rapid growth, heavy pod setting in a short period of time, and with favorable photoperiodic response.
   b. Adequate inoculation (natural or applied) with effective 
      *Rhizobium* cultures.
   c. Plant populations appropriate for variety, season and climate (300,000 or more plants per hectare).

e. Planting time to coincide with climate and rainfall pattern which will support vigorous growth and allow proper maturity, or supply of adequate and timely amounts of irrigation water.

f. Control of major weeds, diseases, and insect pests.

2. Specific information needed to achieve these high yield levels is not yet available for many areas. Some of the general requirements listed above are not well understood or appreciated by crop scientists in developing countries. Much work needs yet to be done on the improvement of varieties and related cultural practices. The best materials and production techniques already available should be studied more closely in coordinated uniform trials in selected environments, particularly in the tropics and subtropics.

Experience with adoption of high-yielding cereal crops indicates that many developing countries are prepared to quickly increase the acreage of new, superior varieties, and also to adopt the necessary changes in cultural techniques, if major economic advantages can be realized. It is reasonable to expect that similar rapid adoption can be expected if improved soybean varieties and cultural practices can be made available. This is reflected in the fact that Brazil has in the past ten years become a major soybean producing area, and that India has begun development of soybeans as a major new crop on significant acreages. Many other countries, including Thailand, Indonesia, Viet Nam, Korea, and Colombia may be ready for prompt adoption of improved soybean production practices, if an adequate incentive is present.
C. Possibilities for Utilization of Soybeans to Improve Human Nutrition

The conventional method of processing soybeans in Western countries is to extract the oil by solvent or expeller processes, and then to convert the oil and meal into a variety of useful products. The oil can be refined and clarified, and then is suitable for direct use as an edible or cooking oil. It can also be hydrogenated for use in shortenings or a wide variety of other oil-based products for human consumption. Since edible fats are one of the nutritional components in critically short supply in many areas, the soybean is therefore a highly valuable potential source of this major nutrient.

Soybean meal, after processing, is most frequently used as protein supplement in animal (including poultry) feeds. At present, it is the most important source of protein supplementation in animal feeds on a worldwide scale. Recent drastic declines in the world supply of fish meal have greatly increased the demand for soymeal and have pushed prices to record high levels. Soybean meal also can be used, through relatively sophisticated processing procedures, for the production of protein food products for direct human utilization.

In the Orient, many traditional high-protein food products are based directly on soybeans. These include bean curd (tofu in Japan, tahu in Indonesia), soysauce (shoyu in Japan, ketjap in Indonesia, various Chinese names), and many other food products. All these require a greater or lesser degree of processing, often under quite primitive conditions, and many of the processes are based on natural or induced fermentation. The principal reason for processing is to eliminate or remove unfavorable taste components and anti-nutritional factors.
Quite recently, processes developed at the University of Illinois as part of its AID-supported PIRIDS (INTSOY) program, give promise for much wider utilization of whole soybeans in a variety of products for direct human use. The process requires minimal processing equipment and technology, and results in products ranging from "cooked beans" very similar to white or navy beans, through spreads and milk-like beverages, to combination foods such as a whole soy-banana flake which appears to be a valuable potential weaning food for many tropical areas.

Intensive further work on perfecting the processing of whole soybeans for direct human consumption is needed. Further, the process needs to be fitted to the specific taste and dietary requirements of the various food-deficient areas. Also, appropriate study of the nutritional value and acceptability of these products is needed before they can be promoted on a large scale.

D. Training in Modern Production and Utilization Techniques

A major need in nearly all developing countries is for training of research and extension personnel in modern practices of soybean cultivation, and in the wide variety of possible techniques for utilizing soybeans as human food. To some extent, these needs also include a requirement for further training in research techniques.

Since much of the appropriate technology is already known, there would be an adequate basis for conducting much of the needed training by demonstrations, short courses, and workshops in the developing areas. This could be done by cooperative efforts of local personnel and skilled technical and training personnel from an appropriate center of excellence in soybean technology.
More intensive training can be conducted at one or a few sites in tropical areas, where ongoing programs of soybean investigations are underway, and where there is a concentration of expert staff. These conditions can be met by the proposed program in Puerto Rico, and also at some of the international research centers if adequate technical support can be made available through the Resource Base.

Some individuals, especially those who are to occupy key positions in future soybean research in developing countries, will require more intensive training than that indicated above. Such training would include a combination of practical experience at tropical research sites, and classroom training at a major educational institution with a developed postgraduate instructional program. Such training usually, though not always, would lead to the award of a graduate (higher) degree.

A most important need will be a steady flow of information on modern soybean research, cultural practices, utilization, marketing information, product demand, and so on. This need can best be met by a communications system that will provide regular newsletters, reports, appropriate publications through an information service which can respond both regularly and on special call to supply needed information. A Resource Base concentrating on soybean development and research should be able to provide this service efficiently and promptly, utilizing the most modern computerized information storage and retrieval systems.
III. JUSTIFICATION FOR ESTABLISHING AN INTERNATIONAL SOYBEAN RESOURCE BASE

The Technical Advisory Committee (TAC) of the Consultative Group (CG) has for some time recognized the potential of soybeans as a source of major quantities of high-quality protein, at relatively low cost. Since adequate supplies of protein are a major concern in a number of developing countries, there is a special need for focusing existing competence in soybean improvement, production and utilization on the problems and needs of such areas.

No organization currently exists with the scope and capability of providing worldwide research linkages and coordination in soybean improvement and utilization studies. Assigning such responsibility to the existing international centers has been considered. However, this has not been favored by the relevant supporting agencies, for a number of valid reasons.

There is an urgent need to establish an effective program which can stimulate and coordinate activities which will lead to sharply improved yield levels and utilization of soybeans, particularly in tropical and subtropical areas where protein deficiencies are serious and where vegetable protein sources are important as present or potential components of the human diet.

Therefore, TAC has requested a study to determine how existing soybean competence, particularly in U. S. Federal and State agencies, can be organized to serve the lesser-developed areas much as is currently being done for other major crops at international centers (IRRI, CIMMYT, CIAT, IITA, ICRISAT and CIP). This proposal has been developed as a result of that study, and of the encouragement from TAC and other agencies.

Because soybeans have a unique value as a source of both vegetable protein and edible fats, their improvement in developing countries is a
logical component of one of the key problem areas in agriculture and world food supply. In general, there is a pressing need for substantially greater coordinated programs on high-protein crops. International institutes (centers) and national institutions in many developing countries are supporting and conducting adaptive research on grain legume crops, including soybeans to some extent. Such efforts have been directed chiefly toward local or regional problems, and for the most part have not yet led to major advances in productivity levels.

Yield levels of soybeans in developing areas generally are very low. In the past, equatorial and subtropical areas have been considered poorly suited for high soybean yields and attempts of several developing countries to improve productivity have not met with success. The present concentration of soybean production in the temperate zones (latitudes greater than 30°) reflects the low productivity levels in tropical and subtropical areas.

Recent research information, as mentioned in II.A. above, gives encouraging evidence that excellent productivity levels can be attained in subtropical and even equatorial latitudes. There is therefore an urgent need for concentrated efforts to develop practical procedures and widely-adapted varieties which can make this valuable crop locally available in areas where greater food supply is needed, particularly of the high-protein and high-energy categories.

There are promising developments of recent date in the direct human food utilization of soybeans. The combination of adaptive research in this field with nutritional studies, marketing and distribution research, and other work on soybean development is essential if soybeans are to be utilized to their full potential for meeting the nutritional needs of developing countries.
IV. PROPOSED LOCATION AND DESIGNATION

A. Existing and Immediately Projected Program Base

It is proposed that a Resource Base be established around the existing international soybean programs of the University of Illinois and the University of Puerto Rico, Mayaguez Campus. These programs have the following present structure and expected support:

1. Coordinated by the University of Illinois' International Soybean Program (INTSOY), an AID-contract supported program with a first-year annual budget of approximately $200,000. This program emphasizes the production and human-food utilization aspects of soybean improvement and development. It operates a cooperative field trial network on a worldwide basis (see map), and is developing a strong field research program in Puerto Rico during 1973.

2. Grants (211d) from AID, for a joint program between the Universities of Illinois and Puerto Rico, will be closely coordinated with the contract-supported operation. The objective of the 211(d) grants is to enhance the capabilities of both institutions for soybean research and training in the tropics and subtropics.

3. A professional staff of approximately eight persons (6 University of Illinois staff, 2 University of Puerto Rico) will be on full-time duty in these activities late in 1973. The proposed Resource Base will incorporate these existing programs, and their supporting budgets into the core and training budgets of the Base.

B. Proposed Location

It is proposed that Base headquarters be established at the Urbana-Champaign Campus of the University of Illinois, Urbana-Champaign, Illinois.
Core staff will be based at Urbana-Champaign, or at appropriate stations of the University of Puerto Rico, Mayaguez Campus. An Associate Director of the Base will be located at the Mayaguez Campus, to supervise operations in Puerto Rico.

C. Rationale for Proposed Location

The University of Illinois was a pioneer in adaptive research which was a principal factor in the successful adoption of soybeans as a new major crop in the United States, during the decades of the 1920's and 1930's. It has developed into the outstanding center of competence in soybean studies, worldwide. Details of specific departmental and affiliated agency activities in soybean studies are presented in the Appendix to this proposal.

