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THE PROCESS OF TRANSFERRING FOOD-PROCESSING TECHNOLOGY

A WORKSHOP ON LOW-COST EXTRUSION COOKING PROJECT IN LDC'S

TECHNOLOGY TRANSFER SERIES

A.I.D. EVALUATION WORKING PAPER NO. 108

by

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TABLE OF CONTENTS

Page

Foreword

Acknowledgements

Executive Summary

Project Data Sheet

1. Introduction

2. The Development, Adaptation, and Demonstration of LEC Technology

2.1 LEC Technology

2.2 History of LEC Technology Transfer Projects

2.3 The Uses of LEC Tech: Ingredients and Products Produced

3. The Technology Transfer Process: Application to LEC projects

3.1 Technology Transfer--The Systems

3.2 Technical Assistance -- Model of Technology Transfer

3.3 LEC Technology Transfer:
-Testing, Adaption and Extension

4. Country Experiences: Sri Lanka and Costa Rica

4.1 The Sri Lanka LEC Project

4.2 The Costa Rica LEC Project

5. Technical Assistance

5.1 Technical Assistance-LEC Plant Construction

5.2 Technical Assistance-LEC Plant operator and Management Training

5.3 Technical Assistance-Marketing
p.22

5.4 Social Marketing and LEC Products
p.26

5.5 Input Production

6. LEC Technology Transfer to LDCs
General Conclusions

References

Annex A Workshop Participants

Annex B Description of AID's Food and Technical Assistance Agreement with USDA

Annex C LEC Demonstration Sites - Details

Annex D Countries which adopted LEC Technology

Annex E Tanzania LEC Experience - Field Notes

List of Figures

Figure 1 Technology Transfer Framework

Figure L LEC Technology Promotion Sequence

EXECUTIVE SUMMARY

In July, 1985 AID's Center for Development Information and Evaluation (CDIE) presented a one-day workshop on the process of technology transfer in LDC's, as demonstrated by several AID-funded projects involved with the introduction of an innovative food-processing technology. This technology, low-cost extrusion cooking (LEC), was identified by AID and US Department of Agriculture (USDA) nutritionists in the 1970's as a potential mechanism for LDC governments to produce highly nutritious, inexpensive foods for distribution in their nutrition feeding programs. Concerned about the imminent cessation of PL 480 donations, which included large quantities of nutritious processed foods, AID and USDA aimed to assist the recipient governments to produce similar foods locally. LEC was selected as the appropriate technology for this purpose, due to its simplicity, the low cost and efficiency of the necessary equipment, and the ability of the equipment to process inexpensive, highly nutritious products, such as soybeans, into palatable human foods.

During the past decade, AID has assisted several LDC's in implementing food processing and nutrition feeding projects using the LEC technology. The purpose of the 1985 workshop was to review the results of these projects, as well as the process of project implementation, which is, in essence, the process of technology transfer. The ultimate aim was to identify mechanisms to more effectively promote this process, which includes the adoption, adaptation, and diffusion of technology. Workshop participants included representatives from the various organizations which had been involved in the implementation or evaluation of the LEC projects, including AID, USDA, CARE, and several US universities.

Workshop participants focussed primarily on two of the major AID-funded LEC projects in Sri Lanka and Costa Rica, although they also drew on their experience in other LDC's where LEC technology has been demonstrated or adopted, including Tanzania, Kenya, Guatemala, Indonesia, Mexico, Guyana, Peru, and Bolivia. From these country experiences, workshop participants derived numerous conclusions concerning the process of transferring LEC technologies to these and to other LDC's.

In summary, these conclusions were the following:

o LEC projects, and other technology transfer projects, as well, should not be viewed simply as the transfer of hard-technology, or the technical mastery of machinery. Instead, these projects also involve the mastery of numerous supporting technologies which are essential to the projects' success; in the case of LEC, this includes project management, facilities layout factory management, factory input production and supply, and the marketing of LEC products. Together these activities and the necessary technologies compose a complex system, and LEC projects should be viewed as such, with each essential component explicitly elaborated. In project design and cost-estimation, each of these components must be considered, since technical assistance may be required not only for the mastery of the hard-technology, but for the supporting technologies, as well.

o The installation of LEC demonstration sites does not usually result in technology adoption, diffusion, and sustained operations. Instead, prolonged assistance is generally needed; this may include financial support, aid in adapting the technology to local needs, technical training, and continuous technical advisory assistance.

This assistance may be necessary not only in machine utilization, but also in such areas as product development, market research and product testing, and operations management.

o Despite the simplicity of the hard-technology, adapting it to local conditions, capabilities, and needs is generally a lengthy, complex process, requiring continuous long-term advisory assistance. Further, the process must be carefullly monitored through an explicit feedback system in order to identify problems as they arise and to correct them in a timely manner. Continuity of feedback is essential.

o The successful LEC projects in several countries have resulted in diffusion of the technology to other LDC's, such as Mexico, Guyana, and Bolivia, where public and private sector organizations adopted and adapted the technology with little external assistance. However, several other countries have also considered initiating similar and decided that the LEC technology was not appropriate for their needs and resources.

o A critical factor in the success of technology transfer projects is the availability of committed, highly competent technical advisors. In the LEC projects this role was played mainly by USDA and Colorado State University (CSU) staff. It is also essential that there be active technology promoters, or champions, to generate and sustain interest in and commitment to the lengthy and sometimes costly process of technology transfer. In Sri Lanka, the main champions were a local health official and CARE personnel, while in Costa Rica, the main promoter was the first CARE Project Director.

o It is preferable that demonstration activities be directed not only at public sector use of technologies, but that they also be designed to generate private sector interest. This may assure broader diffusion and adaptation of the technologies, as well as long-term sustainability.

o In public sector programs, it is essential that LDC governments clearly understand the full direct and indirect costs of maintaining these programs once the expatriate contributions are terminated. Similarly, the recipient governments must be fully aware of the management role which must be assumed at this time; often technical assistance will be needed to aid government personnel in assuming management responsibility for the projects.

o In LEC projects it is imperative that market research be conducted before th initiation of the projects, in order to identify appropriate food products which are acceptable to the product consumers, or project beneficiaries. This is necessary even in public sector programs, where the foods may be given away for free, since even low-income consumers may reject products which are inconvenient or unpalatable, and they may refuse to expend the time and expenses necessary to obtain the free foods.

o In conducting market research for commercial products, it is important to evaluate the market impact of other competitive products. Further, feedback on market reaction to competitive products must be provided continuously, as consumer preferences change and new products enter the market.

o An effective marketing strategy includes not only product and market definition, but also the establishment of distribution channels, product pricing and packaging, consumer education and product promotion, and the development of retailer commitment to the product.

o Because of the risk involved in new product development, production, and marketing, donor and/or government support and subsidies may be necessary to assure the transfer of LEC technology. Public sector operations (e.g. school feeding programs) may require continuous subsidies.

o Programs for technology transfer must be explicitly designed for each different country context; although certain aspects may be applicable to many LDC country settings, other aspects, especially product identification, will be unique in each different country.

o It is advisable, even in public sector LEC programs, to channel a portion of the LEC products to the private commercial market. This will generate revenues for the programs, thereby increasing the chances of their being sustained, and will also reduce the possible stigma that LEC foods are "poor people's food," a stigma that can reduce product acceptance even among low-income consumers.

