PD-ABJ-748
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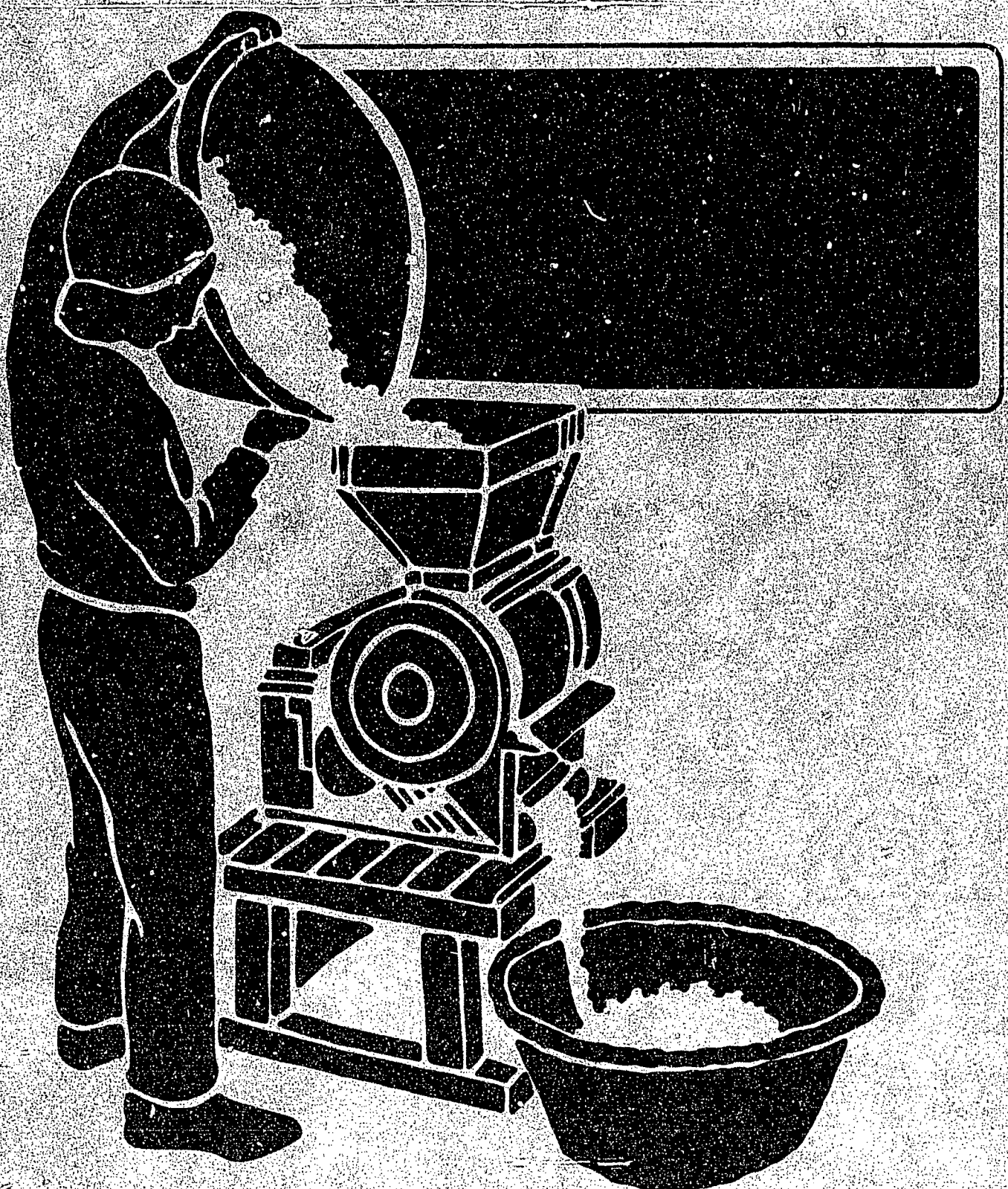
INTERNATIONAL SOYBEAN PROGRAM

INTSOY College of Agriculture
University of Illinois at Urbana-Champaign



PD-ABJ-748

FINAL REPORT
USAID Cooperative Agreement
AID DAN-4132-A-00-0038-00

SOYBEAN UTILIZATION AND RESEARCH
INTSOY/University of Illinois

FINAL REPORT

USAID Cooperative Agreement No. DAN-4132-A-00-0038-00

SOYBEAN UTILIZATION AND RESEARCH

EXECUTIVE SUMMARY

Soybean utilization and research activities under the Cooperative Agreement DAN-4132-A-00-0038-00 were successfully concluded. Major project activities were in applied research, training and technical assistance. Out of 11 output activities in applied research, seven exceeded the respective output goals. Three were on target and two fell short of target. The two activities which feel short of target were new product development and research on effect of soy protein on cholesterol metabolism. This was due to the shift of emphasis into training and technical assistance in which the achievements far exceeded the output goals.

Out of eight output activities under technical assistance and training, all but one exceeded the respective output goals. The deficiency was in postgraduate training. The training mix consisted of short term training, postdoctoral training, and postgraduate training. Training was demand-driven. The deficiency in postgraduate training was offset by achievements in short term training and postdoctoral training.

The total program expenditure was $4,168,404, of which, 43.2% was provided under the cooperative agreement, 9.1% was provided by the University of Illinois as institutional contribution and 47.7% was provided from buy-ins.