The University of Puerto Rico, Mayaguez Campus, has more recently developed competence in broad-based studies in agriculture which are directly related to proposed work with soybeans in tropical environments. In particular, the island site and the proximity to warm ocean currents give Puerto Rico an essentially tropical climate in subtropical latitudes. This fact, coupled with a wide diversity of altitudes, soil types, and rainfall patterns, make Puerto Rico a most suitable physical location for studies on broad-range adaptation of soybeans for tropical and subtropical conditions.

Recently-developed close working cooperation between the Colleges of Agriculture at the two institutions offers a highly complementary potential for a balanced program of soybean investigations with worldwide application.

1. Urbana-Champaign. As mentioned above, the College of Agriculture, University of Illinois, pioneered practical studies with soybeans in the United States. The Urbana-Champaign Campus is centrally located in the most concentrated area of soybean production and processing
in the world. Outstanding physical facilities and technical personnel are already involved in soybean studies, both in the University of Illinois and in closely-affiliated research agencies such as the Agricultural Research Service of the United States Department of Agriculture, the Illinois Natural History Survey, and the Utilization Laboratory at Peoria, Illinois. A number of commercial firms in nearby locations also are engaged in research with primary concentration on soybeans.

The University of Illinois at Urbana-Champaign is a comprehensive land-grant institution. A basic feature is the integration of public service, research and teaching functions. There has long been a significant international dimension in each of these functions. The University has been widely and formally recognized for outstanding service in international programs, studies, and outreach.

In 1964, the University's College of Agriculture initiated and executed an innovative approach to soybean adaptive research and development. This consisted of a multi-disciplinary and inter-institutional program on soybean research and adoption, with major components and activities at the University of Illinois and at two developing agricultural universities in India. The program was organized, funded and operated as part of the larger involvement of the University in AID-funded programs of Agricultural Universities Development in India.

Growing out of this program, with assistance from an initiating grant from the Rockefeller Foundation and substantial support from the University's own institutional funds, was a worldwide linkage system in soybean production, improvement, pest control, and
Figure 1--Location of INTSOY (PIRIDS) Activities, 1971 - 1972
utilization, under the title "Program for International Research, Improvement, and Development of Soybeans." This "PIRIDS" program, now operating under the title "INTSOY," established linkages and cooperating field trial programs at more than 25 sites, in at least 15 different countries (see map). Most of these sites are in tropical or subtropical areas.

Thus, the University of Illinois has a strong existing program and outstanding resources for its support, to achieve the stated objectives of an international soybean resource base.

2. University of Puerto Rico, Mayaguez and Its Sub-Stations. The University of Puerto Rico, Mayaguez Campus, is a land-grant institution and a fully-accredited member of the Middle States Association of Colleges and Secondary Schools. It has a well-developed and competent academic staff, with a particular advantage for contacts in Latin America where Spanish and English are used in a dual role and interchangeably by both academic and subprofessional staff.

Although the latitudinal location is in the middle subtropics, the island site and the proximity to warm ocean currents give a distinctly tropical character to Mayaguez and to some of the other available field sites. Laboratories and field research sites are available on College property at Mayaguez, and also through cooperation with the Federal Experiment Station and the Puerto Rico Nuclear Center, immediately adjacent. In addition, seven branch experimental stations are controlled by the College of Agricultural Sciences, providing a wide range of agroclimatic and ecological conditions. In all, more than 1,000 hectares are available for field experimental work, and ample office and laboratory space can be allocated.
At the Rio Piedras Experimental Station, a modern and fully-equipped food technology laboratory is available for research on processing, food product development, and product storage. There is already a developed cooperation with the School of Medicine, University of Puerto Rico, on the biological value of proteins derived from plant resources.

3. Established Cooperation Between Illinois and Puerto Rico. Work on a cooperative basis was first directed toward identifying the highest-yielding varieties and most appropriate cultural practices at the Corozal substation of the Puerto Rico Agricultural Experiment Station. Activities during 1973 are being expanded to three other field sites, and also will be intensified in the fields of plant breeding, germ plasm collection and assessment, cultural practices, disease and insect control, and food utilization.

The existence and complementarity of this working arrangement provide a firm base for the establishment of the Resource Base on the same concept. Field research programs and training operations can be conducted in tropical environments, yet convenient travel facilities will permit ready staff interchange and contact between the Illinois and Puerto Rico groups.

Another aspect of this complementary relationship lies in the operation of the computerized data bank on soybean germ plasm and insects. The central facility will continue to be located at Urbana-Champaign; however, computer facilities available at Mayaguez also can be used to amplify and assist in the dissemination of this information. The same relationship exists for library and laboratory facilities, since both institutions have well-developed support
facilities in these fields, and free interchange of materials and information will be possible.

4. **Housing, Transportation, and other Supporting Facilities.** Both the Urbana-Champaign site of the University of Illinois and the various locations available to the College of Agricultural Sciences, University of Puerto Rico, offer special advantages for physical and logistic support of the proposed international soybean resource base. Housing and transportation facilities are available on a rental, lease or individual purchase basis and thus will not be required as capital outlays in the establishment of a Center. Rental or purchase costs are in normal ranges at both Urbana-Champaign and Mayaguez, and it is expected that Center staff would provide their own housing expenses in a manner usual to U.S. university arrangements. Official transportation can be provided by rental or lease arrangements with University motor pools or private enterprises at both locations.

Office and laboratory facilities can initially be provided by rental arrangements, as direct costs, or through indirect cost provisions at both Universities. Eventually, the size of the Base will become sufficiently large that capital expenditure for building facilities may prove desirable. Even in this case, the ready availability of the infrastructure such as libraries, computer facilities, greenhouses, laboratories, and field plots will constitute an important advantage and result in a low capital cost for the establishment of the Base.
D. Proposed Name

It is proposed that the new organization be designated "International Soybean Resource Base." The abbreviation "INTSOY" will be retained as a short title.
V. BASIC OBJECTIVES OF THE PROPOSED RESOURCE BASE

A. Overall Goal

The general purpose of the Base will be to enhance worldwide capacity to supply human food needs for protein and fats, through substantial improvement and increase in soybean production and utilization, particularly in tropical and subtropical areas. It will facilitate interaction between strong existing resources for soybean research and development, and rapidly-evolving regional and country soybean programs in developing areas worldwide. The major principle of the operation of the Base will be to build strong competence in country and regional soybean programs. This will be achieved by research, linkage, training and technical assistance operations to develop improved germ plasm, better production practices, effective distribution and marketing facilities, and the widest possible utilization of soybeans and their products for human nutrition.

B. Primary Objectives

More specifically, Base programs will focus on the following principal problem-oriented topical groupings:

1. Production Improvement
   a. Production economics
   b. Improved crop production practices
   c. Soil fertility studies
   d. Rhizobial inoculation studies
   e. Engineering aspects of improved production
   f. Plant breeding and varietal improvement
   g. Assembly, classification and computerized data bank for germ plasm
2. **Plant Protection**
   a. Plant diseases and their control
   b. Soybean insects and their control
   c. Major weeds and their control

3. **Utilization**
   a. Harvesting, handling and storage
   b. Utilization, processing and food development
   c. Marketing processes and market development

4. **Training and Communications**
   a. Training (both short- and long-term)
   b. Communications
   c. Problems of acceptance of new technology
   d. Network linkages and technical assistance

5. **Special Activities**
VI. SCOPE OF THE PROGRAM

The Resource Base will conduct and encourage research, training, linkage and technical assistance to effect significant improvements in soybean production and utilization in developing areas, worldwide. It will operate at principal central sites in Illinois and Puerto Rico, from relay and outreach stations, and through a cooperative linkage network, according to the general objectives set forth in V. above.

Major areas of attention will be as follows: Details of initial approaches are set forth in the "Plan of Work," Section XII.

A. Production Improvement

1. Production economics
   
   a. The competitive economic position of soybeans in relation to other crops will be studies in selected countries. An analysis will be made of the opportunity to increase total food supplies, especially the supply of protein, by producing soybeans. Such studies will examine the technical alternatives in agricultural production with a view toward delineating the role that soybeans might play in an overall food production program.
   
   b. The economic impact of new soybean varieties and production techniques generated by the Base will be evaluated. Differential impact among farms, will be assessed prior to full scale introduction of the varieties or techniques.
   
   c. Research will be initiated at an early stage to determine the economic potential of soybeans in the cropping plans of individual farmers. Managerial decisions of farmers will
be examined to determine optimum combination of enterprises and optimum combination of resources such as fertilizer, capital, equipment and labor. The analysis will include assessment of probably response of farmers to production incentives provided by the market or by other institutions.

d. A study of the inputs for producers will be initiated to assure access to a supply of the resources required for production. Seed, inoculant and fertilizer will be of primary concern in the early stages of development of the industry but equipment, power, and capital will become important as the industry develops.

e. Comparative costs of mechanized and labor-intensive methods will be an important topic of study, especially in countries with high population densities and small land holdings.

2. Crop production practices

a. Uniform trials to study plant population-variety interactions will be conducted cooperatively at various locations.

b. Trials to determine optimum date of planting, with selected variety differentials, will be conducted in each major agro-climatic zone.

c. Crop-sequence trials will be undertaken at locations selected for adequate representation of major zonal conditions, and for adequacy of facilities.

3. Soil fertility

a. Studies of requirements for major nutrients, such as N, P, and K, will be conducted at a few principal locations. Attention will be paid to the possibility of genotype X nutrient interactions.
b. **Minor nutrient elements** will be a topic of special consideration in areas where there is reason to believe that these elements may be limiting factors to effective soybean production.

c. Special attention will be given to the problem of **acidity** (low pH) as it may affect soybean production and **Rhizobium** collections. In collaboration with plant breeders, a search will be made for strains or types of soybeans and **Rhizobium** which may be more tolerant of the low pH conditions often encountered in wet-land tropical and certain special subtropical conditions. **Low-cost methods of correcting low pH** also will be sought.