1. INTRODUCTION

On July 2, 1985, AID's Center for Development Information and Evaluation (CDIE) held a one-day workshop to discuss the transfer of low-cost extrusion cooking (LEC) technology to selected developing countries. LEC is a simple, efficient food processing technology promoted by AID for LDC nutrition and food for peace programs. Typically, corn and soy mixtures are extruded mechanically which generates sufficient heat to cook the blended mixture. The latter is ground and fortified and provides a nutritious food additive. The focus of the workshop was to explore the process of the LEC technology transfer and consequences for both the recipients of the LEC production technology and the consumers of the LEC products, for example, the target beneficiaries for food for Peace commodities.

Since the early 1970's AID and the U.S. Department of Agriculture (USDA), and two U.S. Universities have assisted numerous LDC's to develop food processing capabilities for public nutrition programs and possible commercial marketing.* Since the 1960's, highly nutritious, processed US commodities had been provided for use in LDC nutrition programs under the

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* Colorado State University provided technical assistance in testing and transferring the LEC technology. Texas A&M University provided technical assistance in marketing.

PL 480 program. The food-processing assistance aimed to help these countries to develop the capacity to produce similar products locally, using local commodities; in anticipation of the phase-out of PL 480 donations to LDC's.

Because the typical large scale extrusion processing plants are too expensive and complex to build and maintain in most LDC's, AID and USDA** selected the LEC processing technology as the most suitable and appropriate technology for LDC public sector use. During the last 15 years, in collaboration with agricultural research scientists, engineers, and development administrators from private voluntary organizations, AID has funded the installation several LEC demonstration plants. The CDIE workshop reviewed the experience in transferring of LEC technology to two countries in particular, Sri Lanka and Costa Rica. Dissemination and diffusion of the technology to other LDC's, such as Tanzania, Mexico and Guyana was also discussed.

The workshop participants included many of the key intermediaries and sponsoring agencies who provided technical assistance and funding through the years for the LEC technology transfer. The focus of the workshop then was to offer the participants an opportunity to consider the often undertreated aspects of the role of AID and other intermediaries in assuring that promising technologies are disseminated, adopted, adapted, and sustained to meet the needs of the host country receiving systems.

This report is one of several studies including the Technology Transfer Impact Evaluation Series published by CDIE. An evaluation team was sent to Costa Rica in May, 1985, to assess the process and consequences of the LEC technology transfer process in that country; the team's findings and conclusions are presented in CDIE Special Study No. ___. A field visit by CDIE contractor to Tanzania provided a partial update on the experience with LEC technology in the country. (See annex E).* An examination of these findings and of LEC projects in several other LDC's enabled workshop participants to compare the lessons learned from the transfer of LEC technology to various culturally and politically diverse developing countries. By noting these comparisons, similarities, and differences, this report offers an overview of the technology transfer process, as well as a guideline for the promotion of technology transfer and, more specifically, for the dissemination of the LEC food processing technology to the developing world.

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* A subsequent visit seven months later by the CDIE Technology Transfer Coordinator gave further details on the Tanzanian case.

2. THE DEVELOPMENT, ADAPTATION AND DEMONSTRATION OF LEC TECHNOLOGY

2.1 LEC Technology

The technology for extrusion cooking machinery was developed over 30 years ago. Since then, in the United States, large extruders have been used to produce a variety of products, such as snack foods and breakfast cereals. In the 1960's, smaller and much less expensive units like the Brady cooker were developed to enable farmers to process soybeans into animal feed at the farm level.

An extrusion cooker consists of a heavy cylinder in which a tight-fitting screw rotates at a relatively high speed. Raw cereals or grains feed into the cylinder, are heated and cooked by the action of the screw, and then are pushed out as cooked flakes. The result is a pre-cooked food which still retains the fat and protein of the raw material, and in some instances prevents break down of enzymes which are potentially harmful.

Extruders can process a wide variety of cereals, oil seeds and legumes, as well as blends of these commodities. The LEC machines were considered appropriate technology for developing countries because they can efficiently, process inexpensive, highly nutritious commodities into palatable human foods; they also are simple to operate and relatively inexpensive. There are several advantages to the LEC products, according to Dr.

Irwin Hornstein, formerly with AID's Office of Nutrition: because the processed products are pre-cooked, they reduce energy costs and cooking time; the processing improves the digestibility and flavor of the raw materials, some which are not traditionally consumed by humans; the products are easily fortified with minerals and vitamins, which adds to their nutritional value; and the foods are more easily transported and have a longer storage life than unprocessed commodities. Finally, the LEC equipment permits traditional grains to be blended with pulses; because of the complimentary amino acid structure of these two types of commodities, the resultant blends have an extremely high protein content.

When AID and USDA first became interested in using the Brady Cooker to produce food for human consumption, it was thought to be a very inexpensive means of processing foods. In the early 1970's, the cost of the cooker alone was about $3,000 without the engine according to USDA's Rod Crowley, who first identified the potential utility of the machines for human use. But the installed costs of the entire production system are much higher. As one workshop participant joked, "We were fooled! It cost 50 times more than that, or about $150,000, to establish a LEC plant". In reality, adapting the Brady Cooker from its decentralized farm use to a centralized processing facility required several additional levels of technology to be introduced. First, the grains had to be cleaned and de-hulled before use. In addition, the LEC products could not be used directly for human consumption, as was the case with animal

feed, but had to be ground and packaged. Because factory production required storage facilities, and overhead and management, the entire processing system proved much more expensive than anticipated by AID, CARE, and the recipient LDC countries.