At the termination of the cooperative agreement, INTSOY was brought under the umbrella of the Postharvest Collaborative Agribusiness Support Program (CASP). INTSOY's program activities in applied research, training and technical assistance will continue under the CASP. Consequently, the equipment procured under the cooperative agreement will continue to be utilized for CASP activities.

This is a final report provided under the terms of the subject cooperative agreement between USAID/Washington and the University of Illinois at Urbana-Champaign. Through this agreement and three modifications thereto, USAID provided support for soybean utilization and research activities to the International Soybean Program (INTSOY). The period covered by this agreement and report is January 1, 1990 through September 29, 1993.

Background

Since its inception at the University of Illinois in 1972, INTSOY received support from USAID under successive cooperative agreements. Until 1984, INTSOY's program concentrated on crop production and utilization. From 1985, the mandate has been on soybean processing and utilization. With the change in focus, INTSOY developed a new set of program objectives and activities. This was based on a knowledge of the needs of LDCs gained through predecessor activities in over 100 countries. The main program activities are applied research, training, technical assistance and information dissemination.

Program Objectives

- Develop and refine small- and medium-scale soybean processing technologies to produce nutritious food and feed products.
- Transfer soybean processing technologies to entrepreneurs in developing countries and collaborate in developing locally acceptable food products.
- Develop marketing strategies to spread processing technology and products for the nutritional and economic benefit of a broad segment of the world's population.

PROGRAM DESCRIPTION AND SCOPE OF WORK

1. Conduct applied research to develop and refine soybean processing technologies applicable to developing countries.
2. Study and promote nutritional benefits of soybean products.
3. Use a blend of collaborative R & D, training, networking, and marketing to transfer technology into commercial enterprises.
4. Evaluate cost/benefits of new technology and monitor technology as it is adopted by developing countries.

LOGICAL FRAMEWORK FOR OUTPUTS

Research and Development

	Output Activity	Output Goals
1.	Develop processing parameters for soy/cereal blends	Two blends
2.	Develop prototype products and analyze/test composition/characteristics	Four products
3.	Evaluate expellers to match up with InstaPro Extruders	Three expellers
4.	Evaluate products for shelf life/use	Four products
5.	Develop products/recipes from oil and meal	Ten products
6.	Develop commercial process for making superior quality soymilk	One process
7.	Investigate process for making concentrated soymilk	One process
8.	Study soy proteins effect on cholesterol	Two studies
9.	Study metabolizable energy of partially defatted soybean meal in poultry	One study
10.	Study protein quality of extrusion processed soybean	One study
11.	Develop specific products for selected countries	Four countries

Technology Transfer

Output Activity		Output Goals
1.	Transfer blended extruded products	Five countries
2.	Establish extrusion/expelling plants with private entrepreneurs	Three countries
3.	Conduct short courses on soybean processing and utilization	Two at UIUC
4.	Conduct training programs/workshops in developing countries	Two countries
5.	Conduct postdoctoral and graduate programs for developing country students	Thirteen
6.	Network with U.S. private and public institutions for technology generation/transfer	Six companies
7.	Network with international institutions for technology transfer/promotion	One visit/year
8.	Publish/disseminate research findings:	
	- Journal articles	Five
	- Conference proceedings	Five
	- Instruction manuals	One
	- Newsletters	Three/year
	- Special brochures	Two
	- Videos	Five

END OF PROJECT STATUS BY OUTPUT ACTIVITIES AND OUTPUT GOALS

The following brief summary of progress relates to the research and development output activities 1-11 and technology transfer output activities 1-8.

Research and Development

1. Conventional soy/cereal blends provided by the U.S. under Title-XII food assistance are based on corn as the major ingredient. This program moved towards indigenization when processing in the countries was promoted rather than simply supplying processed products from the U.S. In countries where cereals other than corn are abundant, rice-based supplementary foods can be processed from local ingredients. A masters thesis program was based on the use of rice instead of corn for processing weaning foods using dry extrusion. The processing parameters that relate to product blends, moisture content of input food, operating temperature profiles and extruder configurations were established. Chemical composition, rheological properties, and sensory attributes of the final product were used as dependent variables.

   Traditionally, the blended foods supplied under food aid programs are distributed to nutritionally vulnerable groups such as pregnant/lactating mothers and weaning children. There is the same need for similar products by the populations at large. Such products can meet a critical need for foods of high nutrient density and also provide the basis for agribusiness activities. INTSOY collaborated with the Department of Agriculture (DOA) in Sri Lanka in the development of such a product with a blend of rice, soybean, and mung

bean. The mung bean was used in small quantity to impart the taste that is highly acceptable to the local population. After the initial product development stage, DOA received support from local industries to conduct a market survey of the product. Currently, DOA is collaborating with a non-government institution in the country to commence commercial production of this product.

2. Two prototype products were developed that have potential for commercial exploitation. The first is a texturized soy product derived from partially defatted soybean obtained by extrusion/expelling. Conventional textured soy is made from fully defatted soy flour processed by solvent extraction. Because solvent extracted soy flour is unavailable in many developing countries, there is a need to process such products from raw material that is locally generated. Initial research carried out at INTSOY, using dry extrusion indicated that textured soy can be successfully produced from blends of equal proportions of partially defatted soy flour and conventional defatted soy flour. It was found that the dry extrusion system lacks the degree of process control capability needed to produce good texture. This research is currently being carried out using a twin screw extruder. The objective is to develop a product of good texture from 100% partially defatted soy flour or full fat soy flour.