4. **Rhizobium inoculation.** Commercially-available inoculants, such as Nitragin and E-Z, are being tested at selected locations, in simple inoculation/no-inoculation trials. At locations where a competent local microbiologist is available, strain trials will be undertaken to determine the usefulness of various **Rhizobium** collections. Where available, locally-occurring strains will be included in these trials. Special problems of local inoculant manufacture, including suitable carriers, will be taken up at a few locations. The actual investigations will be conducted principally in Puerto Rico and by local scientists in cooperating countries, where adequate facilities and personnel are available.

5. **Engineering aspects of production.** The development of appropriate tools, machines, and the associated production, harvesting and storage practices must be integrated with economic studies of costs and returns. Equipment currently in general use in large-scale
mechanized agriculture may not be satisfactory in tropical and subtropical environments. Because of the interaction between production equipment, optimum soybean types, pesticides, weed control techniques, etc., the engineering aspects should be integrated with initial development work as indicated below.

a. **Land preparation** including both the initial clearing of unwanted growth and the preparation of satisfactory seed beds requires the major portion of the mechanical energy involved in production. An analysis of optimum land preparation schemes with varying levels of mechanization, power, and labor input will be made for several typical regions.

b. Appropriate seeding methods must be developed to meet the requirement of establishing adequate plant populations. Special requirements include reasonable accuracy of depth control, row width, and spacing within the row. Also, methods used in high-rainfall areas must leave a soil surface with low tendency to crusting, since compaction and crusting can lead to total or partial failure of emergence.

c. Weed control should center around low-cost, effective mechanical methods and is closely related to land preparation. Chemical means of weed control also may be important in some areas. Equipment involving simple operating instructions and special safety precautions must be developed.

d. Appropriate harvesting and threshing techniques and equipment must be developed. Even where hand harvesting is employed, improved tools may be needed. Small, economical threshing equipment which will not severely damage the
threshed beans is a particular need, since proper threshing and low damage are important to the preservation of both seed quality and value for food utilization.

e. The availability of water at critical stages of plant growth is essential for high-level yields. A number of schemes will be studied to determine economical and practical means of irrigating soybeans. As appropriate, studies will include the feasibility of combining surface irrigation and surface drainage systems.

6. **Plant breeding and varietal selection.** The major objective will be to identify the best-performing available improved strains, and to develop even more superior soybean types in the tropics and subtropics, and to a limited extent for lesser-developed temperate areas. Since development of new varieties is a relatively slow process, breeding efforts will be undertaken immediately, but early progress will necessarily depend on identifying promising types already available, or new strains produced in breeding programs already underway.

a. **Breeding of new strains** with special adaptation to the tropics and subtropics will be undertaken in cooperation with national or regional programs of cooperating agencies. Particular attention will be paid to combining desirable agronomic characters already found in improved varieties, with better ecological adaptation to the growing conditions of developing countries and with high resistance to major disease and insect pests. Particular attention will be paid to broad-scale adaptation, since environmental variability is presently a serious deterrent to the use of available
improved varieties. Physically, much of the breeding and selection work must be done at selected cooperating sites, where trained plant breeders are operating. The central location for special crossing, population development, and early selection will be in Puerto Rico. Early-generation selected material will be distributed to cooperating breeders for further selection and evaluation. Breeding populations combining characteristics of special value will be developed, maintained at the Puerto Rico site, and distributed on request to plant breeders in cooperating areas. Close cooperation will be maintained with varietal development activities in cooperating countries, with the objectives of (1) formulating breeding pools combining the widest possible range of desired characteristics, (2) obtaining broad-scale early testing of new selections, and (3) strengthening local breeding programs by free interchange of materials and technical information.

b. A strong early effort will be to continue and expand major zonal trials now being conducted by the University of Illinois under its AID contract program, at locations representing the main agro-climatical zones of the tropics and subtropics. These trials as now conducted consist of at least 15 and usually not more than 30 established or newly-released improved varieties, or populations being considered for release. In format, they are similar to the worldwide wheat trials being conducted by CIMMYT and the AID/Nebraska wheat project. These trials will be repeated in
each principal growing season, at each test location. They will focus on grain yield, maturity, chemical composition, and major agronomic characters affecting the practical usefulness of the variety under a wide range of environments.

Zones of study will include:

(1) Lowland Equatorial (8°N to 8°S, below 1000m)
(2) Middle-altitude Equatorial (1000-2000 meters)
(3) Low-latitude subtropical (8°-16°)
(4) Subtropical (16°-30°)
(5) Temperate (Latitudes above 30°, or higher altitudes in the subtropics which result in temperate-zone agro-climatic conditions)

Special attention will be paid to differences between constantly humid and alternating wet-dry climatic regimes.

c. Preliminary trials of promising new strains will be conducted at a few selected locations in each zone. Such trials typically will include 25 to 40 promising new selections from breeding programs at Illinois, in Puerto Rico, and in cooperating countries, plus a few varieties of known excellent performance as standards for control. The major purpose of these trials will be to evaluate broad-scale adaptation of new types which are identified as high-performing in their areas of origin. These preliminary trials will be conducted at locations typical of important agro-climatic zones, and where experience has indicated that successful trials can be grown.
7. **Assembly of germ plasm.** Germ plasm stocks with special breeding value for the tropics and subtropics will be assembled and studied in detail. This is important because no single agency presently has specific interest in broadly-adapted material of this type. Physical assembly and field growing of this material will be concentrated primarily in Puerto Rico. Close cooperation in this effort will be maintained with the USDA-ARS soybean research group, which now carries formal responsibility for maintaining the world soybean germ plasm collection at Urbana, Illinois, and Stoneville, Mississippi.

The computerized germ plasm information system developed by the University of Illinois will be fully utilized in the identification of material useful to this project, and for recording the new information gained in further evaluation of such material. This information can then readily be made available to soybean research personnel throughout the world. In turn, new information developed by cooperators and relating to the germ plasm collection will be added to the data bank. Efforts will be made to develop the technical capability for Puerto Rico and selected outreach sites to communicate directly, by cable or electronic means, with the computer data bank on germ plasm.

The Base will assume worldwide responsibility for cataloging and obtaining access to major soybean germ plasm collections. It is contemplated that appropriate linkages can be developed to enable the Base to meet this responsibility without physically maintaining all the available collections.
B. **Plant Protection**

1. **Plant diseases**

a. **Virus diseases** will receive first-priority attention, since these appear to be the most important class of plant diseases affecting soybeans and other grain legumes in tropical and subtropical areas. The existing competence of the Puerto Rico Agricultural Experiment Station in this field will add considerable strength to needed work and will be utilized in the research and training programs. Close collaboration will also be maintained with entomologists for insect vector studies, and with plant breeders since genetic resistance is likely to be a key control measure.

b. **Seed-borne and seedling diseases** will be a second major priority area. The problem of controlling seed-borne diseases will be especially acute since international and interregional transfer of seed stocks and breeding materials is a major and necessary step in rapid development of soybean cultivation in new areas. Seed-borne pathogens also will be studied in relation to mycotoxin production and possible effects on food and feed quality of the grain. Seedling diseases have been found to be of particular importance in high-humidity areas and must be adequately controlled if full plant populations are to be achieved.

c. **Nematology** is a third area of high priority in needed studies. Very little is known about possible yield or quality limitations resulting from nematode attack. This is especially true in tropical and subtropical areas, which are more beneficial to nematode reproduction than are cooler climates. Special attention will be given to interactions between nematodes and root
pathogens, and to the possibility of genetic control through the development of resistant soybean varieties.

2. **Insect pests**
   a. **Identification and classification** work on soybean-associated insects will be strengthened, based on the established, computerized INTSOY world reference collection of soybean arthropods and vectors of soybean diseases. The primary objective will be to maximize effectiveness of both Base and local insect research programs.

   b. Closely related to this activity, the **worldwide soybean insect information** catalog and retrieval system will be expanded, and operated as a service to soybean research personnel in cooperating institutions and areas. This system, based on computerized information storage and retrieval, is already functioning as part of the INTSOY program.

   c. Special attention will be paid to the control of major soybean insects. This will include biological, chemical and genetic control methods. Close cooperation with the plant breeding and engineering staff will be necessary, and considerable field work will be conducted at the Puerto Rico sites. Damage thresholds will be studied for insect pests and vectors, with the objective of minimizing insecticide requirements through the development of pest-management systems and programs.

3. **Weed control**
   a. **Information already available** from the strong Illinois weed research group and from commercial research will be utilized to identify major potential weed problems and to indicate possible control measures.
b. Special attention will be paid to simple and low-cost mechanical means of weed control. Cooperation with cultural-practice studies and engineering work will be very close, with the objective of effecting weed control systems best suited to the conditions of developing areas.

c. Chemical control of the most important weeds, in situations where mechanical control is difficult or too costly, will also be a topic of investigation. These studies will be concentrated particularly at the Puerto Rico research site, and in a small number of other locations where adequate facilities are available.

