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JAN 19 1989

Agenda

# Expanding the Use of Soybeans

Office of International Agriculture • College of Agriculture • University of Illinois at Urbana-Champaign

Even in countries where cereal grains are plentiful, soybeans can play an important role by improving the quality of the diet and providing a much-needed economic boost.

One of the keys to increasing the use of soybeans is development of programs that respond directly to the needs and concerns of local farmers, businessmen, and cooperatives.

# Fulfilling the Soybean's Promise

As large-scale technology tightens its grip on agriculture around the world, more and more farmers, entrepreneurs, and government officials are searching for alternative ways to process food and feed products. In the United States and other developed countries, this quest has produced a surge of interest in techniques that bring the benefits of value-added processing directly to the farm or the feed lot.

Huge development projects have also lost much of their allure in developing countries. Suddenly, thriving small businesses are being recognized as the backbone of agribased economies. No longer is "small" automatically equated with "backward." Instead, many policymakers now view scaled-down technologies and private enterprise as potent new forces for change.

This concept of molding small-scale solutions to fit varied circumstances, however, is nothing new. For more than a decade, INTSOY staff members have listened and responded directly to the concerns of individual farmers, local businessmen, cooperatives, and researchers from the heartland of the United States to the sun-baked savannas of Zambia and the lush tropical rain forests of Sri Lanka.

The result is a simple but effective formula for change: assess the needs of the people and regions involved and then introduce appropriate, decentralized technologies. The common goal is to promote economic development and to improve nutrition through increased use of whole soybeans as both human food and animal feed.



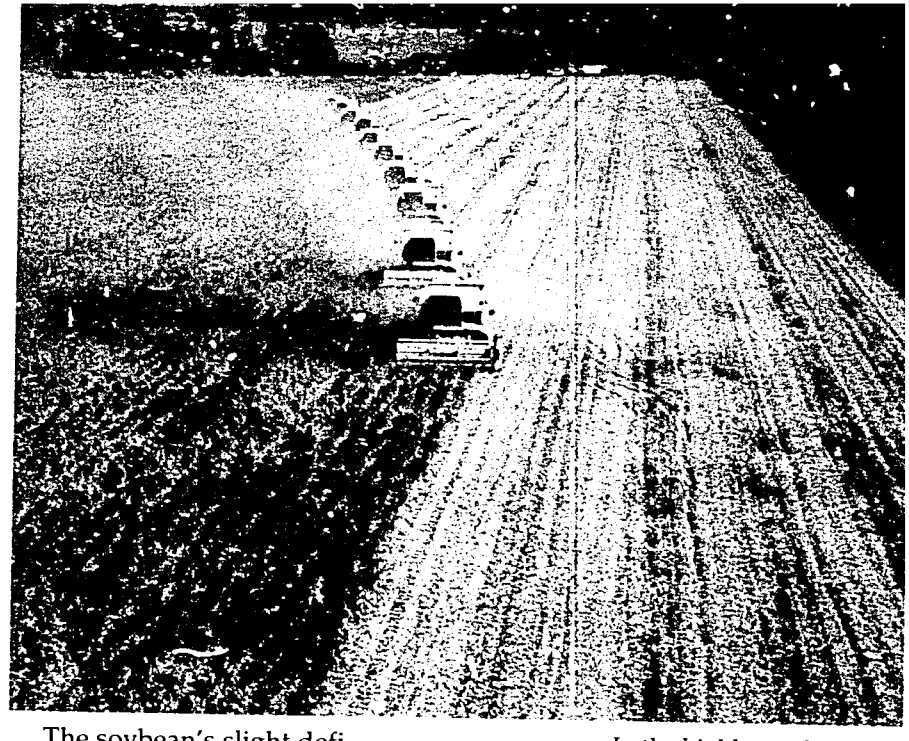
Thriving small businesses, such as this bakery in Sri Lanka that supplies consumers with soy-fortified bread, have emerged as important components in agribased economies around the world.