   The second prototype product was made from a blend of soybean and pigeonpeas. Pigeonpea has become an extremely important food legume for the semi-arid tropics. Its drought tolerance, uniform bearing habit, and ability to serve as a renewable source of bio-fuel makes it an important crop for the cropping system of dry areas. The basis of our research is to produce value added products from this crop. The approach was to use the minimum level of pigeonpea in combination with soybean to produce a snack product having a predominant flavor of pigeonpea. It was found that pigeonpea has excellent expansion properties when extruded. The pigeonpea flavor was found to be quite resistant to extrusion temperature as well. This research will be continued under the Postharvest Collaborative Agribusiness Support Program (CASP).

   Although four prototype products with commercial potential were targeted under this activity, only two were developed. The primary reason behind developing only two commercial pigeonpea prototypes was that commercialization of the extrusion/expelling technology was held at a higher priority level and more time was devoted to that technology.

3. At the beginning of the reporting period, the basic process for extrusion/expelling had been established. The main progress was in scaling up the process to a commercial level. At an early stage of development, the manufacturer of dry extruders (Triple "F", Des Moines, Iowa) became interested in commercialization of this technology. This company produces three sizes of dry extruders having capacities of 550 lbs/hr, 1800 lbs/hr and 2000 lbs/hr for food and feed processing. The main task was to select and test oil expellers that can match up with their extruders for continuous operation. Through a formal collaboration with the University of Illinois, the company built a building and made the equipment available for testing. Four oil expellers from various sources were tested for their efficiency. Appropriate modifications were made in the expellers and the operating parameters were optimized for extrusion/expelling. Through collaborative work, the technology is now being commercially applied in many countries.

The development of extrusion/expelling technology is meeting a great need in developing countries where the infrastructure and scale of soybean production is inadequate to operate solvent extraction companies.

4. Shelf life studies were carried out on partially defatted soy flour, natural soybean oil produced by extrusion/expelling, and on whole soybean milled to various particle sizes. This latter study investigated the potential of milling soy flour at the community level to provide a semi-processed product for home use. Accelerated shelf life studies were also carried out to test various spray dried soymilk packaging materials.

   Partially defatted soy flour could be stored at room temperature for six months without perceptible changes in odor and flavor. Natural soybean oil produced by extrusion expelling had a shelf life of six months when stored under home use conditions. However, if this oil is degummed, there was a drastic reduction in shelf life. This is explained by the fact that the oil contains approximately 60% of the naturally occurring tocopherols which have antioxidant properties. However, upon degumming, these compounds are removed along with the hydrated phosphatides. Consequently, the natural oil is being marketed in several countries without any further processing.

   Whole soybeans milled in raw form had a shelf life of only three months. Intermediate particle size was found to be better than the coarse and fine particle size in terms of shelf life. As expected, high moisture content resulted in reduced shelf life. For practical purposes, it is not possible to mill raw soybeans in large bulk and store for long periods of time. At the community level, small millers may carry out milling and marketing of raw soybeans, provided the consumer has a thorough understanding of few critical facts with regard to storage of the product at the home level.

5. With regard to the use of partially defatted soy flour in food preparations, extensive work was done on specific food products for developing countries. The appropriate levels of incorporating soy flour into leavened bread, unleavened breads, tortilla, chapati, and nshima was determined. These concepts were demonstrated and transferred in the training programs. Use of partially defatted soy flour in making a peanut butter analog was also studied. The product is now being commercially marketed in Zimbabwe. Many appropriate food recipes were developed by trainees from various countries during the annual training programs.

6. Applied research on soymilk was based on the fact that traditional oriental soymilk is unacceptable to other populations due to beany flavor. The University of Illinois has researched this topic for many years and considerable improvements were made in flavor. The specific emphasis during the reporting period was to develop a process profile, equipment profile, and cost profile for a small scale soymilk operation suitable for application in developing countries. The new process eliminates the cumbersome overnight soaking and is based on double blanching and double filtration. This small scale process is now being marketed to interested clients. The first such operation is currently being established in Egypt.

   This study also resulted in the production of bland soymilk at pre-determined protein levels suitable for further processing into yogurt and frozen desserts. The procedures for making soymilk for these purposes, formulation of non-dairy yogurt and ice cream and their

processing techniques were completely worked out. These products are being made in several developing countries.

7. The intention of the concentrated soymilk project was to explore possibilities for producing a product which can be kept at room temperature (without refrigeration). Some serious constraints were discovered in the preliminary stages of this work. Therefore, the focus was changed from concentration to spray drying. Many countries have spray drying facilities which are under-utilized due to shortages of dairy milk. A dry product has greatly reduced bulk, can be packaged in simple inexpensive packs, stored at room temperature and transported over long distances. These are attributes that will be beneficial to developing countries.

   Studies on spray drying of soymilk were conducted as a doctoral dissertation by a student from Sri Lanka. The study included development of basic spray drying parameters for soymilk, formulation of the liquid feed with various additives to improve functionality, sensory evaluation of the final product and its shelf life. Prototype products with high nutritional composition, good rehydration characteristics and high sensory ratings were developed. The basic information necessary to scale up the process is now available for dissemination. The results of the study have been reported in the doctoral dissertation and submitted for publication into technical journals.