C. **Utilization, including Harvesting, Storage, Processing, Food Preparation, Nutritional Value, and Economic Considerations**

1. **Harvesting handling and storage**

   a. Trials of hand and simple harvesting methods will be undertaken at appropriate locations. Objectives will be to determine simple and effective methods which are economical and which lead to the lowest possible losses of grain and the least damage to seed.

   b. Conditioning and storage investigations to determine methods suitable for putting and keeping grain in condition for use as seed, human food or for commercial markets in subtropical or tropical climates will be initiated. The investigations will include a study of the availability of power and equipment for grain conditioning and storage in these areas. Simple storage methods, to preserve seed viability and food value, in tropical areas, will receive special emphasis.

   c. Engineering studies of handling and processing as related to the maintenance of human food quality factors will be undertaken.
Areas of particular importance include:

1. Level of enzyme activity in stored soybeans
2. Ease of processing for food use
3. Yield and quality of protein and edible oils
4. Use of whole soybeans as food or in food products

Engineering support will be provided to food utilization research and close liaison will be maintained in conducting engineering studies.

d. Storage of soybeans involves a seasonal price variation reflecting a time preference of consumers. An analysis of the economic and social factors involved in this time preference is a necessary prerequisite to a rational program of storage.

2. Utilization, processing and food product development

a. Existing work on direct utilization of soybeans for human food will be incorporated in the Base program. This would provide a coordinated, interdisciplinary structure which would be unique, and which would be aimed at direct solutions to critical problems to human food supply and nutrition.

b. Nutritional studies would be undertaken, in cooperation with a number of existing research groups, with the aim of developing knowledge of the role of whole soybeans and soy-based food products in human dietary combinations. Necessarily, this program will have ramifications into many regional and local programs. These studies will include appropriate bioassay and human feeding trials of soy-based products. Close cooperation will be maintained with plant breeders, in efforts to develop soybean types with improved nutritional characteristics.
3. **Marketing processes and market development**

a. Research on *consumer acceptance* and markets for soybeans in various forms will be required for each country that has a significant potential for consumption. Special emphasis will be placed on food products based on whole soybeans.

b. For soybeans to become a significant product in consumption or production a market system that moves beyond a single transaction economy is essential. The structure of this market will vary widely from one country to another. Research will be undertaken to establish criteria for choosing ways of organizing a market consistent with the desired goals of society. A plan should be developed for providing facilities and institutions for transferring the product from producer to consumer in the desired form. This includes a system of quality standards and grades, the location of storage and processing units, optimum size of firms in the market, transportation if needed, and a mechanism for balancing supply and demand.

c. In order for these functions to be performed in an efficient and equitable manner a system of *market information* should be
provided to buyers and sellers. Market intelligence at the local, national, and international levels is necessary for rational decisions and development of an efficient industry. The Base, in addition to providing training and developing information systems in individual countries, will function as a primary source of market information and will disseminate such information as is needed by decision makers.

d. Studies will be undertaken to indicate the optimum location and concentration of production, and the marketing facilities required to assure equitable and efficient distribution of returns and products among producers and consumers.

e. The kind and magnitude of problems encountered in financing development projects involving soybeans will vary among countries and regions. Research plans will be developed as needed to provide solutions to problems such as credit for farmers, financing of storage, processing, and marketing facilities.

D. Training and Communications

Training and communications with appropriate networks and linkages are essential aspects of Base operations.

1. Training

a. Conferences. A major international soybean conference will be organized at least once every two years. Puerto Rico is a logical choice for the first conference following establishment of the Base. The objective will be to hold a conference in different major geographical areas of the world during the first few years.
b. **Local and regional workshops** will be organized in cooperation with appropriate agencies. The goal will be one workshop per year at each major linkage site or somewhere in the geographic region. If that is infeasible, one workshop per region will be held during years when there is no international conference.

c. **Practical in-service training** will be made available to personnel from developing areas who are to be actively engaged in soybean research and development. This training will be organized by the project specialists in individual disciplines and fields of concentration. It will be specifically oriented to the particular needs of individual areas and institutions. The Universities of Illinois and Puerto Rico will be major central sites for such training, but outreach locations will be utilized.

d. **Formal training** will be of a more intensive nature including applied and academic aspects. Two types of such training will be:

i. "Post-doctoral" or "visiting professor" appointments will be available, chiefly at the University of Illinois but in selected cases at the University of Puerto Rico, Mayaguez Campus.

ii. Degree programs will be available for limited numbers of persons from developing areas and for students from developed areas who plan careers in international agricultural development. The University of Illinois will be the principal degree-granting agency, but the University of Puerto Rico, Mayaguez, and other selected agricultural universities in the U.S. and developing countries may also be used for
such training. Field work in a tropical or developing country site will usually be a part of such degree program training. Study programs will be developed to meet individual needs and will be monitored by appropriate project specialists.

2. **Communications.** Constant flow and exchange of information is essential to a worldwide program. Conferences and workshops mentioned above are means of communicating. Other methods are proposed.

a. A **newsletter** will be issued regularly, possibly six times a year. It will be started during the summer of 1973 and will be distributed to all cooperating personnel, institutions and agencies. It will also be made available to others on request.

b. The Base will maintain a **roster of soybean specialists** and sources of detailed information which will be used to answer inquiries about the same.

c. **Staff visits** to cooperating sites will provide person to person communications over the range of disciplines involved in the Base. Use of such persons for seminars and workshops will be encouraged.

d. **Dissemination of technical information on request.** Limited quantities of publications, unpublished papers, reprints, etc. including technical information on soybeans will be made available. Sources of such information will be:

i. **Computerized information storage and retrieval system.** The Base will establish and operate such a system to provide information contained therein, on reasonable call, to cooperating agencies and persons. Such a system has already
been initiated with respect to germ plasm and entomological information.

ii. **Library of soybean publications.** Reference libraries of publications related to soybeans will be built up in cooperation with existing major library facilities at the Universities of Illinois and Puerto Rico and closely coordinated with the computerized information system. Cooperation also will be developed with the existing USDA-ARS soybean reprint service, maintained presently by the Regional Soybean Laboratory at Urbana-Champaign.

3. **Problems of acceptance.** Introduction of a new crop and especially of new food products in the diets of people requires much more than simple communications. Early in programs for individual countries several types of studies will be appropriate:

   a. What incentives are necessary to encourage cultivators to produce a new crop? How can such incentive be provided?

   b. Studies to measure probable acceptability of new food products and highly important. Soybean and soybean products must be consumed before they will remedy nutritional problems.

   It is proposed that such studies be a part of the program of the Base.

4. **Network linkages and technical assistance.**

   a. Special linkage relationships are planned with International Centers such as IITA, CIAT, IRRI, ICRISAT and CIMMYT. If soybeans appear to be potentially significant components of cropping systems in the respective Center's area of concern, the Resource Base and the Center should develop cooperative arrangements to maximize effectiveness in soybean studies and training.
It is contemplated that this linkage function could best be served by stationing a Resource Base nucleus team (typically one senior and one junior scientific staff member) at appropriate International Centers. The Resource Base staff would be funded through contractual arrangements between the Base and the Center, retaining their appointments and formal affiliation with the Base. Analogous arrangements already are functioning for the stationing of IRRI and CIMMYT staff at other International Centers. The Resource Base personnel with their special experience and competence would cooperate in soybean work with the strong regionally-oriented resources of the International Centers. The resulting joint programs would make possible rapid achievement of Center objectives related to soybeans, with considerable economy in staffing since only the Resource Base would be required to establish an in-depth soybean program.

b. Technical assistance programs will be developed by joint efforts with donor agencies and cooperating countries. Since the Base's emphasis will be directed toward rapid development of competence in country and regional soybean programs, the principal activities will be at developing research centers in the various cooperating countries. These activities may take various forms. One model would be similar to the "linkage relay" pattern outlined above. In this operational pattern, a small Resource Base technical team would operate at a principal research station or other appropriate location in a cooperating country. Such an operation is currently being considered by INTSOY for Sri Lanka, under UNDP funding. Through a proposed contractual arrangement,
two INTSOY staff members and a few short-term consultants would aid in the development and coordination of a national soybean research and development program.

Other technical assistance patterns also could be developed, depending on the needs of cooperating countries, the availability of country or donor financial support, and the staffing potential of the Resource Base.

E. Some Special Activities

Several special activities will be desirable as particular features of the INTSOY program. Some of these will be of a lasting nature, others will be of quite short duration. While the entire range of such activities cannot be specified at the present time, the following appear important for special consideration and early activation:

1. Soybean Germplasm Collection Program. There is an urgent need to collect soybean germplasm in certain nations of the world in the immediate future. As its program develops INTSOY will be at least partially responsible for the disappearance of "local" and "wild" types as they are replaced by new and introduced varieties. If this happens before such types are added to the collection they may be lost forever. INTSOY, therefore, will be vitally concerned with collecting such material and adding it to the world soybean germplasm collection before it is lost. This project will have a short life, but is a high priority need for the first several years of INTSOY operations. Collection activities and the subsequent maintenance of seedstocks will be closely integrated with existing germplasm maintenance activities of the USDA-ARS Regional Soybean Laboratory work at Urbana, Illinois and Stoneville, Mississippi. It is
probable that a maintenance site for tropical material will be necessary. This can be established in Puerto Rico, probably at Mayaguez, in cooperation with the Federal Experiment Station, USDA-ARS.

2. International Soybean Training Center. The University of Illinois with its field research plots, greenhouse and control chamber experiments, and numerous other services and facilities can now offer short courses on soybeans and training programs to soybean specialists from the developing countries. Participants would receive practical training on plot techniques, methods of inoculation, methods of planting, soybean pathology, insect identification and control, production cost analysis, experimental design, experimental methodology, data collection, harvesting, threshing, analysis of variance, interpretation of results, market system analysis, soy-food preparation, nutritional analysis and communication. This training activity could be shared with Puerto Rico as the program develops and as staffing of the Puerto Rico activities reaches a sufficient level for the needed operations.