2.2 The History of LEC Technology Transfer Projects

The initial concept of using LEC equipment to produce nutritious human foods in LDC's originated during a visit to an Iowa farm which produced soybeans. In 1971, after returning to the United States from an AID consulting job in India, Crowley was visiting his brother-in-laws' farm when he first saw a low-cost extrusion cooker. The machine was used to process the farm's soybeans into a nutritious animal feed supplement. His brother-in-law explained that the Brady division of the Koering Company had invented the cooker to help farmers process animal feed economically right on the farm.

While in India, Crowley recalled that he had been asked if there was a way to make full-fat soy flour (FFSF) on a small scale for use in LDC nutrition feeding programs. Upon seeing the Brady cooker in Iowa months later he wondered if the machinery could be adapted and sent to India for the processing the flour and even other nutritious blended foods based on soy, an inexpensive commodity with extremely high protein and calorie content.

At the same time that Crowley was research the Brady cooker, AID's Office of Nutrition, Science and Technology Bureau, had identified the lack of availability of low-cost nutritious foods in developing countries as one of the five key problems to be addressed by the Agency during the 1970s. Protein was considered to be the most promising solution to the nutrition problem; therefore the conversion of soybeans into high protein human foods was explored during this period.

The USDA, Kansas State University, and several private companies conducted research on the capabilities and uses of various small extrusion cookers, including the Brady cooker, and they began to develop and test several food products to determine their acceptability and versatility. During this initial research, the Brady division donated three cookers to AID, which in turn set up hardware research demonstration projects in Kenya, Guatemala, and Indonesia, in order to test the LEC technology for adaptability and effectiveness. However, it soon became clear that there was insufficient knowledge of the technology and of the product possibilities.

In 1974 Colorado State University (CSU) was contracted by AID and USDA to research and develop the LEC technology, focussing primarily on the Brady and Triple F cookers.[1] As

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[1] Triple F extrusion cookers are similar to the Brady cookers but somewhat larger, more expensive, and more versatile in the products which can be produced.

Crowley pointed out, extrusion with the LEC machines was considered more of an art than a science and the cooker technology, when used for the production of human foods, proved to have design and performance tradeoffs. The Brady cooker, for example, cannot form shaped foods but makes irregular chips or pieces. However, it can be used to process a variety of flour-like products, such as soybean flour, blended foods, drink and soup bases, meat extenders, and breakfast gruels. But the Brady cooker has limited versatility and requires a 6 six percent oil content in the input ingredients to function properly. In addition, any change of inputs, such as switching from sorghum to soybeans, requires adjustment to the machinery, because of the difference in oil content of the grains.

AID and USDA hoped that by installing LEC equipment in several LDC demonstration and test sites, interest in replicating the factories would be generated in other LDC's. However, the first test sites did not generate the expected diffusion of the technology, so eventually project personnel asked CARE to help identify additional demonstration (Annex C provides further details on the initial demonstration sites). USDA, CSU and CARE agreed to collaborate to develop complete LEC factories at three additional sites; Sri Lanka, Costa Rica and Tanzania were ultimately selected. In March 1976, the first LEC factory opened in Sri Lanka, followed by one in Tanzania in 1978 and one in Costa Rica in 1979. Eventually, the technology was also adopted in numerous other LDC's, including Guyana, Mexico, Peru and Bolivia. (Annex D offers

information on the various LDCs which adopted the LEC technology). More recently, India has considered using the LEC technology, as well as Honduras, Panama, Ecuador, and Haiti. However, as Crowley noted in the workshop, LEC technology is not appropriate or the best technology for all situations. Several countries such as the Dominican Republic and Indonesia considered using LEC cookers but subsequently decided against it.

2.3 The Uses of LEC Technology: Ingredients and Products Produced

3. THE TECHNOLOGY TRANSFER PROCESS: APPLICATION TO LEC PROJECTS

3.1 The Technology Transfer Process

Dr. Peter Delp, Technology Transfer Series Topic Coordinator for the AID/PPC/CDIE, initiated the workshop by presenting a systems framework for analyzing the technology transfer process (Figure 1). Further explanation the terminology is provided in Annex 2. As these materials indicate, the process of technology transfer begins with idea origination and the identification of the technology sources; together these farms the generating system which provides technologies to receiving systems of technology recipients, end-users, and beneficiaries. The Brady division of the Koering Company of Iowa was the original source of the technology, which had been developed for an entirely different purpose. Crowley was the idea originator, the person who conceptualized the application of the technology to human food production. The technology itself is disseminated to the recipients through various intermediaries who help facilitate the adaptation of the technology, as well as its adoption and diffusion in LDC environments. AID served as a principal financial intermediary by making the Brady Cookers available to CARE and local governments in Sri Lanka, Tanzania, and Costa Rica. In each LEC project, CSU was the key technology source, which provided the technical assistance and technological knowledge to establish LEC facilities and to adapt the

technology to the LDC settings and intended uses. Other technology sources included the USDA's Nutrition and Agribusiness Group, as well as the various US universities providing technical assistance. CARE served as a key financial and managerial intermediary. The recipients of the technology in these projects were the operators of the equipment at the LEC plants, while the end-users were the preparers of the LEC products, the cooks and parents who actually cooked the foods for the target beneficiaries. The final beneficiaries were the consumers of the LEC products distributed through the government feeding programs.

Delp stressed that technical mastery is a key goal of technology transfer, which he defined as the continued utilization of technology after its initial importation and preliminary use. Successful transfer is an on-going process, not simply a case of setting up turn-key factories run by expatriates. The challenge in donor-assisted efforts is to assure that the recipients achieve the technical knowledge and skills to operate, adapt, expand, and disseminate the technology in their own country. As Delp pointed out, successful LEC technology transfer involves more than just the transfer of machinery and factory designs. It involves the transfer of an entire system which must include management and operations training, marketing, distribution, and continued product development and adaptation to local needs and competing products.

Also critical to the technology transfer process are the roles played by various intermediaries. In the technology transfer literature, these roles are often characterized as technology promoters (champions), knowledge brokers, and technology inhibitors (gatekeepers).2/

3.2 Technical Assistance -- Model of Technology Transfer

In the international donor community, the main "champion" of the LEC technology from concept through implementation has been Rod Crowley. During the initial session of the LEC workshop, Crowley provided background on USDA's experience in disseminating the LEC technology. He noted that technology while LEC technology was available for decades, it was not until the an appropriate problem was identified, specifically the need to substitute domestically grown and processed foods for imported, process PL 480 products, that the LEC technology became a solution. To better illustrate this process, Crowley presented the sequence of activities illustrated in Figure 2.