8. The relationship of diet and health is a significant issue in developing countries just as it is in the Western world. Soybeans have been associated with health benefits. Studies on the health benefits of consuming soybeans would enhance and influence the promotion of soybean consumption in developing countries. INTSOY collaborated in a multi disciplinary study to determine the effect of dietary soy protein on plasma cholesterol levels in human subjects. Results indicate that consumption of 50 grams of soy protein per day effectively lower total cholesterol, LDL-cholesterol and apolipoprotein B while maintaining HDL-cholesterol concentrations. The findings have been published in American Journal of Clinical Nutrition.

9. The fastest growing sector of the livestock industry in developing countries is poultry. Poor quality protein meal is a major problem faced by the poultry industry. With the development of INTSOY's process for soybean processing extrusion/expelling, soybean meal with high protein and energy content is made available to small scale poultry operations. Studies were undertaken to determine the efficiency of soybean meal from the extrusion/expelling process when it is used as a protein ingredient in poultry feed. The studies indicated that this soybean meal gave improved weight gain and feed efficiency. There was no significant differences between the performance of this meal and conventional soybean meal produced by solvent extraction. The results were submitted for publication in the Poultry Science Journal.

10. Protein quality of extrusion processed soybean was studied as part of the project on developing extrusion/expelling into a commercial operation. The major interest was to evaluate the effects of process temperature on protein quality. In the first study, it was found that extrusion processing at temperatures of 137°C - 149°C produced meal with a high nutritional value (as measured by increase in basic amino acids) without destruction of lysine. Extrusion temperatures below 120°C gave poor quality meal. The second study was to study the effect of extrusion temperature on quality of meal using animal models. Diets containing 10% protein from the soybean meal and formulated weaning foods were tested. Amino acid

digestibility and amino acid scores were measured. Results indicated that soybeans processed at temperatures between 137°C and 149°C had high protein quality. Lower processing temperatures were ineffective.

11. Much progress was made in developing specific soybean food products for selected countries. Because food habits vary so much between countries and among regions within countries, the development of specific food products must be a collaborative activity with LDC personnel. During the reporting period, this activity was carried out in collaboration with representatives from Asia, Africa and Latin America. The approach was to teach collaborators the basic concepts for cooking with soybeans and to work with them in developing food recipes containing desirable proportions of soybean. The recipes so developed were tested by representatives from their respective countries during training programs conducted at INTSOY. Sixty soybean recipes were developed during the reporting period. Collaborators from India, Pakistan, Sri Lanka, Vietnam, Egypt, Zambia, Zimbabwe and Brazil were involved in this soy food development. Hence, their collection of recipes has general application in Asia, Africa and Latin America.

    These food recipes will be incorporated into a home-level soybean utilization manual which is currently under preparation. Publication of this manual could not be completed during the reporting period. With the agreement of the USAID/Procurement Office, funds for publication of this four color manual was committed before close out. The University of Illinois, Department of Agricultural Communications and Education contracted for this task under a fixed price agreement. Publication of this manual is built into INTSOY's current program of work under the CASP.

Technology Transfer

1. Blended extruded products are supplementary foods of high nutrient density derived from co-extrusion of cereals and legumes. Soybean is eminently suited as the legume component in such products on account of its contribution of both protein and calories. These products may take the form of dry powders for reconstitution at the point of consumption or particulate products that can be cooked in various forms.

    A supplementary food based on rice (instead of maize, which is the conventional cereal component in Title XII blended foods) and soybean was developed as a masters degree research program by a candidate from Sri Lanka. This prototype product was further refined with the addition of mung bean to improve flavor. Consumer acceptability surveys were conducted in country with the assistance of the private sector. Sri Lanka Department of Agriculture and Plenty Canada (a Canadian NGO operating in Sri Lanka) are currently collaborating on a program for commercial production of this product.

    A pre-cooked "dhal" substitute was developed at INTSOY to extend the available supplies of traditional pulses. The product consists of a blend of partially defatted soybean flour produced by extrusion/expelling and small quantities of traditional pulses to impart the familiar flavor to the product. The blends are cooked and formed into a biconvex shape using the Insta-Pro dry extruder. The final product is fully cooked and has the general shape of decorticated traditional pulses such as lentil. This product is being commercially produced in Sri Lanka.

A peanut butter substitute was developed from optimum blends of peanut and partially defatted soybean flour derived from extrusion/expelling. While peanut is highly acceptable in many countries, it is also one of the most expensive food legumes. The blend was developed as a means of incorporating substantial amounts of soybean into an acceptable product which can be produced at a lower cost relative to traditional peanut butter. This product is commercially produced by a private company in Zimbabwe.

Collaborative work with the Central Institute of Agricultural Engineering (CIAE), Bhopal, India, resulted in upgrading the technical capability of that institution. Dry extrusion facilities were established with INTSOY's collaboration. CIAE has a strong program to play the role of a business incubator with the intention of promoting agribusiness. CIAE is conducting pilot projects with the private sector to promote soy fortified crackers and soymilk.

INTSOY provided technical assistance to a joint venture between a U.S. and Kenyan agribusiness in the establishment of extrusion processing of cereal and soybean products. The Kenyan company received training at INTSOY and proceeded to establish the processing plant which is producing supplementary food for the World Food Program. Plans are underway to incorporate processed soybean flour into bakery products which are manufactured by the Kenyan company.