3. Soybean Resource Library. Much of the published literature on soybeans is not available to research workers in the developing countries because of expense, foreign exchange limitations or because it is historical. Other literature is in the form of unpublished working papers or seminar papers. Establishment of a resource library incorporating all the available literature of this type (but excluding books and general periodicals) and providing reprint and bibliographical services to soybean scientists would be a priority activity for the INTSOY program. Physically, the collections can be handled by existing library activities of the Universities of Illinois and Puerto Rico.
4. **Inoculum Training Center.** A serious limitation to soybean production in many of the developing countries is the lack of highly effective *Rhizobium japonicum* strains for optimum soybean nodulation and nitrogen fixation. INTSOY, perhaps with the assistance of a commercial inoculum enterprise, should consider the establishment of an Inoculum Training Center. Emphasis would be given to selection of efficient strains, maintenance of stock cultures, requirements for growth factors, methods of culturing rhizobia, selection of appropriate carriers, the preparation of inoculants, growth and longevity of rhizobia in the carrier, quality standards, quality control, inoculant costs, survival on seeds, and special techniques in inoculating.
VII. GOVERNANCE AND ADMINISTRATIVE STRUCTURE

The University of Illinois, Urbana-Champaign Campus, will be headquarters for the International Soybean Resource Base, hereafter referred to as the Base. The functions of the Base, as described in other sections of this proposal, will be comparable to those of existing international centers.

The University of Illinois has sufficient administrative and operational flexibility to incorporate the Base within its structure. The existence on the Urbana-Champaign Campus of schools, institutes, centers, colleges and agencies of both Federal and State Governments is evidence of this.

A major comprehensive university will provide resources much greater, much sooner, and at much less cost than could be provided through development of a self-standing center. The administrative organization and operation of the Base will obviously be somewhat different than that of the international centers.

A. Basic Principle

Staff members of the Base appointed to the University of Illinois staff will enjoy the rights and privileges of University of Illinois staff members subject to conditions pertaining thereto. The privileges and fringe benefits available include insurance, retirement, use of facilities, annual leave, etc.

B. Governance

The Base headquarters will be established at the Urbana-Champaign Campus of the University of Illinois and will function as a unit of the College of Agriculture. The overall legal basis for governance will rest with the Board of Trustees of the University of Illinois as provided in the
University Statutes: "The Board of Trustees is the governing body of
the University and exercises jurisdiction in all matters except those
for which it has delegated authority to the President, other officers,
or bodies of the University.

"Sec. 1. The Board of Trustees formulates University policies but
leaves the execution of these policies to its administrative agents
(officials of the University), acting under its general supervision."

In practice, as with other University agencies, responsibility for the
Base would flow from the Board of Trustees, and in this case then to
the Office of the Chancellor of the Urbana-Champaign Campus, and to the
College of Agriculture. The Director of the Base would report to the
Dean of the College of Agriculture who may involve associate deans of
the College of Agriculture, allied agencies such as ARS or the Illinois
Natural History Survey, or others, as appropriate, for expeditious func-
tioning of the Base. The Director of the Base would be responsible for
its administrative and technical operations.

C. International Advisory Board

The President of the University of Illinois, with advice and in consul-
tation with appropriate officials of the Consultative Group, will ap-
point an International Advisory Board for the Base. This Board will
consist of 12 to 15 members, broadly representative of donor agencies
and cooperating groups.

Additionally, the Dean of the College of Agriculture, University of
Illinois at Urbana-Champaign, The Dean, College of Agricultural Sciences,
University of Puerto Rico, Mayaguez, as well as the Director of the
Resource Base will be members of the Board.
The International Advisory Board will be concerned with matters of policy and long-range planning including budget considerations. It will meet once a year to discuss such matters as well as regular reports prepared by the Management of the Base, and other reports requested by the Board or prepared on the initiative of the Director.
INTSOY ORGANIZATION CHART

University of Illinois, Urbana-Champaign
(Higher Administration)

International Advisory Comm.

Dean, University of Illinois College of Agriculture


Director, INTSOY

Asst. Director (Administration)

Associate Director (Ill.)

(Illinois activities)

Associate Director (P.R.)

(Puerto Rico activities)

PRODUCTION
Coordinator
Staff

PROTECTION
Coordinator
Staff

UTILIZATION
Coordinator
Staff

TRAINING & COMMUNICATIONS
Coordinator
Staff

Relay Station Teams

Technical Assistance Teams

Consultation and Coordination

Direct Administrative Flow Pertaining to INTSOY
VIII. INTERNAL STRUCTURE AND OPERATIONS OF THE BASE

A. Directorate

The Director of the Resource Base will be assisted by an appropriate staff. Two Associate Directors, one at the University of Puerto Rico, Mayaguez, and one at the University of Illinois, Urbana-Champaign, will be appointed. A major function of the Associate Directors will be to assume responsibility for the program activities conducted by the staff at their respective sites. They will report to the Director.

B. Internal Structure

The broad scope and multidisciplinary nature of the Base make it imperative that the internal structure be flexible, particularly in the early years of its development. Initially, it is proposed that the following functional groups be constituted, each under the guidance of a coordinator and reporting to the office of the Director.

(1) Production Improvement (agronomy production and plant breeding, production economics, production engineering)

(2) Plant Protection (pathology, entomology, and weed control)

(3) Utilization, Marketing and Engineering (engineering, food science including nutrition, and economics)

(4) Training and Communications

Linkage relay station and technical assistance (outreach) teams will be organized as individual conditions require. They will operate under the immediate supervision of local agencies or centers to which they are attached. The Assistant Director, INTSOY, will have a special responsibility for administrative and logistical matters pertaining to these teams.
C. Status of Base Staff

Staff members located at Urbana will hold appointments in the Base and in the appropriate units or allied agencies of the University of Illinois. Certain staff members, if holding appointment from institutions other than the University of Illinois, may hold multiple appointments and thus appointment on the University of Illinois staff. Similar arrangements will be followed for Base staff located in Puerto Rico. To the extent that programs are developed at other locations, analogous arrangements will be developed.

Physical housing (officing) of Base staff will ordinarily be in space allocated to the respective departments. When separate Base space is required, every effort will be made to locate offices in the closest possible proximity to appropriate staff members of the nearest-related department.
IX. FACILITIES AVAILABLE AND NEEDED

A. General Statement

Reference has been made to the fact that major supporting and infrastructure facilities already are available at both the University of Illinois, Urbana-Champaign Campus, and at the main campus and substations of the University of Puerto Rico, Mayaguez Campus. Such facilities will be sufficient to house and support the initial activities of the proposed Resource Base, although operational and maintenance costs must be provided either through rental arrangements or on a cost-sharing basis.

A complete listing of all such support facilities available at major educational institutions such as the two Universities would be beyond the scope of this proposal. Directly pertinent to proposed INTSOY activities are the major facilities listed in B. below.

It is clear that full development of INTSOY activities as proposed in this document will require office space, laboratory facilities, and work space not now available at either institution. The addition of more than 50 individuals in professional and sub-professional staff and trainees will generate space requirements exceeding available areas now available. At such a time, the needed requirements could probably be met by rental or lease arrangements, in areas nearby the respective campus areas. This will lead to inefficiencies in operation which could best be overcome by capital construction in the campus areas themselves. However, this problem can be approached through a variety of channels when it actually arises.

The ready availability of housing, utilities, educational facilities, and transportation in both Illinois and Puerto Rico eliminate need
for capital outlays to provide these items, or for special reimbursement to staff from the Base budget. Such items will become a part of the Base budget only in programs at outreach (technical assistance) and perhaps relay station sites.

B. Major Facilities Available

Following is a partial listing for both locations of the major facilities available to support INTSOY operations. More details are given in the Appendix.

1. Urbana-Champaign Campus, University of Illinois
   a. Buildings and Office Space. The College of Agriculture and its component departments are housed in six major buildings and a number of subsidiary structures. Space is available for office and laboratory operations of six to ten INTSOY staff members; beyond this number, additional space must be provided by rental or other arrangements. The College has been under substantial space pressure from expanded enrollments, for some years, but has been unable to obtain capital funds for new construction.
   b. Research Farms and Facilities. The College has extensive farms and other research facilities, sufficient to meet the needs for field research to the extent contemplated by INTSOY. Cost-sharing can provide for use of such facilities.
   c. Analytical Laboratories and Facilities. Adequate, modern analytical facilities are available, including gas-liquid chromatographs, amino-acid analyzers, a Varian Nuclear Magnetic Resonance instrument, and other equipment needed for the analytical work contemplated under the INTSOY proposal.
d. Computer Facilities and Staff. The University has adequate modern computer facilities and appropriate staff to handle, on a cost-sharing basis, the statistical work contemplated for the INTSOY program. A computer terminal is located in one of the buildings of the College of Agriculture, and will be readily available for use in the INTSOY work.

e. Soybean Germplasm Collection. The affiliated Regional Soybean Laboratory, USDA-ARS, houses a major portion of the official soybean germ plasm collection. With some cost-sharing, these facilities can be utilized for the first work of INTSOY connected with germ plasm assembly and distribution. As additional collections are made, additional seed storage and work space facilities will be required (see C. below).

f. Library. The University of Illinois library is the largest among the Land-Grant institutions, and is a major depository for official and international collections of publications. Branch libraries exist in agricultural, the natural sciences, chemistry, and other fields related to INTSOY work. No capital requirement for library facilities is contemplated during the foreseen existence of INTSOY.

g. Housing, Utilities, etc. As mentioned in A. above, the location of INTSOY headquarters in the "university town" surroundings of Champaign-Urbana will eliminate any need for special expenditures for housing, educational allowances, transportation, or other necessities of everyday life. This will effect major economies, as compared with the existing international centers located in lesser-developed areas.
2. University of Puerto Rico, Mayaguez Campus

a. Buildings and Office Space. The sections of the University of Puerto Rico, Mayaguez, which will be concerned with INTSOY activities are dispersed among the Mayaguez campus itself, the main Experiment Station at Rio Piedras, and at least three of the field substations (Corozal, Isabela, and Lajas). For the initial activities of INTSOY, it appears that adequate office space can be made available for staff to be added as part of the program. In particular, the office and laboratory space available at the Lajas substation can be utilized for an important portion of the production-oriented activities.

b. Research Fields and Related Facilities. The six field substations of the Agricultural Experiment Station offer unique possibilities for field work under a variety of microclimatic conditions, all in tropical/subtropical environments. In particular, the Lajas substation, with some 500 acres of land, an excellent office/laboratory building, ample cold storage for seed lots, and a hydroponic facility, offers excellent possibilities for use as a major field site. These facilities can be made available to INTSOY on a direct-cost basis for operations, without capital expenditure.