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2 See Annex 2 for further explanation of the terminology used in describing the roles plays by the various actors in the technology transfer process.

Crowley admitted that the sequence outlined in Figure 2 is ideal; he noted that in several cases they bypassed the product research and development phase, as well as the demonstration phase. In India, after AID identified the lack of availability of low-cost nutritious foods as a key problem, CARE/India purchased Brady Cookers to make enriched soy flour. Once the means, the Brady Cooker, had been identified, the research phase began, carried out by private companies, Kansas State University, and USDA's Northern Regional Research Center. During this demonstration phase, three Brady Cookers were donated to Kenya (East Africa Industrial Research Organization), Guatemala (INCAP), and Indonesia (CARE) to test the cooker in developing countries. It was during this phase that USDA realized that the knowledge about the utilization of the technology was incomplete. It was at this point that CSU's Agricultural Engineering Research Center was called in to help evaluate both the Brady and Triple F cookers. This evaluation uncovered the limitations of the Brady Cooker vis a vis the other LEC equipment.

Crowley also noted that, in some cases, further demonstration and R & D were bypassed because the LEC technology seemed so simple. To demonstrate its simplicity, USDA decided to set up three full-fledged LEC processing plants; Tanzania, Sri Lanka, and Costa Rica were ultimately selected as the sites. At the same time, the focus of the LEC projects expanded as they concluded that the LEC factories should demonstrate the entire processing operation, and not just the Brady Cooker part of the production process.

Eventually, the efforts to proliferate LEC technology resulted in the spontaneous diffusion of additional LEC plants in Guyana, Mexico and Bolivia. In addition, Crowley noted research and development has continued on LEC products. In one instance, the extraction of edible rice brain oil is now being tested. And in another case, LEC technology is being used to produce calorie-dense, low-viscosity products for Oral Rehydration Therapy, which helps prevent dehydration while renourishing the child during a diarrheal episode.

3.3 LEC Technology Transfer:
Testing, Adaptation and Dissemination

CSU's Research Institute, under the direction of Dr. Judson Harper, played a critical role in the LEC technology transfer as one of the key technology sources and intermediaries, a knowledge-broker for the LEC technology. From its research and field experience, the CSU team has concluded that there are a number of requirements for technology transfer to take place. The first requirement, noted Harper, is the introduction of the technology by making LEC equipment available for testing at selected sites in developing countries, in order to demonstrate the operating capabilities of the technology. During the initial pilot demonstrations of the Brady cooker in Guatemala, Kenya, and Indonesia, the CSU team realized, as well, that the transfer of LEC technology involves the installation and operation of an entire system, rather than the development of a product or the

operation of a machine. Another lesson learned in this initial phase included the need to use experienced technologists in order to achieve successful testing. From its experience in this introduction phase, CSU concluded that while the introduction of technology generated interest in LDC's, it did not lead to significant transfer of the technology.

The second step for technology transfer, according to Harper, is the demonstration of the technology. This involves the actual installation of LEC processing plants in LDCs, the documentation of the operating requirements and costs, product acceptability, testing and management capability. In this phase, CSU has provided both the plant designs and engineering expertise to Sri Lanka, Costa Rica and Tanzania, to assist in the establishment of LEC plants and to teach host-country nationals to use the technology. In assisting in technology transfer, Harper stressed the importance of a variety of transfer targets, in both the public and private sectors, since demonstration projects earmarked only for the public sector may lead to skepticism in the private sector. He suggested, however, that private voluntary organizations, such as CARE, can be instrumental in bridging the gap between the two sectors.

The third phase of technology transfer requires the documentation of demonstration results through articles, newsletters, and most important, through direct face-to-face contacts with LDC users. Under lessons learned from this phase, the CSU group concluded there is a continuing need for a

technology transfer group that acts as spokesperson. They also stressed the need to conduct detailed feasibility studies for both factory installation and subsequent operation. Harper suggested that the creation of an entire pilot plant at CSU would be useful in promoting and demonstrating the LEC technology and also offer a site for experimentation and the development of products using ingredients indigenous to LDC's.

The fourth step in the continuing process of technology transfer is the continuous explanation of the LEC process through such means as research reports, demonstration plants, and scholarly and popular publications.

The fifth step involves the diffusion of the technologies, or secondary transfer. Diffusion of the LEC technology has already occurred in Mexico, Peru, Bolivia, Ecuador, Costa Rica, Surinam, India, Liberia and Haiti. In each of these countries LEC plants have been established in either the public or private sectors. Lessons learned from these transfers indicate that there is a strong desire to make the technology indigenous by using local equipment and ingredients. But, as Harper concluded, the need remains for technical assistance and transfer agents to facilitate the process of diffusion.

4. COUNTRY EXPERIENCES: SRI LANKA AND COSTA RICA

The workshop participants were discussed at length two prominent case studies in LEC Technology Transfer, Sri Lanka and Costa Rica. Crowley led the discussion of the Sri Lanka experience.

4.1 The Sri Lanka LEC Project

After the initial demonstration phase for the LEC technology was completed, the first plant was begun in Sri Lanka in 1975. A weaning food called THRIPOSHA, based on imported wheat soy blend (WSB) and local sorghum, was already being successfully distributed through government feeding programs at the time. However, the local mixing of the WSB and sorghum was complex and time-consuming; since it was necessary to cook the ground sorghum before mixing it with the pre-cooked WSB, sorghum cookies were first made and then ground into a flour, which was then blended with the WSB. When CARE officials heard about the Brady Cooker, they saw it as a possible means of simplifying the Triposha production process. They also hoped to eventually phase-out the importation of PL 480 WSB and to assist the Indian government to produce it locally. The Brady Cooker seemed to offer a solution to the Trioposha production problems, as well as to make possible the local production of its major component, WSB.

CSU was brought in to help in the design and construction of the plant; the facility was constructed in nine months and began operations in March 1976. One factor which contributed to the quick start-up was that the LEC processing facility was attached to an existing grain processing plant which was already processing sorghum. Therefore, much of the equipment required in the processing system was already installed and in operation. However, it was necessary to add several components to the existing facility, including equipment for the cooking, blending, and packaging operations; CSU made provisions for these in its design of the LEC facility.