Technical assistance was provided to a local NGO in El Salvador for establishment of a supplementary food processing plant. A representative of the program received training in soybean technology at INTSOY and was also given assistance to prepare the project proposal for submission to EEC sources for funding. The project has been funded by the EEC. The building for the processing plant has been constructed and the equipment has been ordered from U.S. sources. INTSOY will continue to support this project under the CASP.

2. The progress of establishing extrusion/expelling plants far exceeded the target of three countries. The main impetus for this was the fruitful collaboration with the manufacturer of extruders (Triple "F"), Des Moines, Iowa. After the successful program of process scale-up, the company proceeded to prepare a package of technology for extrusion/expelling technology at various scales of operation. At the time of reporting, there are some 30 operations in Asia, Africa, Latin America, NIS and the United States, using this technology. The scales of operation vary from 7 - 100 metric/tons per day. According to company sources, a rapid expansion in the application of this process is anticipated in the near term.

3. INTSOY's international training programs consist of: a) the annual group training program on soybean processing for food uses, b) individual short term training, c) postdoctoral training/research, d) postgraduate training and, e) agribusiness tours. The total training output for the reporting period was 212 person-months of training provided to 116 persons from 28 countries. The countries involved were, Cameroon, China (PRC), Bulgaria, Brazil, Ecuador, Egypt, El Salvador, India, Indonesia, Ghana, Jamaica, Japan, Kenya, Malaysia, Malawi, Mexico, Mozambique, Nigeria, Republic of South Africa, Sudan, Thailand, Turkey, Uganda, Venezuela, Vietnam, Zambia, Zimbabwe, and Sri Lanka.

The annual short course on soybean processing for food uses was conducted four times during the reporting period. This course is designed to discuss soybean technology in the class room, provide hands-on experience in the pilot processing pant and laboratory and to expose

participants to the U.S. soybean industry. The output of this component was 59 person-months with 60 participants. In the past, enrollment in this program has been primarily from the public sector institutions. In recent times, there has been a rapid increase in enrollment from the private sector of LDCs.

Individual short term training is provided upon request. This program involves one-on-one training where individuals from private and public sector institutions concentrate on specific technological aspects of their interest. The output of this component was 38 person-months with 23 participants.

Postdoctoral programs are provided for various durations depending upon the program objectives of the participants. Participants conduct their programs at INTSOY facilities with general oversight from INTSOY staff who specialize in the relevant program areas. The output of this component was 23 person-months with six participants.

Postgraduate training programs are nested in the Department of Food Science and INTSOY staff serve as advisors/co-advisors to facilitate dissertation research relating to soybean processing and utilization. The output of this component was 78 person-months with three participants. One masters program and one doctoral program were completed. One masters program is continuing.

Agribusiness tours are provided to the business community and relevant government officials of LDCs. The objective is to facilitate interaction between LDC and U.S. agribusiness. These programs involve visits to U.S. agribusinesses, attendance at professional meetings and visits to food expositions. The output of this component was 14 person-months with 20 participants.

4. During the reporting period, INTSOY coordinated one international workshop, conducted one in-country training program and participated in several international conferences.

   (a) In 1990, INTSOY co-sponsored the first international conference on soybean processing and utilization, held in Gongzhulin, Jilin Province, China. The other sponsors were Jilin Academy of Agricultural Science, Chinese Academy of Agricultural Science, Japanese Ministry of Agriculture, Forestry and Fisheries, International Institute for Tropical Agriculture, and the Chinese Scientific Research institute for Food and Fermentation Industries. The purpose of the conference was to review the current status of technologies for processing and use of soybeans, share experiences of soybean processing and marketing programs, and develop ways for mutual cooperation. Approximately 100 foreign participants from 23 countries and 150 Chinese participants were present at the meetings. In addition to the technical presentations, the participants worked in groups and developed specific recommendations for further development of breeding, processing, utilization, nutrition, and marketing aspects of soybean.

   (b) INTSOY attended the first FAO conference on the soybean network for Latin America, held in Londrina, Brazil in 1990. This conference was held in response to a memorandum submitted by LDC soybean scientists to FAO. The need for a soybean network was emphasized in this memorandum because IARCs had little if any

emphasis on soybean which is an important crop for LDCs. The conference emphasis was on the constraints of soybean development and to formulate strategies for incorporating a regional network.

(c) INTSOY attended the second FAO conference on the soybean network for Africa, held in Ibadan, Nigeria, in 1991. The theme of the conference was the same as that of the first conference held in Brazil. The outcome of the conference was a working document outlining constraints and opportunities for soybean development in Africa and the strategy for establishing a regional network for Africa.

(d) At the invitation of Association des Produits a Marche (APROMA), INTSOY attended a five-day workshop on oilseeds, held in Harare, Zimbabwe, in 1991. Uganda, Kenya, Malawi, Tanzania, Zambia, Zimbabwe, Botswana, and the Republic of South Africa were represented at the meetings. Discussions were centered on the constraints faced by oilseed industries in the participating countries and strategies for development of profitable commercial enterprises. INTSOY presented opportunities for soybean development in the region and ways in which it could contribute to the process.

(e) INTSOY attended the third FAO conference on the soybean network for Asia, held in Chiang Mai, Thailand, in 1992. The theme of the meeting was the same as that of the previous meetings in Brazil and Ibadan. The outcome of the meeting was a working document for the establishment of the Asian Soybean Network. INTSOY will work with FAO on further development of this project.