The soybean, which is one of nature's most versatile crops, combines unparalled nutritional quality with the potential to spark economic progress in the rural areas of both rich and poor countries alike.

## The Unique Versatility of Soybeans

Simply stated, the soybean is a unique crop that combines unparalleled nutritional quality with the potential to spark economic progress in the rural areas of rich and poor countries alike. The soybean, for example, yields more usable protein per acre than any other commonly cultivated crop—at least three times more than rice, wheat, or maize. Unlike most plant sources of protein, the soybean has a relatively balanced amino acid pattern close to the standards of the World Health Organization. It also contains about 20 percent unsaturated oil and is rich in vitamins, minerals, and calories.

The soybean's slight deficiency in the amino acid, methionine, can be easily overcome by combining soybeans with cereal grains, and the rich lysine content of soybeans can supplement deficiencies of this amino acid in cereal grains. Blending soybeans with cereals also increases protein density so that less food is needed to provide adequate protein for vulnerable groups like young children and pregnant and lactating women.



In the highly mechanized agricultural environment of the United States, more and more producers are seeking alternative processing techniques that will allow them to benefit directly on the farm from the soybean's huge value-added potential.

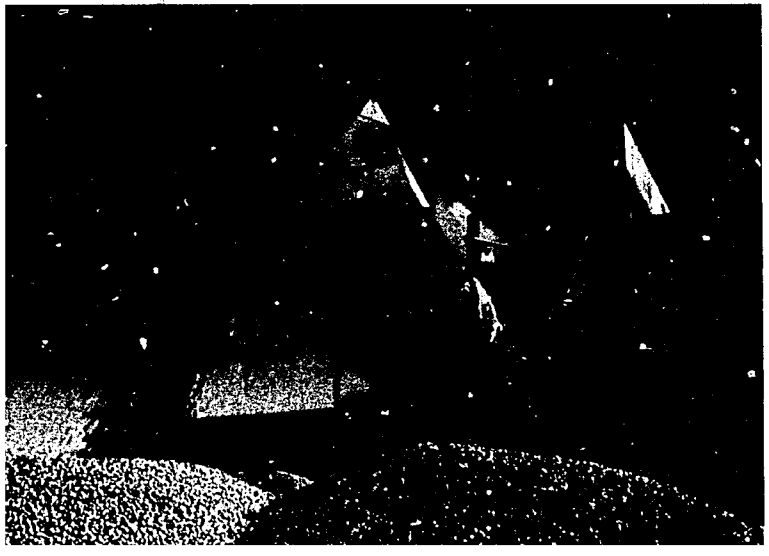
These attributes make the soybean a nearly ideal addition to the predominately cereal-based diets of the developing world. Besides improving these diets, the major byproducts from processing soybeans also have huge economic potential. The high-quality oil can help meet chronic shortages of edible oil in many Asian, African, and South American countries. At the same time, soybean meal provides a much needed source of animal feed for the rapidly growing livestock industries in developing countries.

In the major producing countries, farmers and small-scale processors are turning more and more to the soybean because of its significant value-added potential. Throughout the midwestern United States, for example, there is a sudden surge of interest in using full-fat soybean meal from on-farm extrusion cooking directly in swine rations. Meanwhile, a number of small-scale food businesses are beginning to consider the soybean as a source of added protein for baked goods and other food products.

But, regardless of the region involved, INTSOY's approach centers always on the key premise that realizing the soybean's potential calls for processing technologies and food products that fit the needs of individual producers and small-scale processors.

In India and much of South Asia, the focus is gradually returning to the concept of the soybean as an affordable source of protein in the diet. The most important factor in expanding the use of soybeans as human food in this region is development of an array of products that fit readily into existing dietary patterns.

The soybean remains largely underutilized as a direct food source for rapidly expanding populations in developing countries outside the Orient.



In the major producing areas of the Western Hemisphere, the soybean is grown on a huge scale almost exclusively as feed for livestock and as a source of oil and highly processed food products.