Some laboratory and field facilities also will be available, on a cooperative basis, at the Federal Experiment Station, USDA-ARS, at Mayaguez. These facilities will be particularly suited to the maintenance of germ plasm collections of long-season and tropical soybean types.

c. Analytical and Computer Facilities. An excellent range of analytical and computer facilities will be available at Mayaguez,
and also at the Experiment Station, Rio Piedras. No needs for capital construction or provision of major equipment items are contemplated in present INTSOY plans.

d. Library. A modern library building, well-stocked with reference materials pertaining to Latin America and the Caribbean area, is on the campus at Mayaguez. The library of the Experiment Station at Rio Piedras also is well-supplied with agricultural reference materials. These two facilities can be further augmented with specific reference materials pertaining to soybeans, to form an excellent base for study and training activities of INTSOY.

e. Housing, etc. The urban area of Mayaguez offers all facilities and conveniences for residential life, so that no construction or special provisions for INTSOY staff will be needed. For short-term trainees, University housing in dormitory-type facilities can be arranged on a low-cost basis, if training courses are organized at appropriate seasons in relation to the University calendar.

C. Facilities Needed

Early needs of INTSOY for office, laboratory and work space can be met at both Universities, as indicated in B. above, by internal rearrangements and possibly by some rental of nearby space. Cost-sharing rental, or lease (provided in the planned budget) will be used to reimburse the institutions for the direct costs of such facilities.

One exception to the above statement is the urgent need for a work building and seed storage facility at the Agronomy Farm, Urbana. The present USDA-ARS building housing the official soybean germ plasm
collection and providing related work space is not adequate to accommodate the additional requirements which will arise within the first year or two of INTSOY activities. Also, it will not be possible to carry out germ plasm operations, seed packeting, etc. entirely in Puerto Rico. Thus, a need exists for a work building-seed storage facility, estimated to cost approximately $25,000 to $30,000, in early stages of the INTSOY activities.

As the program develops to full staffing, space needs at Urbana will rapidly become acute, and some similar problem may also arise in Puerto Rico. Office and laboratory space will be needed for a total of over 20 professional staff, supported by at least 20 sub-professionals, at Urbana alone. Also, desk and laboratory space for an expected 12 to 20 trainees (post-doctoral and graduate students) will be required on a continuing basis at Urbana.

Two major options appear to exist to meet this anticipated need. The first, rental or lease of the needed space, has the attraction that such costs can be budgeted in the recurring annual costs of the operation. The chief disadvantage would be that it would enforce separation of INTSOY staff from the professional staff of their respective subject-matter departments. This would lead to inefficiencies and also to loss of a major advantage in the proposed INTSOY operation, namely, that of close personal contact between INTSOY staff and colleagues in the Illinois domestic soybean program.

A second option is that of capital construction, adjacent or as an addition to an existing major building of the University. This option would require allocation of substantial capital funds, or the development of a lease-payment system of reimbursement for the necessary construction. Firm estimates of the likely cost cannot be
provided at this time, since costs would vary widely depending on the
precise nature of the construction undertaken, and also because recent
rapid rises in construction costs make the anticipated timing of con-
struction an important element in cost estimation.
X. STAFFING REQUIREMENTS

The staffing plans set forth below assume that the Resource Base would be activated July 1, 1974 with projected core support of approximately $700,000 for the first year, derived from existing AID contract and 211(d) grant support plus additional funding from other donor agencies to meet the needed budget. Training support of approximately $100,000 annually for 4 to 5 years is expected from the 211(d) grants; additional training support, as well as the funding of relay station and technical assistance programs, will depend on development of specific plans and sources of funding. Interest has already been expressed by IITA for a relay station team and by FAO/UNDP and the government of Sri Lanka for a technical assistance operation.

It is anticipated that professional core staff time would be divided as follows: one-third in residence at the headquarters site (Urbana or Mayaguez), one-third in alternative service at the other principal site (Puerto Rico for Illinois-based staff, Illinois for Puerto Rico-based staff), and one-third in short-term visits to cooperating field, linkage, and technical assistance sites. Assignments of linkage relay station and technical assistance staff ordinarily will be for periods of 2 years, but may be extended by mutual arrangement. Such assignments could also be for shorter duration.

A. First Year (1974-75) Staffing

Supported by Core Budget

Full time equivalents (FTE's) show for partial positions, others are 1 FTE, *indicates position or part of position to be transferred for expected AID contract or 211(d) staffs.
Expected Headquarters Location

<table>
<thead>
<tr>
<th>Urbana</th>
<th>Puerto Rico</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Directorate:**

*Director

Associate Director (.5 FTE) X

*Assistant Director (.5 FTE) X

*Editor/Communications Specialist X

Administrative Secretary

Secretarial-Clerical (1.5 FTE)

**Production Group:**

*Senior Agronomist X

*Plant Breeder X

*Production Agronomist X

Production Economist X

*Soil Specialist/Microbiologist X

Technicians (1.5 FTE)

Secretarial-Clerical (1.0 FTE)

**Utilization Group:**

*Food Scientist X

Applied Nutritionist X

*Marketing Economist X

Agricultural Engineer X

Technicians (2.0 FTE)

Secretarial-Clerical (1.0 FTE)

**Protection Group:**

Pathologist X

*Entomologist X

*Virologist X
Expected Headquarters Location

<table>
<thead>
<tr>
<th>Urbana</th>
<th>Puerto Rico</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weed Specialist</td>
<td>X</td>
</tr>
<tr>
<td>Technicians (2.0 FTE)</td>
<td></td>
</tr>
<tr>
<td>Secretarial-Clerical</td>
<td></td>
</tr>
</tbody>
</table>

**Supported from Non-Core Budget**

**Training Group:**

- Senior Training Officer | X
- Training Officer | X
- Post Doctoral Student | X
- 4 Graduate Student Participant Trainees (2.0 FTE) | X
- 6 Graduate Students (4.0 FTE) | X
- Short term in-service trainees (1.5 FTE) | X
- Secretarial-Clerical (2.0 FTE) | |

**Linkage Relay Teams:**

One or more teams, each consisting of:

- Senior staff member-leader
- Junior staff member
- Technician

**Outreach Teams:**

One or more teams, each consisting of:

- Senior staff member (one or more, long-term)
- Short term consultants (3-6 months)

**B. Full Staffing (possible by 1976 or 1977)**

The Base will attempt to achieve the major objectives set forth in V, through executing programs as indicated in VI (Scope). At any given time,
not all the specific programs listed will be in operation. The staffing estimates listed below are based on the present (1973) appraisal of realistic expected progress in staffing and developing the Base program. They are also developed from estimates of likely budget support levels. Additional core support and provision of adequate capital facilities would permit a higher staffing level.

**Directorate:**
- 2.5 FTE Administrative
- 2.0 FTE Professional
- 4.5 FTE Secretarial and Clerical

**Production Group:**
- 6.0 FTE Professional
- 3.0 FTE Sub-professional technicians
- 2.0 FTE Clerical

**Protection Group:**
- 5.0 FTE Professional
- 2.5 FTE Sub-professional technicians
- 2.0 FTE Clerical

**Utilization Group:**
- 6.0 FTE Professional
- 3.0 FTE Sub-professional technicians
- 2.0 FTE Clerical

**Training and Communications Group**
- 3.0 FTE Professional
- 2.0 FTE Clerical

**Trainees**
- 4.0 FTE Post-Doctoral Trainees (These numbers flexible, depending on support and candidates available)
- 12.0 FTE Graduate Students (18 individuals)
- 3.0 FTE In-service Trainees (18 individuals)

**Linkage Relay Station Teams**
- 3 to 5 teams, each organized as indicated in A. above

**Technical Assistance (Outreach) Teams**
- 4 or more teams, each organized as indicated in A. above
XI. BUDGET ESTIMATES

The budget estimates presented below are divided in "core" and "non-core" components, essentially reflecting the distinction that "core" expenses will recur regularly and be essentially non-varying, while "non-core" expenditures may vary widely from year to year, depending on support and on demand for the training, relay and technical assistance services involved.