5. Postdoctoral and postgraduate programs were reported under item #3 above (Training).

6. Linkages were developed with a number of private institutions in the U.S. to support INTSOY's applied research programs, facilitate technology transfer, and to strengthen international training programs. These linkages have brought reciprocal benefits to the private companies in terms of marketing their equipment, technologies and products. Among the private companies with which INTSOY has developed working relationships are Archer Daniels Midland (Decatur, Illinois), BAR North America Inc. (Seymour, Illinois), Anderson International (Cleveland, Ohio), Kyoto Food Corporation (Terre Haute, Indiana), Buhler Inc. (Minneapolis, Minnesota), Agronico Inc. (Le Center, Minnesota), Cargill Inc. (Minneapolis, Minnesota), Crown Iron Works (Minneapolis, Minnesota), Protein Technologies (St. Louis, Missouri), Triple "F"/Insta-Pro International (Des Moines, Iowa), and Wenger International (Sabetha, Kansas).

   Likewise, public institutions such as the Illinois Soybean Association (Bloomington, Illinois), American Soybean Association (St. Louis, Missouri), American Oil Chemists Society (Champaign, Illinois), and The National Center for Agricultural Utilization Research (Peoria, Illinois) provided financial and programmatic support to INTSOY.

7. INTSOY continued to collaborate with the Food and Agriculture Organization of the U.N. (Rome), Food and Agriculture Organization Regional Office for Asia and the Pacific (Bangkok, Thailand), International Crop Research Center for the Semi Arid Tropics

(Hyderabad, India), and the Asian Vegetable Research and Development Center (Taipei, Taiwan).

8. The following publications and communication materials were generated during the reporting period:

(a) Spray Drying of Soymilk. Ph. D. Thesis: By D.B.T. Wijeratne, Department of Food Science, University of Illinois, 1993.

(b) Effect of Milling Raw Soybean on the Compositional Uniformity of Soybean Cake During Extrusion-Aided Screw Press Oil Extraction. M.S. Thesis: By A.N. Nziiga, department of Food Science, University of Illinois, 1992.

(c) Depression of plasma cholesterol in men by consumption of baked products containing soy protein. S.M. Potter et. al., American Journal of Clinical Nutrition, 58:501-6, 1993.

(d) INTSOY Agenda-Expanding the Use of Soybeans. INTSOY Series Publication, University of Illinois, 1990.

(e) Extrusion Cooking and Oil Expelling. Informational Bulletin, INTSOY, University of Illinois, 1990.

(f) Soymilk and Dairy Analogs. Informational Bulletin, INTSOY, University of Illinois, 1990.

(g) Home and Village Soyfood Preparation. Informational Bulletin, INTSOY, University of Illinois, 1990.

(h) Effects of extrusion and expelling on the nutritional quality of conventional and kunitz trypsin inhibitor-free soybeans. Y. Zhang, C.M. Parsons, K.E. Weingartner and W.B. Wijeratne, Poultry Science, 72:2299-2308, 1993.

(i) Soybean Processing For Food Uses-Training Manual. K. Tanteeratarm (Ed), INTSOY Series Publication, 1992.

(j) Introducing Soybeans into Developing Countries: A Case Study. J. Gleason, INTSOY Series Publication, University of Illinois, 1992.

(k) Characterization and oxidation stability of mechanically expelled soybean oil. S.E. Hill, W.B. Wijeratne, A.I. Nelson, E.G. Perkins, Journal of the American Oil Chemists Society, in Press.

(l) Evaluation of commercial dehydrated soymilks. D.B.T. Wijeratne, W.B. Wijeratne, K. Tanteeratarm, L.S. Wei, ASEAN Food Journal, in Press.

(m) The INTSOY program and technology transfer to Thailand. K. Tanteeratarm and W.B. Wijeratne, in Proceedings of the Second International Workshop on Advanced Science and Technology transfer to Thailand, S. Nanthavanji and M. Wecharatana (Ed), Bangkok, Thailand, 1992.

(n) Effects of major soy protein fractions on some functional properties. In "Uniformity by 2000", an International Workshop on Maize and Soybean Quality. L.D. Hill (Ed.) Chapter 16, P. 227-239. 1991. Scherer Communications, Urbana, IL.

(o) Bound water associated with 7S and 11S soy proteins determined by vapor sorption isotherms and pulsed NMR. J. Food Sci. 55:130, 1990.

(p) Solubility, emulsion stability and gelation of isolated soy proteins from various maturation stages during storage. J.J. Yao, K. Tanteeratarm and L.S. Wei. J. Amer. Oil Chem. Soc. 67:974.

Project Implementation Reports

Annual Work Plans: Annual work plans were submitted at the beginning of the cooperative agreement and with each modification for incremental funding.

Quarterly Reports: All quarterly reports were submitted as required.

Special Reports: Special project highlights and media coverage for significant program events were appended to annual reports.

Annual Activity Reports: All annual reports were submitted.

Technical and Research Reports: A listing of technical and research reports for the reporting period is listed above under "End of Project Status by Output Activities and Output goals."

Environmental Impact: Outputs of this project has no adverse environmental effects.

Trip Reports: All trip reports were submitted. A summary of travel was included on an annual basis in the respective annual reports.