For thousands of years, the amazing food qualities of the soybean alone were enough to spread it rapidly from a small area in north central China to the far reaches of the Orient. For the Chinese, this simple crop has long served as a dietary staple. The soybean was known from ancient times as the "the meat of the fields." Today, soyfoods, such as tofu, shoyu, miso, soymilk, tempeh, and the immature green beans remain an important source of protein for more than a billion people in China, Japan, Korea, and Indonesia, as well as for pockets of Chinese living across East and Southeast Asia.

But for much of the rest of world, the concept of the soybean as a direct food source is virtually unknown. With the exception of some farmers and commodity brokers, the topic of soybeans as a food is treated by most people in Europe and the Americas with indifference. In fact, every day the average consumer spreads toast with margarine made from soy oil or savors a slice of beef from a steer fattened on soy meal without once thinking about soybeans.

Ironically, the United States, Brazil, and Argentina—countries in the Western Hemisphere where the soybean is largely dismissed as feed for livestock or a source for highly processed food products—now account for more than 80 percent of world production. During the last 50 years, the Orient's share of world production has declined from nearly 90 percent to less than 10 percent.

The driving force behind this explosion in production in the Western Hemisphere is the large-scale solvent extraction process that can easily remove almost 99 percent of the oil from soybeans. An average facility costs at least $20 million to build. This complex, industrial system thrives on huge volume. A single plant can easily consume 2,000 tons of soybeans in a day.

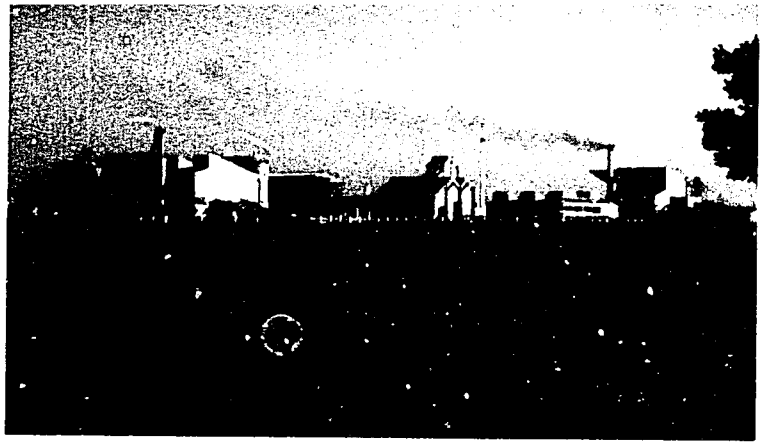
The oil from this process provides the base for a countless array of commercial products, from cooking oil and margarine to printing inks and dust suppressants. And the low-cost protein meal, which is the other major byproduct, has sparked a virtual feed revolution in the swine and poultry industries.

The result has been a massive shift away from soybeans as a direct food crop. Instead, the soybean in much of the world is entrenched as a cash crop marketed exclusively through a complex worldwide agribusiness network. More than three-fourths of the world's soybeans are processed in large-scale solvent extraction facilities. Currently, less than 5 percent of the world's soybean protein goes directly into human food

For the developed countries, the availability of cheap and abundant soybean meal for animal feed has helped transform meat, eggs, dairy products, and fish into primary sources of protein and calories. Recently, some of the more affluent developing countries have also successfully expanded livestock production and fish farming to help meet growing food needs.

The situation, however, is very different for most developing countries. Currently, almost 90 percent of their food needs come directly from plant sources, many of which are relatively high in calories but lack the high-quality protein that is essential for growing children and pregnant women.