The "core" budget will include research and communications activities, as well as the basic administrative and operational costs of the program. "Non-core" items include all training, relay station, and technical assistance (outreach) teams and activities.

<table>
<thead>
<tr>
<th>Budget Summary (estimates)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Core activities</td>
</tr>
<tr>
<td>$ 700,000</td>
</tr>
<tr>
<td>$ 975,000</td>
</tr>
<tr>
<td>Non-core activities:</td>
</tr>
<tr>
<td>Training</td>
</tr>
<tr>
<td>170,000</td>
</tr>
<tr>
<td>400,000</td>
</tr>
<tr>
<td>Linkage Relay Teams (@$85,000)</td>
</tr>
<tr>
<td>85,000</td>
</tr>
<tr>
<td>340,000</td>
</tr>
<tr>
<td>Outreach Teams (@$75,000)</td>
</tr>
<tr>
<td>75,000</td>
</tr>
<tr>
<td>375,000</td>
</tr>
</tbody>
</table>

Details

A. Core Budget

<table>
<thead>
<tr>
<th>Salaries and Wages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional</td>
</tr>
<tr>
<td>(258,000)</td>
</tr>
<tr>
<td>Sub-professional</td>
</tr>
<tr>
<td>( 80,000)</td>
</tr>
<tr>
<td>Hourly wages</td>
</tr>
<tr>
<td>( 18,000)</td>
</tr>
</tbody>
</table>

Fringe Benefits (13.76%)   48,160 68,800
Travel and Transportation  58,800 80,000
Other Direct Costs         35,500 46,200
Expendable Supplies        26,000 35,000
Inventory Equipment        20,000 20,000
Indirect Costs (30%)       161,540 225,000

TOTALS $ 700,000 $ 975,000
B. Training Activities (Non-Core)

<table>
<thead>
<tr>
<th>Item</th>
<th>First Year</th>
<th>Full Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Salaries &amp; Wages</td>
<td>$74,350</td>
<td>$193,000</td>
</tr>
<tr>
<td>2. Fringe Benefits</td>
<td>7,900</td>
<td>9,900</td>
</tr>
<tr>
<td>3. Travel &amp; Transportation</td>
<td>7,750</td>
<td>35,000</td>
</tr>
<tr>
<td>4. Other Direct Costs</td>
<td>12,000</td>
<td>15,000</td>
</tr>
<tr>
<td>5. Equipment</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>6. Conferences &amp; Workshops</td>
<td>20,000</td>
<td>30,000</td>
</tr>
<tr>
<td>7. Trainee Stipends (short-term)</td>
<td>21,860</td>
<td>36,000</td>
</tr>
<tr>
<td>8. Indirect Costs (30%)</td>
<td>39,235</td>
<td>71,200</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$170,000</strong></td>
<td><strong>$400,000</strong></td>
</tr>
</tbody>
</table>

C. Linkage Relay Station Teams (Non-Core)

In the first operational year, it is estimated that 1 or 2 such teams may be on this type of assignment. Tentative costs per team (1 senior staff member, 1 junior staff member, and 1 technician locally hired) are estimated at $85,000; this estimate is derived from the representative budget shown below, which is based on the assumption that the host relay station Center or Institute will provide housing, local transportation, and local operating costs of field or laboratory work.

In full operation, 3 to 5 such teams may be on service at any given time.
Linkage Relay Station Team - Representative Annual Budget

1. Salaries $42,900
2. Fringe (13.76%) 5,900
3. Allowances 10,600
4. Travel & Transportation 7,600
5. Recurrent Costs 6,500
5. Indirect Costs (25% of salaries) 11,500

TOTAL $85,000

D. Outreach Teams (Non-Core)

One or more outreach teams are expected to be on service during the first Base operating year. This number may rise to 5 or more, depending on requests received and support available. Costs per team (typically one senior staff member and 3 to 5 man-months/year of short-term consultants) will vary with location and the basic salary scales of the staff involved.

An approximate annual cost of $75,000 per outreach team appears reasonable. This would include:

Outreach Teams - Representative Annual Budget

1. Salaries $34,800
2. Fringe (13.76%) 4,800
3. Allowances 8,080
4. Travel & Transportation 13,100
5. Recurrent Costs 4,520
6. Indirect Costs (25% of salaries) 8,700

TOTAL $75,000

To the above would need to be added operational funds for project activities, insofar as these are not provided by the host country or agency.
# Staff Allocations

## Projected 1st Year

<table>
<thead>
<tr>
<th>Professional Positions</th>
<th>Core Budget</th>
<th>Puerto Rico 211(d) Grant</th>
<th>Training Program</th>
<th>Linkage Relays</th>
<th>Outreach Teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTE</td>
<td>$</td>
<td>FTE</td>
<td>FTE</td>
<td>FTE</td>
<td>FTE</td>
</tr>
<tr>
<td>14.0</td>
<td>258,000</td>
<td>2.0</td>
<td>2.0</td>
<td>2 each</td>
<td>2 each</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-Professional</th>
<th>Core Budget</th>
<th>Puerto Rico 211(d) Grant</th>
<th>Training Program</th>
<th>Linkage Relays</th>
<th>Outreach Teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTE</td>
<td>$</td>
<td>FTE</td>
<td>FTE</td>
<td>FTE</td>
<td>FTE</td>
</tr>
<tr>
<td>10.0</td>
<td>80,000</td>
<td>2.0</td>
<td>2.0</td>
<td>1 each</td>
<td>1 each</td>
</tr>
</tbody>
</table>
# XII. FIRST-YEAR PLAN OF WORK