Training Reports: All training activities were reported quarterly. Detailed training reports were included in annual reports.

Care of Laboratory Animals: Not applicable.

Research Involving Recombinant DNA: Not applicable.

FINANCIAL SUMMARY

The total amount obligated by USAID under the cooperative agreement was $1,829,250. Total expenditure was $1,798,905, leaving an unspent balance of $30,345.

University of Illinois matching contribution in staff time and use of facilities is estimated at $378,100 (Table 1), approximately 21% of the USAID contribution.

Contribution from formal and informal buy-ins was $1,991,400 (Table 3), approximately 100% of the contribution under the cooperative agreement.

Table 1

INTSOY Financial Summary

Contract Number: AID DAN 4123-A-00-0038-00
Contract Date: January 1, 1990 - September 29, 1993

Category	Budget	Expenditures
Salary	910,942.00	929,924.44
Fringe	143,515.00	140,796.82
Indirect Costs	458,896.00	454,694.01
Travel	148,279.00	78,845.30
Equipment	33,820.00	18,512.90
Other Direct Costs	133,798.00	176,131.39
Total	$1,829,250.00	$1,798,904.86

Total Obligated Amount	$1,829,250.00
Total Expenditures	$1,798,904.86
Obligated amount unspent	$30,345.14

Table 2

Institutional Matching Funds (January 1, 1990 - September 29, 1993)

Origin	Description	Years	Amount
R. Bernard	Agronomist	1990 - 1993	26,000.00
J. Nicholaides	Acting Director	1992 - 1993	70,000.00
A. Nelson	Food Scientist	1990 - 1993	69,600.00
T. Soskin	Ag. Economist	1990	10,000.00
T. Trone	Economist	1990	10,000.00
L. Wei	Food Scientist	1990 - 1993	20,000.00
S. Williams	Economist	1990 - 1993	77,500.00
Pilot Plant	Facilities/Equipment Utilization	1990 - 1993	95,000.00
		Subtotal	$ 378,100.00

Table 3

INTSOY Buy-ins from January 1, 1990 - September 29, 1993

Year	Institution/Agency	Recipient Country	Amount
1990	American Soybean Association (ASA)	China	7,000.00
	ASA	Malaysia	3,500.00
	ASA	Thailand	3,500.00
	AVRDC	China	4,000.00
	Buler LTD./Switzerland	China	1,000.00
	Chinese Central & Provincial Gov't.	China	50,000.00
	CIDA/PLENTY	Sri Lanka	1,000.00
	ESCAP	China	6,000.00
	FAO/Nepal	China	4,000.00
	FAO	China	7,000.00
	FAO	China	46,000.00
	FAO	China	23,000.00
	Fulbright/USA	China	4,000.00
	Germany	China	1,000.00
	IBPGR	China	1,500.00
	IDRC	Pakistan	4,000.00
	IITA	China	18,000.00
	Indofood	China	2,000.00
	InstaPro	China	2,000.00
	ISAB/France	China	6,000.00
	Israel Government	China	2,000.00
	Japan (MAFF, Industry)	China	45,000.00
	Korea	China	4,000.00
	LINTCO/Zambia	China	3,000.00
	MCC/USA	China	4,000.00
	MCC Vietnam	Vietnam	4,000.00
	MCC/EXT-EXP/Vietnam	Vietnam	75,000.00
	NeXT Computer	China	3,000.00
	Ralston Purina	United States	7,000.00
	Rockefeller Foundation	China	12,000.00
	Thailand Government	China	4,500.00
	US Commerce	Ghana	10,500.00
	USAID/WINROCK	China	1,400.00
	USAID/Pakistan	China	4,000.00
	USAID/WINROCK/India	China	4,000.00
	USAID/Egypt	Egypt	5,000.00
	USAID	Egypt	1,000.00
	USAID/WINROCK	India	17,500.00
	USAID Delhi/Winrock	India	3,500.00
	USAID/WINROCK	India	25,200.00

Year	Institution/Agency	Recipient Country	Amount
	USAID/WINROCK/India	India	10,000.00
	USAID/USDA	Malaysia	3,500.00
	USAID	Mexico	3,500.00
	USAID	St. Lucia	3,500.00
	USAID/Uganda	Uganda	2,000.00
	USAID	Uganda	300.00
	USAID/Zambia	Zambia	25,000.00
	USDA	China	18,000.00
		Subtotal	$ 495,900.00
1991	FAO	Turkey	5,000.00
	IAES	China	2,000.00
	InstaPro	USA	75,000.00
	ISPOB	China	12,000.00
	ISPOB	China	2,000.00
	ISPOB	China	10,000.00
	ISPOB	China	500.00
	ISPOB	Zimbabwe	7,000.00
	Japan Government	Japan	7,000.00
	LOLSA	USA	4,000.00
	MCC	Vietnam	7,000.00
	Plenty Canada	Sri Lanka	7,000.00
	Reynolds Foundation	Vietnam	18,000.00
	SoyaTech	USA	3,000.00
	UNDP	Kenya	6,000.00
	UNDP/USAID/Zambia	Zambia	5,000.00
	UNDP	Zambia	7,000.00
	USAID/San Diego State Univ.	Egypt	1,200.00
	USAID/Kenya	Kenya	7,000.00
	USAID/Univ. of California	Pakistan	300.00
	USAID/USDA	Thailand	7,000.00
	USAID/Zambia	Zambia	10,000.00
		Subtotal	$ 203,000.00
1992	ASA	USA	35,000.00
	China Government	China	6,000.00
	DuPont	USA	3,900.00
	FAO/Kenya	Kenya	7,000.00
	InstaPro	USA	10,000.00
	LOLSA	China/RSA	19,500.00
	LOLSA	USA	4,500.00
	RSA/Oilseed Board	RSA	10,000.00
	RSA/Private	RSA	6,000.00
	Sri Lanka/Private	Sri Lanka	6,000.00