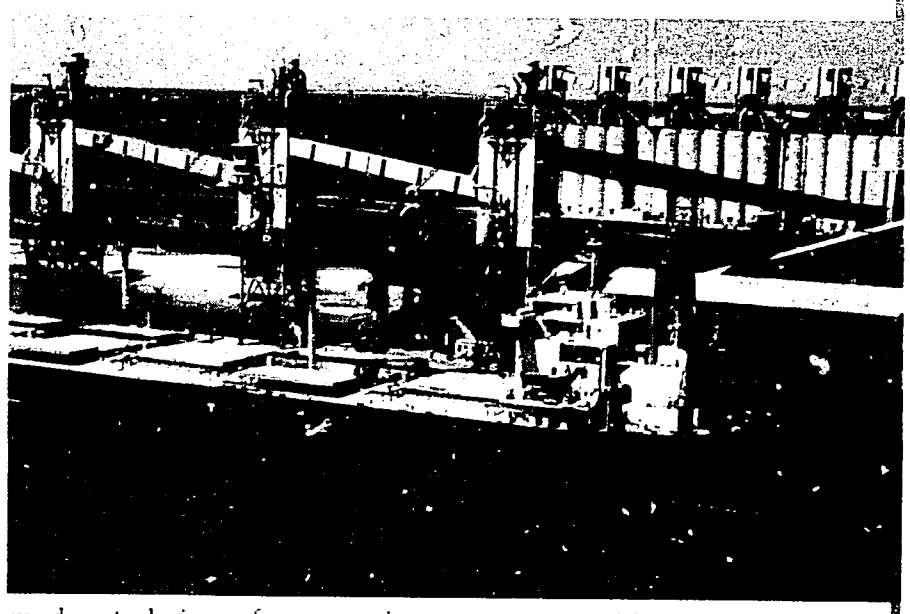
Yet, despite the soybean's enormous impact in countries, such as Brazil and Argentina, it has had only a limited economic effect in most developing nations. Many of them simply lack the processing technologies to participate in the world soybean boom. Hard currencies are unavailable to import processed soybean meal and edible oil. Multimillion-dollar solvent extraction facilities are too expensive to build and require a huge volume of soybeans to operate economically.