By the end of 1976 several problems had arisen, including personality clashes with the plant manager and logistical problems due to the plant's long distance from Colombo. As a result, CARE made several changes; the plant was relocated to the outskirts of the capital, and it was decided that the LEC equipment should be installed in an independent plant managed by a local private company. The Ceylon Tobacco Company was contracted to run the plant, and a local architect was hired to assist CSU in designing the plant. As a result of these changes, the second factory operated much more smoothly , partly because the management firm provided better skilled labor.

By 1980, the second plant was completed, and it remains in operation as of July 1985. However, once again the plant has faced production bottlenecks. Although it is operating at maximuim capacity (24 hours a day), it cannot meet the demand for its products. Although 90% of the products are distributed through government feeding programs, the remainder are sold commercially, largely to low and middle income groups, where demand has steadily increased. However despite the success of Triposha in both public and private markets, the GOSL has failed to assume financial and managerial responsibility for the plant, as agreed at the initiation of the project. The plant is still supported by CARE funds, and CARE continues to manege the overall project. Thus the future of the plant is uncertain, indicating that the technology transfer process has not been fully successful and the sustainability of the technology is in question.

4.2 The Costa Rica LEC Project

The impetus for establishing a LEC plant in Costa Rica was similar to that in Sri Lanka. In 1974, USAID, CARE, and the Costa Rican government began discussions to plan for the eventual phase-out of PL 480 foods, mainly Corn-Soy Milk (CSM), which were being used in the country's nutrition feeding programs. The result was a decision to introduce soybean production into Costa Rica, while simultaneously building a LEC plant to process the soy into blended products similar to CSM. In September, 1976, USAID Costa Rica awarded CARE an Operational Program Grant to design and install a LEC processing plant.

Construction of the facility began in 1977 but was not completed until 1979, due to design changes, administrative problems, and personnel turnover. The plant became operational in 1979, shortly after the new CARE/CR Director, Justin Jackson, was appointed. Jackson, who was the former CARE Director in Sri Lanka, brought with him the expertise of installing and operating LEC plants not only in Sri Lanka, but also in other countries.

The Costa Rican LEC plant closed temporarily in 1980, due to the lack of acceptability of the products it was producing. During the seven months shutdown, new products were developed and tested. Further, the local plant which had been selected in 1977 to operate the plant, ProNutre, resigned from the project, and CARE became responsible for operations and management. As a result of these problems and the consequent delays in project implementation, AID extended the life of the project. The plant re-opened late in 1977, introducing several new products, including a soybased drink and cooking flour. By 1983, a new, highly popular drink, Vitaleche, became the major product of the factory; Vitaleche was composed of soy, PL 480 powdered milk, vanilla and other flavoring.

As in Sri Lanka, in Costa Rica the government failed to fulfill it's commitment to assume financial and managerial responsibility for the plant after it's start up. As a result, in 1985, CARE, which was managing both the plant and the project, established a quasi-private foundation with a board of

directors from the public and private sectors to plan the phase-out of CARE operational assistance to the LEC plant. As of July, 1985, the Costa Rican plant is still managed by CARE. However, as in the Sri Lankan experience, the Costa Rican plant has succeeded in developing and producing several highly nutritious, low-cost products which are extremely popular in the government feeding programs.

5. TECHNICAL ASSISTANCE

5.1 Technical Assistance: LEC Plant Construction

As the key technology transfer intermediary in LEC plant installation, CSU was a knowledge broker providing plant designs and operations assistance to the factories in Sri Lanka, Tanzania and Costa Rica. (Annex E provides information on the Tanzania experience). Once the plants were near completion, the CSU team assisted in the final installation of the LEC equipment and the initial start-up of the operations, acting as a procurement agent, expeditor, and technical advisor.

The construction of the plants in both Costa Rica and Sri Lanka encountered engineering problems because of communication problems between CSU, CARE and site engineers. In Sri Lanka, as a result, some of the equipment was not installed properly. Also, in an effort to construct the plant in Sri Lanka as cheaply as possible, the local engineers undersized some of the equipment. Only site visits by CSU engineers were able to correct such problems.

The LEC plant construction in Costa Rica also encountered difficulties that resulted in a lengthy start-up delay. Lack of communications between USAID/San Jose and CSU led CARE/Costa Rica to turn to other sources for technical advice, which only further confused the situation. Several modification also had to be made in the equipment specifications, in the supporting

electrical system, and in the plant design. Further, the turnover in CARE personnel in Costa Rica created communication gaps with the numerous local and expatriate organizations in the project, as well as lapsed record-keeping of necessary documentation. Other problems facing CARE personnel in both Sri Lanka and Costa Rica are their lack of expertise in engineering and food processing technology and in plant management. Finally, in both countries, feasibility studies for both projects should have been more detailed and comprehensive.

The events and outcomes of the Sri Lanka and Costa Rica experiences were directly influenced by AID's program in Food and Nutrition, which through its technical assistance agreement with USDA provided the person-to-person contact essential to technology transfer.

In Sri Lanka, after CARE decided to move the LEC plant closer to Colombo, they contracted a local architect to work with CSU on the second plant design. CSU's approach has been to provide basic layout and then have local firms design the final drawings. According to Lo Christy, team leader of the Costa Rica LEC project impact evaluation, this approach works only if the role of the local engineering and architectural firms in the design phase is clearly specified from the outset, if there sufficient incentive for their participation, and if the necessary skills are available for use in the project.

From his field experience in setting up the LEC plants for CSU, agricultural engineer Ron Triblehorn noted at the workshop that several factors are crucial to LEC technology transfer. First, he stressed that identification of effective local counterparts who will act on behalf of the project is critical. The counterparts have to be both knowledgeable about the project and be continually updated about changes, to assure maximum effectiveness. Triblehorn pointed out that when there was no counterpart, the transfer process faltered, as was the case in both Costa Rica and Sri Lanka when key individuals left the project. The key to a smoother transfer of technology, he stated, is to keep communication channels open with the counterpart and to stay in close contact. It is essential for the counterpart to keep the technology intermediary, such as CSU, informed of progress, problems and changes as they occur, through regular communications.