Year	Institution/Agency	Recipient Country	Amount
	UNDP/Cameroon	Cameroon	7,000.00
	USAID/Egypt	Egypt	226,900.00
	USAID/Egypt	Egypt	7,000.00
	USAID/Mozambique	Mozambique	7,000.00
	USAID/Sri Lanka	Sri Lanka	6,000.00
	USAID/Uganda	Uganda	7,000.00
	Venezuela/Private	Venezuela	6,000.00
		Subtotal	$ 374,800.00
1993	Diocese of Torit	Sudan	7,500.00
	FAO	Philippines	8,000.00
	InstaPro & Rab Processor, Ltd	Malawi	7,500.00
	ISPOB	Bulgaria	13,000.00
	ISPOB	Turkey	6,500.00
	Mennonite Central Committee (MCC)	Vietnam	4,000.00
	Oleica, S.A.	Ecuador	8,000.00
	Phinomar (Nig.) Limited	Nigeria	8,000.00
	Plenty Canada	Sri Lanka	1,500.00
	Reynolds Foundation	Vietnam	18,500.00
	USAID/Jamaica	Jamaica	7,000.00
	USAID/NARP/Egypt	Egypt	266,200.00
	USAID/SDSU/Egypt - Short Course	Egypt	42,000.00
	USAID/SDSU/Egypt - Training	Egypt	189,000.00
	USAID/CIS - FFI	Ukraine	331,000.00
		Subtotal	$ 917,700.00
		Buy-in total	$ 1,991,400.00

Table 4

Personnel, Collaborators and Advisors (January 1, 1990 - September 29, 1993)

Name		Title	Department	Time Period
Project Professional Staff				
Erickson	Danny R.	Ag Development Specialist	Intl Agriculture	9/80 to present
Galerani	Marise E.	Food Specialist	Food Science	10/88 to 8/91
Kauffman	Harold E.	Director, INTSOY	Intl Agriculture	12/81 to 1/92
Nelson	Alvin I.	Professor Food Science	Food Science	8/88 to 8/90
Nicholaides	John J.	Acting Director, INTSOY	Intl Agriculture	1/92 to 9/93
Savage	William D.	Research Associate	Food Science	1/90 to present
Smith	Steven E.	Ag Development Specialist	Intl Agriculture	1/87 to 9/93
Tanteeratarm	Kukiat	Asst. Professor Food Science	Food Science	8/89 to present
Weingartner	Karl E.	Asst. Professor Food Science	Food Science	8/88 to present
Wijeratne	Wilmot B.	Associate Director	Food Science	8/85 to present
Williams	Sheldon	Professor Ag Econ	Ag. Economics	8/89 to present
Wynstra	Robert J.	Communications Specialist	Intl Agriculture	8/86 to 8/90
Project Technical Staff				
Begum	Shahnaz	Academic Hourly	Food Science	6/91 to 12/92
Buchanan	Dee	Staff Secretary	Intl Agriculture	8/85 to 6/92
Buchanan	Scott A.	Asst. Physical Science Staff	Food Science	10/85 to present
Clarke	Dennis A.	Equipment Attendant	Food Science	8/89 to present
Godbee	Paul A.	Laboratory Helper	Food Science	9/89 to 2/91
Masoud	Mona	Academic Hourly	Ag Agronomy	12/92 to 12/93
Snipes	Lori L.	Staff Secretary	Intl Agriculture	6/92 to present
Winfrey	Victoria	Laboratory Helper	Food Science	12/89 to 2/91

Name		Title	Department	Time Period
Collaborating Professionals				
Bernard	Richard L.	Geneticist	USDA & Agronomy	8/90 to present
Nelson	Alvin I.	Professor	Food Science	8/90 to present
Soskin	T.	Economist	Ag. Economics	8/89 to 9/90
Trone	Thomas N.	Adjunct Professor	Business Mgmt	8/90 to present
Wei	L.S.	Professor	Food Science	8/88 to present
Wynstra	Rob J.	Media & Communc Spec	Ag. Communications	8/90 to present

INTSOY Executive Committee

Chassy	B.M.	Food Science
Easter	R.A.	Animal Science
Evans	J.F.	Ag. Communications
Hymowitz	T.	Agronomy
Irwin	M.E.	Ag. Entomology
Johnson	S.H.	Ag. Economics
Kauffman	H.E.	Intl Agriculture
Litchfield	B.J.	Agricultural Engineering
Nelson	R.L.	Agronomy
Nicholaides	J.J.	Intl Agriculture
Nichols	S.Y.	Human Resources
Potter	S.M.	Foods and Nutrition
Seidler	A.J.	Food Science
Sinclair	J.B.	Plant Pathology
Unnevehr	L.J.	Ag. Economics
Wijeratne	W.B.	Director, INTSOY