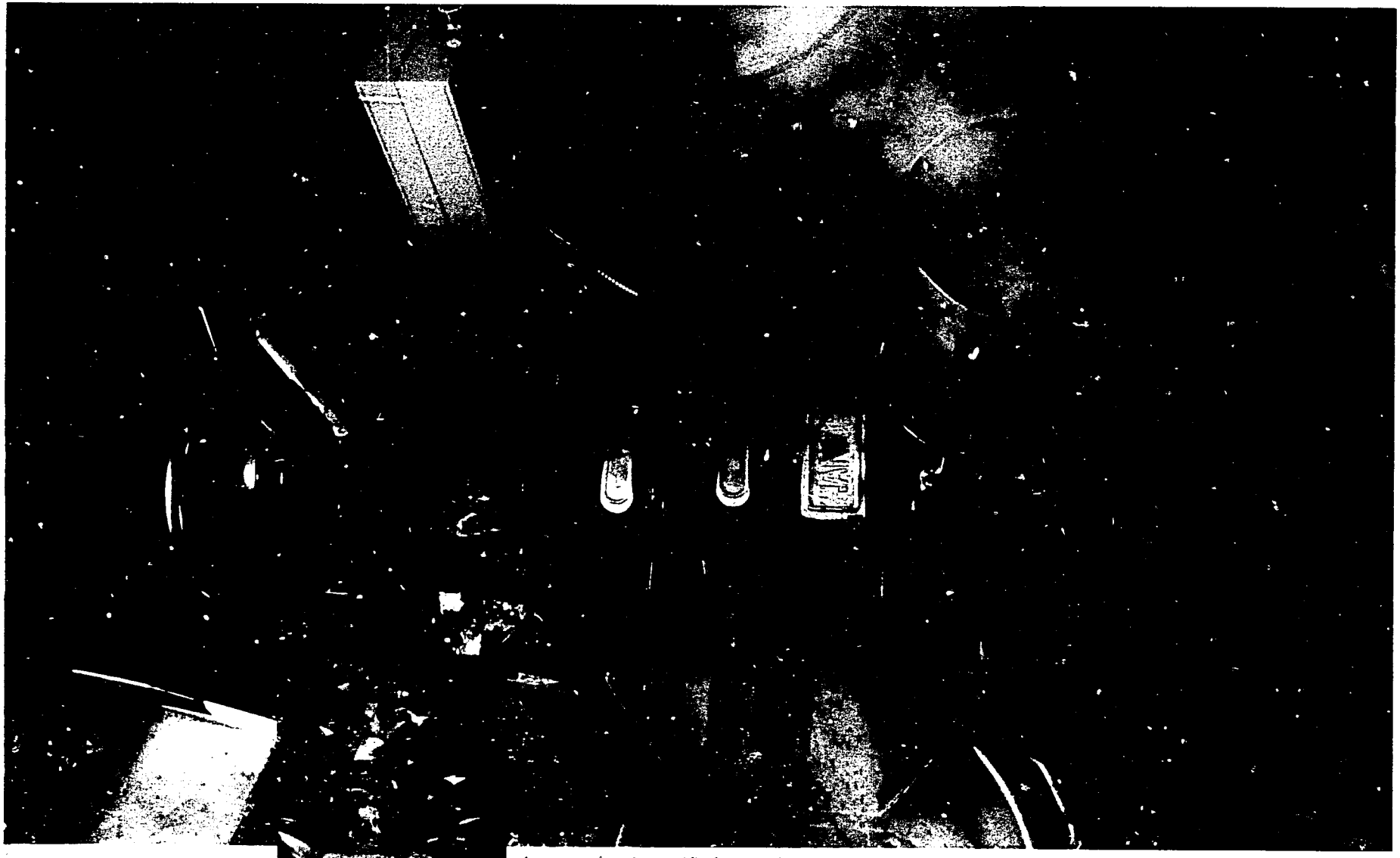
Severe shortages of edible oil have prompted some larger developing countries, such as India, to concentrate on solvent extraction as the primary means of processing soybeans. For most countries, however, this alternative is not economically feasible.

Furthermore, in those developing countries forced to concentrate exclusively on food crops, the shortage of affordable small-scale processing equipment and poor local marketing systems continue to impede the acceptance of soybeans as a direct human food. Meanwhile, simple Oriental processing techniques have not been accepted widely outside East Asia because many consumers do not like the beany flavor of traditional soyfoods.

As a result, fulfilling the soybean's promise for the world's developing countries requires an affordable, decentralized approach that combines the best of both traditional and modern techniques for processing soybeans. For most of the world, expanding the use of soybeans will require development and introduction of new products, processes, and equipment adapted to village-level operations, cottage industries, and small-scale private enterprises.



The sheer size and complexity of the international agribusiness network have prevented many smaller nations from participating in the recent worldwide soybean boom.



As part of an intensified research and development effort, INTSOY has developed new products, processes, and equipment adapted to decentralized processing of soybeans at the village and medium-scale commercial levels.

# Meeting the Challenge

For its part, INTSOY is committed to a new three-part program spanning a seven-year period through the early 1990s. Its first phase is an intensified research effort aimed at developing new soy products and processes fitted to the needs of developing nations. This phase is to be followed by adaptive testing of the technology in selected countries. The last phase consists of on-site technical help in establishing soybean processing businesses in developing countries.

In each phase, the goal is to maintain the highest standards of taste and quality. Special care is taken during processing to prevent the development of the beany flavor that has plagued so many soyfoods in the past. The emphasis throughout this effort will be on promoting multiple uses for soybeans as both food and feed and on developing methods that are as competitive as possible with large-scale processing.

Clearly, the needs of producers and processors vary greatly from region to region around the world. As a result, the choice of how to utilize the soybean's full potential is more wide open than ever. Each country can use different techniques to fit its specific circumstances. But certainly, almost every country—large or small—can now benefit in some way from the nutritious foods and processing techniques for whole soybeans devised by INTSOY.