5.2 Technical Assistance - LEC Plant Operator and Management Training

Through providing assistance in the installation and operations phases of the LEC plants the CSU group has determined the exact skills, training, and education necessary to operate the facilities, including both management and technical skills. For the installation phase, Triblehorn recommended that a self-motivated individual with a college education, or training and experience in plant installation, be selected. Plant management requires an experienced factory

manager, usually with a college degree, who has an interest in management and who is willing to involve himself in daily plant operations. Even equipment operators should have a vocational degree, as well as technical or mechanical experience. Originally, CSU thought that anyone could be trained to handle plant operations, but they encountered difficulties in Sri Lanka in training plant operators who were largely unskilled workers. Another problem Triblehorn cited is the personnel turnover rates at the LEC plants in several countries. High turnover required a more active role by CSU, which was obliged to visit the plants, retrain personnel, and monitor operations much more closely than would otherwise be needed. This significantly increased project costs and the time required for technology mastery.

CSU's involvement in Sri Lanka and Cost Rica has helped them to develop comprehensive in-country training programs for plant managers and operators. According to Triblehorn, when CSU first started to train plant managers and operators, the training was very limited and related largely to equipment operation. But CSU soon discovered that it was necessary to train personnel not only in technical areas, but also in all areas of management and operations. As for training methodology, Triblehorn recommended that initially a classroom setting be used, one that offers the students hands-on experience with specific equipment. Personnel should then use their skills in the plant, be observed, and be retrained if necessary. He also stressed the need for continued development

of documents specific to problems that occur in the plant so that personnel will have reference material. Since unanticipated consequences often develop, it is critical in technology transfer to follow up on problems, reinforce what is being done and be diligent with reporting mechanisms to assure that updated information and feedback is passed back to the plant.

As the development of LEC plants progressed, CSU learned that the transfer of technology was more than just an engineering task in design and planning; it required the transfer of "software" technology skills as well. Because managerial experience in LDC's is so limited, the most crucial of these is general management. CSU realized that in order to assure sustained mastery and adoption of the LEC technology, their training had to cover a wide range of management skills, such as basic business strategy, the calculation of operating costs, production scheduling, personnel management, knowledge of commodity inputs and outputs, plant maintenance, product formulation, marketing techniques, quality control and the introduction of packaging standards.

In both Sri Lanka and Costa Rica, CARE intended that the responsibility for plant management would be assumed by a local private company. In Sri Lanka, the second LEC plant was, in fact, successfully managed by such a company. However in Costa Rica, project delays and the seven month plant shut-down caused local companies to lose interest in project participation;

apparently the rewards were inadequate and there were other more economically attractive alternatives to pursue. As a result, CARE/Costa Rica assumed plant management responsibilities; local personnel were hired and trained by CSU, thereby creating a new management team, rather than drawing on a pre-existing one. However this increased project costs and plant start-up time.

5.3 Technical Assistance: Marketing

The original goal of the LEC projects was to continue to improve the nutrition of the most needy in the participating countries, despite the phasing out of PL 480 commodities. To accomplish this, products made from local commodities were to be gradually substituted for PL 480 imports in the feeding programs.

When AID, CARE and the host governments began the phase-out of the PL 480 foods in both Sri Lanka and Costa Rica, the projects already had effective channels of distribution for these foods. These channels minimized market risk for the new locally produced products, thereby assisting in their substitution for the PL 480 commodities.

Professor John Nichols emphasized the importance of these marketing systems. As he noted, "the real product of LEC technologies is the <u>impact</u> upon nutritional levels of targeted beneficiaries, not the actual food products. But because

people are making decisions regarding the product, and time, energy, and transport costs are required to obtain it (despite the fact it may be given away for free), this places the entire situation in a marketing context."

Although the new LEC products were directed mainly at the public sector market, Nichols noted that marketing the products within the private sector, as well, can serve a useful function. In Sri Lanka, Texas A & M, one of the technical advisory groups, conducted market research jointly with Lever Brothers (Colombo) to determine the size of the potential commercial market for Thriposha. At no point were commercial sales ever intended to replace public sector distribution of the products. Instead, commercial sales offered a supplementary distribution system which could assure product delivery to broader market than could be reached by the public distribution system of health clinics, which were already overburdened and understaffed. According to Justin Jackson, former CARE director in Sri Lanka, the commercial sale of Thriposha was also designed to generate revenues to contribute to the overhead costs of the plant.

Nichols explained that there are three basic steps in the marketing of a commercial product. The first step is to define what the specific product and market will be. In the case of Sri Lanka, the product Thriposha was already acceptable to public sector clients, but the size of the commercial market was undetermined. The preliminary market investigation in Sri

Lanka involved the use of secondary sources, but Nichols noted that this step could include actual product acceptability tests. In market identification, he noted that it is important to assess other competitive products; this is often resisted by LDC counterparts, who fail to appreciate competitive marketing issues, such as comparative quality, availability, and pricing. Further, there must be continuous feedback on consumer attitudes and behavior, since markets are not static, but they constantly change as preferences and incomes change, and as new competitive products enter the market.

The second basic marketing requirement is to target the product to the precise market which has been identified, and to define the distribution channels which can most effectively deliver the product to that market. This is the most complex and time-consuming aspect of marketing, and includes such issues as product packaging, pricing, promotion through advertising and consumer education, physical distribution of the products, and developing retailer acceptance of the product and obtaining desirable shelf-space in retail outlets. Generally, Texas A & M tries to identify local expertise to assist with market research at this stage. In Sri Lanka, for example, Lever Brothers was instrumental in the distribution of Thriposha, and in Guyana, Guyana Pharmaceuticals performed the same function. Once effective local marketing agents are identified, Texas A & M attempts to transfer marketing responsibilities to them.

The third basic market development priority is the monitoring of marketing activities to determine consumer and retailer reaction to the product and potential market share and revenues. The best means of assessing these factors is to conduct market surveys; these should not be one-time surveys, but must be periodic, in order to evaluate shifts in consumer loyalty to the product, as preferences and purchasing behavior changes overtime.

In highlighting the lessons learned from providing marketing assistance to the LEC projects, Nichols noted that LEC technology can produce a relatively low-cost, low price, highly nutritious, quality product that consumers consider desirable. The product may be three to four times more expensive than traditional staple commodities, such as rice or wheat, but only 20 percent of the cost of equivalent imported foods, or 50 percent of the cost of other highly nutritious local foods. However, because the LEC products are more expensive than the staple foods normally consumed by the nutritional target groups, consumer education and product promotion are especially critical; the consumer must clearly understand why he/she should pay more for these new foods, which are often similar to traditional dishes.

Another problem which Texas A & M encountered with the LEC managers was their was lack of experience in the costing of plant operations and in product pricing. Even in publically supported programs, the real cost of product production and distribution must be understood and covered for the plants to remain viable.