<table>
<thead>
<tr>
<th>Period</th>
<th>Activity</th>
<th>Primary Staff</th>
<th>Cooperating</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/74 - 6/75</td>
<td>1. Develop research programs to be undertaken by junior staff and graduate students</td>
<td>Senior Agronomist</td>
<td>Collaborating staff</td>
</tr>
<tr>
<td>7/74 - 6/75</td>
<td>2. Continue world-wide major zonal variety trials, in at least 30 locations</td>
<td>Agronomists</td>
<td>Counterparts in cooperating sites</td>
</tr>
<tr>
<td>7/74 - 6/75</td>
<td>3. Undertake agronomic practice trials in selected locations, to include plant populations, row spacings, planting dates, and Rhizobial inoculation</td>
<td>Agronomists</td>
<td>Agricultural Engineer, staff of cooperating agencies</td>
</tr>
<tr>
<td>9/74 - 12/74</td>
<td>4. Perform site visits and begin preliminary trials of new germ plasm and varieties from other breeding programs</td>
<td>Plant Breeder, Agronomists</td>
<td>Counterparts</td>
</tr>
<tr>
<td>7/74 - 6/75</td>
<td>5. Provide continuing, effective coordination with International Crop Research Centers and major national research agencies</td>
<td>Senior Agronomist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>9/74 - 6/75</td>
<td>6. Arrange and undertake special germ plasm collection activities, particularly in Asia and Africa. Develop germ plasm maintenance program for new collections</td>
<td>Agronomists</td>
<td>Counterparts, Federal Exp. Sta., Puerto Rico, Regional Soybean Laboratory</td>
</tr>
<tr>
<td>8/74 - 6/75</td>
<td>7. Develop and undertake a plant breeding program, with principal field base in Puerto Rico, aimed at creation of breeding populations adapted to tropical and subtropical conditions. Some first hybrids may be made at Illinois</td>
<td>Plant Breeder</td>
<td>Senior Agronomist, collaborating staff, especially in Puerto Rico</td>
</tr>
<tr>
<td>12/74 - 6/75</td>
<td>8. Evaluate newly-collected germ plasm lots and new varieties in field trials in Puerto Rico</td>
<td>Plant Breeder</td>
<td>Counterparts, Plant Pathologist, Entomologist</td>
</tr>
<tr>
<td>Period</td>
<td>Activity</td>
<td>Primary Staff</td>
<td>Cooperating</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------------------------------------------------</td>
<td>------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>11/74 - 6/75</td>
<td>9. Initiate and undertake applied studies on light and temperature influence on soybean development, yield, and seed quality under tropical conditions, using controlled environment facilities where appropriate</td>
<td>Production Agronomist</td>
<td>Plant Breeder and other agronomists</td>
</tr>
<tr>
<td>7/74 - 12/74</td>
<td>10. Determine major soil fertility needs for soybean culture in Puerto Rico and other major cooperating locations, through soil tests and exchange of data</td>
<td>Soil Scientist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>9/74 - 6/75</td>
<td>11. Determine and develop appropriate soil test and field trial procedures to facilitate soil test-field trial coordination in further soybean studies, particularly in countries where adequate data are not available</td>
<td>Soil Scientist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>7/74 - 6/75</td>
<td>12. Advise on appropriate procedures for production and quality control, including field trials, of <em>Rhizobium</em> inoculant suitable for tropical and subtropical conditions and appropriate varieties</td>
<td>Soil Scientist</td>
<td>Counterparts, Plant Breeder</td>
</tr>
<tr>
<td>7/74 - 9/74</td>
<td>13. Establish firm contacts with economists in 6-8 tropical areas with high potential for soybean production, or where they are presently being produced (mail and personal visits)</td>
<td>Production Economist</td>
<td>INTSOY staff counterparts</td>
</tr>
<tr>
<td>9/74 - 11/74</td>
<td>14. Design and pretest survey instrument to determine resources, cropping systems, costs and returns, operational constraints, of farm producers in cooperating areas</td>
<td>Production Economist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>Period</td>
<td>Activity</td>
<td>Primary Staff</td>
<td>Cooperating</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>7/74 - 6/75</td>
<td>15. Develop an outline for a soybean production manual to be written cooperatively by INTSOY scientists during the second or third year of the program to serve as a prototype manual for developing countries</td>
<td>Production Economist</td>
<td>Production Protection Staff</td>
</tr>
<tr>
<td>12/74 - 2/75</td>
<td>16. Design experiments to determine economically optimal fertilizer practices, weeding techniques, water use in appropriate locations</td>
<td>Production Economist</td>
<td>Engineer, Agronomist</td>
</tr>
<tr>
<td>2/75 - 10/75</td>
<td>17. Carry out initial study of cropping systems and cost and returns</td>
<td>Production Economist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>Period</td>
<td>Activity</td>
<td>Primary Staff</td>
<td>Cooperating</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------------------------------------------------</td>
<td>----------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>7/74 - 6/75</td>
<td>1. Continue operation of soybean insect information center and soybean insect synoptic collection</td>
<td>Entomologist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>7/74 - 9/74</td>
<td>2. Establish additional insect collection networks in Southeast Asia, Mexico and Puerto Rico</td>
<td>Entomologist</td>
<td>Counterparts</td>
</tr>
<tr>
<td></td>
<td>3. Establish quarterly research note publication series on soybean insects</td>
<td>Entomologist</td>
<td>Editor/Comm. Specialist</td>
</tr>
<tr>
<td>9/74 - 6/75</td>
<td>4. Collaborate in determination of insect damage under field conditions in Puerto Rico, and in selection for resistance to insect attack</td>
<td>Entomologist</td>
<td>Plant Breeder, Counterparts</td>
</tr>
<tr>
<td>9/74 - 6/75</td>
<td>5. Determine, from field observations and data sharing, the major weed pests of soybeans in Puerto Rico and other Major cooperating sites</td>
<td>Weed Specialist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>9/74 - 6/75</td>
<td>6. Conduct studies of most effective and economic methods of weed control under humid and sub-humid tropical conditions, with emphasis on field work in Puerto Rico</td>
<td>Weed Specialist</td>
<td>Agr. Economist, Agr. Engineer</td>
</tr>
<tr>
<td>7/74 - 12/74</td>
<td>7. Assemble information on major limiting soybean diseases in cooperating areas</td>
<td>Plant Pathologist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>7/74 - 12/74</td>
<td>8. Conduct screening of soybean varieties and germ plasm collections, for reaction to white-fly transmitted virus diseases</td>
<td>Plant Pathologist</td>
<td>Plant Breeder</td>
</tr>
<tr>
<td>7/74 - 6/75</td>
<td>9. Observe differential reactions to other soybean diseases, in field trials in Puerto Rico and other locations</td>
<td>Plant Pathologist</td>
<td>Agronomists, Counterparts</td>
</tr>
<tr>
<td>1/75 - 6/75</td>
<td>10. Undertake coordinated program for selection for virus disease resistance, in conjunction with plant breeding activities</td>
<td>Plant Pathologist</td>
<td>Plant Breeder, Counterparts</td>
</tr>
<tr>
<td>Period</td>
<td>Activity</td>
<td>Primary Staff</td>
<td>Cooperating</td>
</tr>
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</tr>
<tr>
<td>7/74 - 9/74</td>
<td>1. Establish firm contacts with marketing specialists in appropriate country and regional programs where soybeans are presently being produced (mail and personal visits)</td>
<td>Marketing Economist</td>
<td>INTSOY staff</td>
</tr>
<tr>
<td>9/74 - 11/74</td>
<td>2. Design and pretest study of soybean marketing systems in potential production areas</td>
<td>Marketing Economist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>7/74 - 11/74</td>
<td>3. Organize a data system to collect current and relevant historical world data on soybean prices, production, trade, consumption, processing</td>
<td>Marketing Economist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>12/74 - 2/75</td>
<td>4. Design and pretest a study to determine the characteristics of protein food demand and the potential demand for soybased food</td>
<td>Marketing Economist</td>
<td>Nutritionist, Food Scientist</td>
</tr>
<tr>
<td>2/75 - 6/75</td>
<td>5. Carry out initial study of soybean marketing systems</td>
<td>Marketing Economist</td>
<td>Counterparts</td>
</tr>
<tr>
<td>7/74 - 9/74</td>
<td>6. Establish firm contacts with researchers and processors in appropriate tropical and subtropical areas, to determine special problems of handling and storing soybeans</td>
<td>Agricultural Engineer</td>
<td>Counterparts, Food Science staff</td>
</tr>
<tr>
<td>9/4 - 12/74</td>
<td>7. Develop a research program in Puerto Rico on soybean storage under tropical conditions</td>
<td>Agricultural Engineer</td>
<td>Appropri ate staff in Puerto Rico, Food Science staff</td>
</tr>
<tr>
<td>1/75 - 6/75</td>
<td>8. Conduct studies of storage and seed quality problems relating to food utilization and seed quality for planting</td>
<td>Agricultural Engineer</td>
<td>Counterparts, Food Science and Agronomy staff</td>
</tr>
<tr>
<td>Period</td>
<td>Activity</td>
<td>Primary Staff</td>
<td>Cooperating</td>
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<tr>
<td>7/74 - 12/74</td>
<td>9. Continue development and research on prototype human food products based on whole soybeans, especially for home or village processes</td>
<td>Food Scientist</td>
<td>Counterparts, Nutritionist</td>
</tr>
<tr>
<td>7/74 - 6/75</td>
<td>10. Demonstrate basic &quot;Illinois Process&quot; and modifications in selected developing countries</td>
<td>Food Scientist</td>
<td>Cooperating agencies</td>
</tr>
<tr>
<td>9/74 - 12/74</td>
<td>11. Plan, with U. Puerto Rico staff, cooperative product development work for Latin American area</td>
<td>Food Scientist</td>
<td>U. Puerto Rico staff, Nutritionist</td>
</tr>
<tr>
<td>1/74 - 6/74</td>
<td>12. Conduct cooperative research to develop products and diets utilizing whole soybeans, for Latin American areas</td>
<td>Food Scientist, Nutritionist, UPR staff</td>
<td>Counterparts</td>
</tr>
<tr>
<td>7/74 - 9/74</td>
<td>13. Design diets incorporating soy-based foods, especially for Latin American areas</td>
<td>Nutritionist</td>
<td>Food Scientist, staff of UPR and ITAL (Brazil)</td>
</tr>
<tr>
<td>12/74 - 6/75</td>
<td>14. Test diets indicated above, for acceptability and nutritional value, under appropriate local conditions</td>
<td>Nutritionist</td>
<td>Cooperating staff in Puerto Rico, Brazil and other areas</td>
</tr>
<tr>
<td>1/75 - 6/75</td>
<td>15. Conduct bioassay, including PER, of selected soy-based food products in appropriate dietary combinations</td>
<td>Nutritionist</td>
<td>Counterparts and cooperating staff</td>
</tr>
<tr>
<td>1/75 - 6/75</td>
<td>16. Survey food preferences and possible utilization of soy-based products in Africa and Asia</td>
<td>Nutritionist, Counterparts</td>
<td>Food Scientist in appropriate countries</td>
</tr>
<tr>
<td>Period</td>
<td>Activity</td>
<td>Primary Staff</td>
<td>Cooperating</td>
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<tr>
<td>7/74 - 4/75</td>
<td>1. Organize a World Soybean Conference to be held in summer '75</td>
<td>Sr. Training Officer</td>
<td>INTSOY staff world scientist</td>
</tr>
<tr>
<td>7/74 - 4/75</td>
<td>2. Organize workshops on production, protection and utilization for soybean researchers, at three locations in LDC's for winter-spring '75</td>
<td>Sr. Training Officer</td>
<td>INTSOY staff scientist</td>
</tr>
<tr>
<td>7/74 - 9/74</td>
<td>3. Compile a world list of soybean scientists and research institutions by mail and personal contacts</td>
<td>Sr. Training Officer</td>
<td>INTSOY staff scientist</td>
</tr>
<tr>
<td>7/74 - 2/75</td>
<td>4. Organize a program of short-term in-service training for junior soybean scientists for summer '75</td>
<td>Sr. Training Officer</td>
<td>INTSOY staff scientist</td>
</tr>
<tr>
<td>5/75 - 10/75</td>
<td>5. Operate in-service training program</td>
<td>Training Officer</td>
<td>INTSOY staff</td>
</tr>
<tr>
<td>7/74 - 2/75</td>
<td>6. Develop training materials (texts, self-learning pamphlets teaching modules, etc.) to be used for in-service training</td>
<td>Training Officer</td>
<td>INTSOY staff</td>
</tr>
<tr>
<td>7/74 - 10/74</td>
<td>7. Establish and organize a specialized resource library of technical soybean information especially non-published, non-regular papers</td>
<td>Training Officer</td>
<td>INTSOY staff</td>
</tr>
<tr>
<td>Monthly</td>
<td>8. Assume overall responsibility for monthly INTSOY newsletter</td>
<td>Editor/C.S.</td>
<td>INTSOY staff</td>
</tr>
<tr>
<td>6/75</td>
<td>9. Compile and Edit annual report of INTSOY</td>
<td>Editor/C.S.</td>
<td>INTSOY staff</td>
</tr>
<tr>
<td>7/74 - 6/75</td>
<td>10. Develop a comprehensive information system to answer requests by integrating present computerized data and bibliographical data systems</td>
<td>Editor/C.S.</td>
<td>INTSOY staff Computer staff</td>
</tr>
</tbody>
</table>