With new processing techniques, even smaller developing countries, such as Sri Lanka, can now benefit from the soybean's unlimited potential.

One of the keys to producing quality products with extrusion cooking is proper cleaning and handling of the soybeans before processing.

A major focus of current INTSOY research is the development of new products and improved processes, using relatively low-cost extrusion cooking technology. A single-screw dry extruder, unlike more costly and complex twin-screw models, is well adapted for medium-scale processing of soybeans on individual farms and cooperatives and by entrepreneurial businesses in both developed and less developed countries.

Dry extrusion cooking produces high temperature by means of friction under pressure, thereby eliminating the need for an external heat source. The single screw transports the ingredients through a series of restrictions within a cylindrical chamber, finally forcing the material out through a die.

The beans remain in the cooking system for less than 30 seconds at a temperature of about 135 degrees Centigrade. The short time at this high temperature is long enough to cook the material and destroy antinutritional agents, such as the trypsin inhibitor. But the heat treatment does not damage important nutritional components, such as protein.

Drying takes place almost instantly as super-heated moisture in the cooked material vaporizes upon exiting the extruder. Little or no further drying is required to make the material stable for storage. This low-moisture content, combined with the sterilizing effect of the high heat within the extruder, produces a finished material that is also microbiologically stable.

These features make the extrusion system almost perfect for the continuous, commercial production of cooked soy and soy-cereal combinations. With soybeans as the only raw material, the final product is a full-fat meal or cake suitable for both animal feed and a wide range of human soyfoods. The extruder also can blend soybeans with maize and cereals, such as rice and wheat, or with more unusual ingredients, such as vegetables and even fruits.

Mixing soybeans with corn or cereal grains yields products with an average protein content of 20 percent or more. The blending process also improves the amino acid balance, a fact that makes extrusion cooking

Soybeans emerge from the extruder in a semi-fluid state at a temperature high enough to effectively destroy the antinutritional trypsin inhibitor.

superb for supplementing cereal grains and maize with high-protein soybeans.

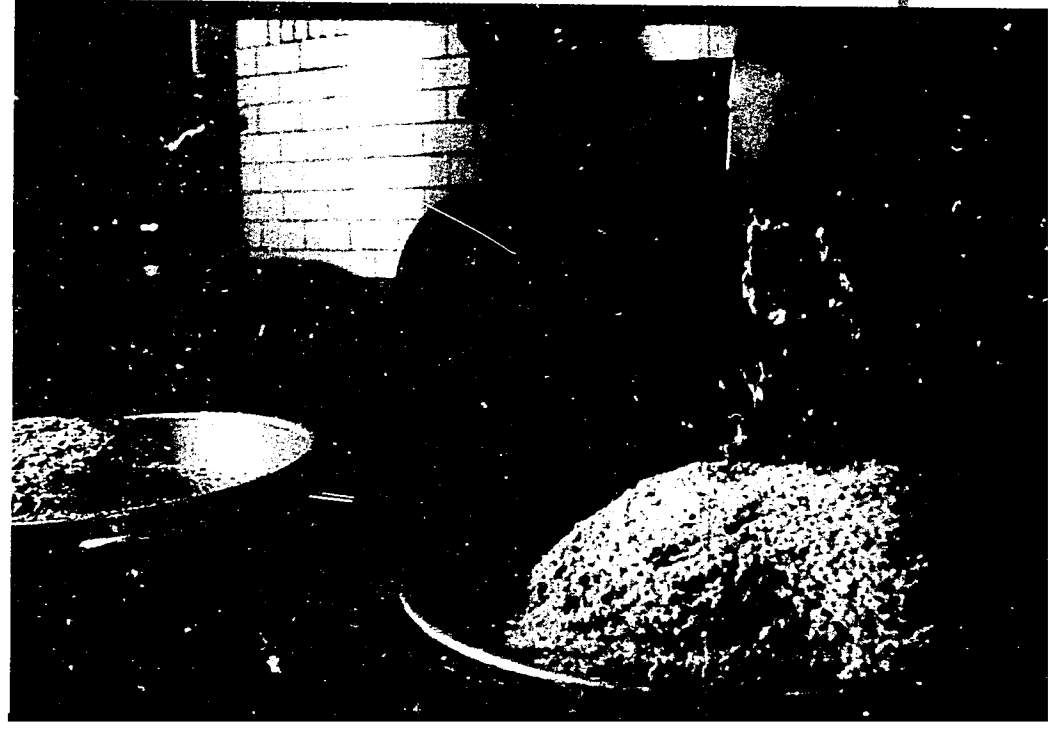
Furthermore, with soy-cereal blends, the sudden emergence of the material into the atmosphere from the high-heat, pressurized environment in the extruder causes the material to puff or expand. This feature is highly suited for making snack foods. By using this technique, INTSOY researchers have produced a wide range of tasty, high-protein snack foods and breakfast foods made from a combination of 30 percent soybeans and 70 percent maize or rice.