Another lesson learned is that it is important to insure that there are adequate incentives throughout the distribution channels by building in reasonable margins for wholesalers and retailers. Further, in LDC's, technical assistance is most needed in the areas of product packaging and advertising. According to Nichols, it is essential to create a high quality image for LEC products, because there are frequently negative attitudes toward products targeted to low income consumers and toward local products which are often considered inferior to imported ones. Although packaging is important, he advised that expensive packaging be avoided, in order to maintain prices low enough for the target consumers. Despite the importance of image-building and product promotion, from its experience in several countries, Texas A & M has concluded that these activities are usually the least successful aspects of product marketing in LDCs. As Nichols observed, "In Guyana and Sri Lanka these companies are simply not organized for effectively marketing a product."

Finally, Nichols noted that in any environment, commercial market ventures are highly risky. Therefore, temporary subsidies may be necessary in LEC projects to underwrite product development, research, and marketing, as well as plant development and start-up activities.

5.4 Technical Assistance: Product Identification and Development

Perhaps one of the most important lessons learned in the transfer of LEC technology to developing countries is that, as Irwin Hornstein, explains "No one size fits all." In some cases, what worked in Sri Lanka also worked in Costa Rica, in other cases, it did not. However, there is one particular area of technology transfer which seems to defy cross-country generalizations: the choice of appropriate LEC products.

In Sri Lanka, even before the LEC facility was installed, Thriposha already showed good name recognition and acceptability, due partly to a successful marketing program which created a positive product image. Thriposha was promoted to mothers of the target beneficiaries as a healthful and nutritious product; subsequently, it also proved to be acceptable to the mothers and their children. Since the distribution channel for Thriposha (the health clinics) was already in place, project managers did not have to develop a distribution system for the plant's products. At the same time, because of the product's acceptability even to the broader commercial market, the Sri Lanka LEC facility was able to sell some of its output through conventional retail channels.[1]

There were two main reasons which workshop participants cited for the success of Thriposha in Sri Lanka: the effective marketing campaign directed by CARE and the Ministry of Health, and the commitment of Dr. Bridie Demal, a Ministry of Health pediatrician who acted as product champion. According to Justin Jackson, because of Dr. Demal's creditability with Sri Lankans and her energetic promotion of the product, she helped to create project loyalty among GOSL officials and product loyalty among the consumers.

However the situation in Costa Rica was entirely different. The original product of the LEC plant, a corn-soy blend (CSB) called Nutrisoy, proved to have poor consumer acceptance. Because it was similar to an imported product, corn-soy milk (CSM), which was already being distributed through the government nutrition programs, it was automatically assumed that the CSB would be acceptable to the consumers. Nutrisoy was also similar to Thriposha; thus it was assumed that Nutrisoy would be as successful in Costa Rica as Thriposha was in Sri Lanka. Therefore, the Costa Rican plant began producing CSB without assessing local consumer reaction to the product. According to Costa Rica evaluation team leader Lo Christy, this direct adoption of the Sri Lankan product, without testing it with Costa Rican consumers, was a serious mistake. When, in 1979, it became apparent that CSB was unacceptable both to the end-users and the intended

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[1] In 1985 appropriately 10% of the plant's output was being sold commercially.

beneficiaries in Costa Rica, the plant was forced to shutdown while product reformulation, development, and testing was conducted. It was during this shut down that Vitaleche was developed; this product proved to be highly successful and has remained the main plant output through 1985.

The experience with Nutrisoy in Costa Rica highlights the need to conduct a careful product testing and marketing campaign for any new products, and even to continuously evaluate consumer reaction to existing products; CSM was apparently acceptable before Nutrisoy was introduced, but evidently acceptability rates had declined, as consumers tired of the product. "It wasn't until the experience with Costa Rica that any LEC plant saw the need to experiment with product acceptability and continuous product variation," noted Justin Jackson, former CARE Director in both Costa Rica and Sri Lanka. In a discussion of lessons learned, Jackson concluded they should have placed more priority in Costa Rica on product development and marketing. Jud Harper agreed, and suggested that product development and testing components be included in the design of any LEC projects, rather than assuming that new products which are similar to previously imported PL 480 products will continue to be acceptable. Christy noted the importance of introducing a mechanism to obtain market feedback from end-users, as well as from target beneficiaries.

In conclusion, Christy pointed out that because of the exclusively public sector distribution of LEC products and non-existent promotional activities, soy has yet to significantly enter or alter dietary patterns in Costa Rica. Thus the potential contribution of soy-enriched products, although successful in public sector feeling programs, has not begun to have an impact in private sector markets.

6. LEC Technology Transfer to LDC's: General Conclusions

In the concluding session, workshop participants discussed AID's role in the LEC technology transfer process. Jud Harper stated that the AID missions in both Sri Lanka and Costa Rica assumed a low profile in the LEC projects, as well as in the technology transfer. Another problem cited was the turnover of AID personnel at the missions, a problem which prevented staff from becoming involved in and committed to the LEC projects. While it was acknowledged that the lack of staff continuity at AID is an institutional problem, the need was cited for more AID mission involvement in technology transfer, especially in the overall design of the projects. Harper also advised that there is a need to make the LEC projects more comprehensive, to emphasize market development, and to encourage private firms to implement projects utilizing the LEC technology.

In addition, Delp observed that there was also a high level of personnel turnover at CARE in Costa Rica; CARE Directors and other staff members changed frequently. However, there was a

continuity of CARE Directors with LEC experience in other countries assigned to Costa Rica; this was apparently unintentional, although critical to the success of the project, according to Justin Jackson and John McLeod.

In discussing the future of the LEC plant in Sri Lanka, it was noted that GOSL must make a major commitment of resources if it assumes responsibility for the Thriposha project. To reach the present target group, funding of $2 million per year is required. In order to reach the entire population, $6 million would be required. According to Jackson, the Sri Lanka government never really considered the total cost of the program, especially the full costs without foreign subsidies. As Crowley noted, "frequently countries choose a technology that appears appropriate to their technical needs and goals, without placing sufficient emphasis on the end-cost full costs, both direct and indirect, of sustaining the technology."

The question of cost and sustainability of LEC projects raised the issue of the profitability of LEC plants. While profit-seeking was not considered by USDA to be a requirement for project success, he said Crowley noted that private sector for-profit sales by LEC projects, as in Bolivia, contributed to the greater success of these projects. Christy noted that when marketing mechanisms are totally dependent on public sector programs, the long-term sustainability of the projects may be called into question. The debate over project sustainability also raised the issue of AID's involvement in the

commercialization of commercializing the LEC products. While AID is not funding USDA to help private entreprenuers in LDCs to compete with multinational corporations, the partial or even full commercialization of the LEC products may be necessary to sustain the technology transfer, due to the cost burden of public sector programs, which most LDC governments are unable or unwilling to bear.