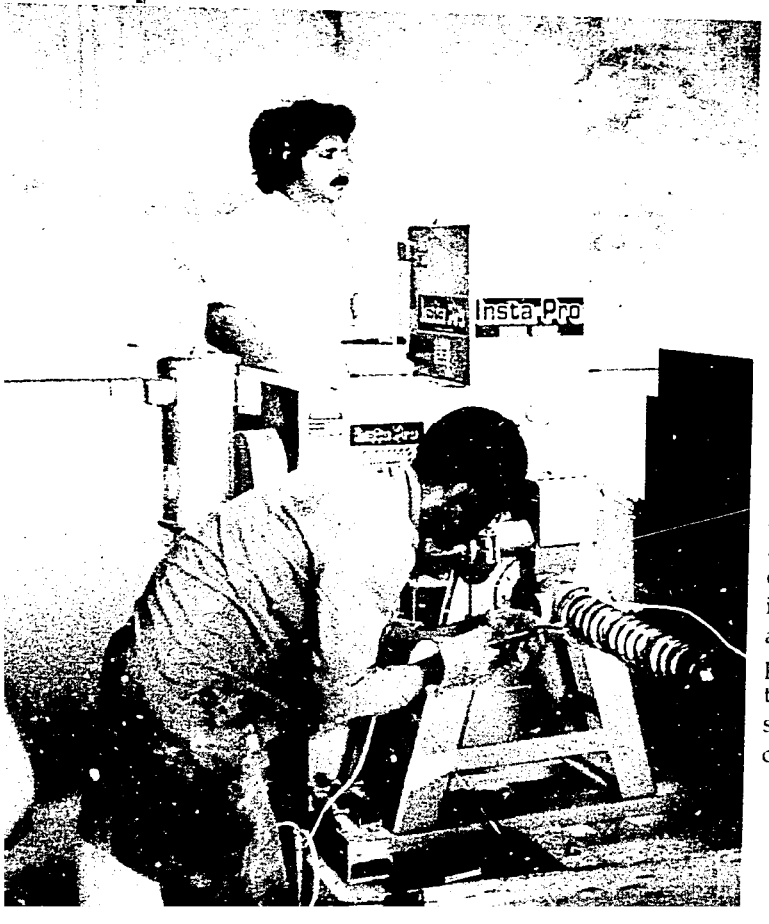
Low-cost and high-protein granola bars also can be made using various other extruded soybean-cereal combinations. Tremendous potential also exists for making breads and tortillas from soy-wheat or soy-corn flour. In fact, the extruder is so versatile that it can be used to produce a wide range of innovative soy-based products from soups to texturized protein supplements.

Because of its relatively low cost, extrusion technology offers the potential for local entrepreneurs to produce full-fat animal feeds and high-protein food supplements at competitive prices. For populations dependent on cereal-based diets, this development would mean the increased availability of affordable high-protein foods.