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References

1. The Case of Costa Rican Soybean Production and Low-Cost Extrusion Cooking Plant, by Lo Christy, Cathy Strachan Lindenburg, Sonia de La Cruz, and Christopher Mock, September 1985

2. Sri Lanka, Triposha and Low Cost Extrusion Cooking Technology Transfer, by Dan Westrick (forthcoming?)

3. A systems representation of the technology transfer process, by Peter Delp, July 85

4. Status of Low-cost extrusion cooking technology, Dar es Salaam: March 1985 (and November 1985), by Abe Waldstein and Peter Delp, December, 1985

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Suggested Annexes

1. Diagram or photo of Brady cooker, flow chart of machine operation, layout of plant. To do. — To reference in text

2. Time Line of LEC (Annex 5, done for CR) (Elaborated, if possible) — Referenced p. 9. / as Annex X

3. Matrix Chart of Status of LEC projects worldwide — To do. — Annex Y — Referenced p.

4. Descriptions of Major LEC Products (CSB, WSB, CSM). Plus others developed in CR, etc. (drinks etc) Get info. fr. CR annexes (description of CSM; formulae for products (Annex 8 CR) — To reference in text.

5. Protein Content & Utilizable Protein of Major (typed for CR, not used — was listed as Table 3) — Done To reference in text

6. List of participants at workshop w/ complete titles. — To ref.

7. Time Line — CR — Plant operations, Nutrition Programs — Annex 5-6 CR - Done. To ref

8. Time line — SL — (See if Dan will do this). — To ref.

9. Time Line - Tanzania

Text ref. p.

10. New Foods: ch. fr. A. Berg. (Would be useful, but is long). (p. 107 - 122) optional

To ref.

11. Oilseeds & Soy in National Foods (p. 123 - 126) optional

To ref.

12. ~~Table B-7 fr. Berg - Price & Protein Content of Protein products, 71-72~~
p. 14 - FAO Soybean Rpt - Efficiency of Land use & Comparative Prices.

To ref.

13. Tech Transfer process - explain technology, term, stages, etc (use the forward you're preparing for the other evaluations in the series).

Ref p. 1
as Annex
2

14. Workshop Schedule (list of sessions)

Data to get on LEC projects

1. Type LEC (Brady etc)
   # machines

2. Year inaugurated

3. Managed by: local (MoH, etc)
   expatriate (CARE etc)

6.52 uses of food - eg. weaning.

4. Distribution: public %
   Foods private %

4.5 Target groups

5. Sale [redacted] or free

6. Products manufactured.
   CSM, CSB, WSB, others.

6.5 Source of inputs (CARE, local products)

6.51 Commodity production component?

7. Years in operation
   (still, or stopped)

9. Major problems

10. Major successes.

11. Other comments

42

Annex 4 — 1986 Status of LEC in LDCs — Summary

1. Costa Rica
2. Sri Lanka
3. Tanzania
4. Mexico
5. India?
6. Thailand?
7. Guatemala
8. Kenya
9. Indonesia?
10. Honduras?
11. Guyana
12. Bolivia
13. Haiti
~~14. CARS = Mobile~~ ?

14. Liberia
15. Surinam
16. Peru
17. Ecuador

Countries which seriously considered, did not instal

DR
Panama

Annex I

Kenya
Guatemala - INCAP
Indonesia - CARE
Honduras - on hold.
Mexico - private (several)
Sri Lanka - CARE
Tanzania.
CR.
Guyana.
India - consider.
CRS - mobile.
Bolivia - middle class, compete w/ Kellogg.
what is product?
Thailand?

Super ORS.

DR - rejected
Indonesia - reject!!

Annex ___.

Descriptions of major foods - (like the CR CSB annex).

CSM, WSB, CSB, FFSF,
(+ other major products in main LEC projects).

Other products developed - (in projects).

Drinks (milk + spices)
Bean soup
Flours
Meat extenders

(Use CR description for CSM, Annex 8, formulae for other products).

Table

from CR - already typed, but can't find it

Table 3 and Utilizable Protein

Protein Content of Major Grains and Pulses

Products	Protein Content %	Relative Nutritive Value %	Utilizable Protein[1] %
Soy flour	52	60	31
Peanut flour	48	54	26
Full fat soya	39	58	23
Rice flour (high protein)	19	44	8
Wheat flour (white)	14	28	4
Sorghum	10-13	26-34	3-4
Rice	8	50	4
Corn meal	8	37	3

[1] Utilizable protein is derived by multiplying the protein content by the relative nutritive value (an indicator of the products amino acid structure ~~of the product~~, which determines the usability of the product's nutritional content).

Source: Adapted from: World Health Organization, Protein Requirements, Report of a Joint FAO/WHO Expert Committee, WHO Technical Series No. 301 (Geneva: WHO, 1965), as presented in J.E. Austin, Ed., Global Food Production and Consumption (Cambridge, Mass.: Ballinger Publishing Co, 1979), p. 18.

TABLE 8

Efficiency of Land Use for Protein Production

Commodity		Average Yield/Acre	Protein lb/Acre
Soybean	...	24.2 bu.	508
Other Legumes	...	20.7 bu.	293
Corn	...	64.1 bu.	323
Wheat	...	25.1 bu.	180
Milk	...	2780 lbs.	97
Beef	...	342 lbs.	58

Ref: Martin, R.E. Soybean Digest Blue Book Issue, March 1970, 30, p. 27.

TABLE 9

Comparative Prices of Edible Protein Concentrates

Protein Product		Cost of protein/lb. U.S. $
Beef (retail)	...	4.44
Chicken (dressed)	...	1.50
Milk solids (whole)	...	1.00
Dry skim milk	...	0.40
Isolated soy protein	...	0.40
50% protein soy flour	...	0.14

Ref: Martin, R.E. Soybean Digest, Blue Book Issue, March 1970, 30, p. 27.

Dimler, R.J., Soybean Digest, Nov. 1970, 31, p. 19.

49

FAO AGRICULTURAL SERVICES BULLETIN 11

technology of production from soybean

by
s. s. de
food and agricultural industries officer

food and agricultural industries service
agricultural services division
agriculture department

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome 1971