In the United States and larger developing countries, extrusion cooking can also greatly enhance on-farm production of high-energy feeds for the swine and poultry industries. In fact, the wide application of dry extrusion technology could significantly increase the use of whole soybeans as a food and feed source both in the United States and throughout the world.

With soybeans as the only raw material, the final product of extrusion cooking is a full-fat meal or cake suitable for both animal feed and a wide range of human soyfoods.






Several companies in Nigeria and Zambia have already successfully introduced extruders for processing soybeans into animal feed and a high-protein soy flour used to supplement the local staples made from cassava or maize.

## Catalyst for Developing Countries

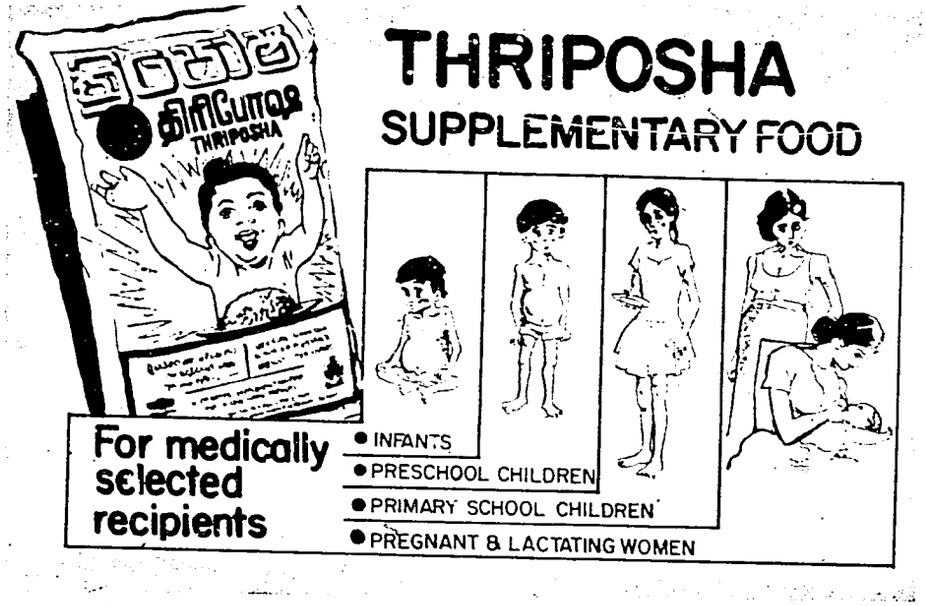
Already a number of developing countries in Africa have successfully increased the use of soybeans through extrusion cooking. In Zambia, for example, direct assistance by INTSOY food scientists in 1985 helped spark the rapid introduction of extrusion cooking by several private companies. This action, in turn, led to the widespread local marketing of full-fat soy meal for animal feed and the introduction of several foods fortified with soy.

Commercial processors are now expanding into production of soyfoods. The availability of these new products, along with improvements in the quality of traditional soyfoods, has opened up additional markets.

Two companies in Zambia have already purchased extruders for processing soybeans. Both are making full-fat meal for animal feed, and one of them has begun producing a soy-based meat extender and high-protein bread supplements. In addition, the largest milling company in the country is anxious to use soy in bread products and in the local staple known as maize mealy meal.

Commercial extrusion cooking companies are also operating in other African countries, including Nigeria, Zimbabwe, Ethiopia, and Uganda. Indeed, in Nigeria, extruded soy meal for the poultry industry is rapidly becoming a major commercial product. Local producers have already purchased several new extruders and are moving toward increased production of high-protein soyfoods.

Government agencies and private businesses in countries as diverse as Swaziland, Kenya, and Tanzania are also moving ahead on opening extrusion operations for processing soybeans. Similar enthusiasm for the potential of extrusion cooking has sparked interest in expanding soybean processing for both animal feed and human food in Belize, Jamaica, Trinidad, Colombia,



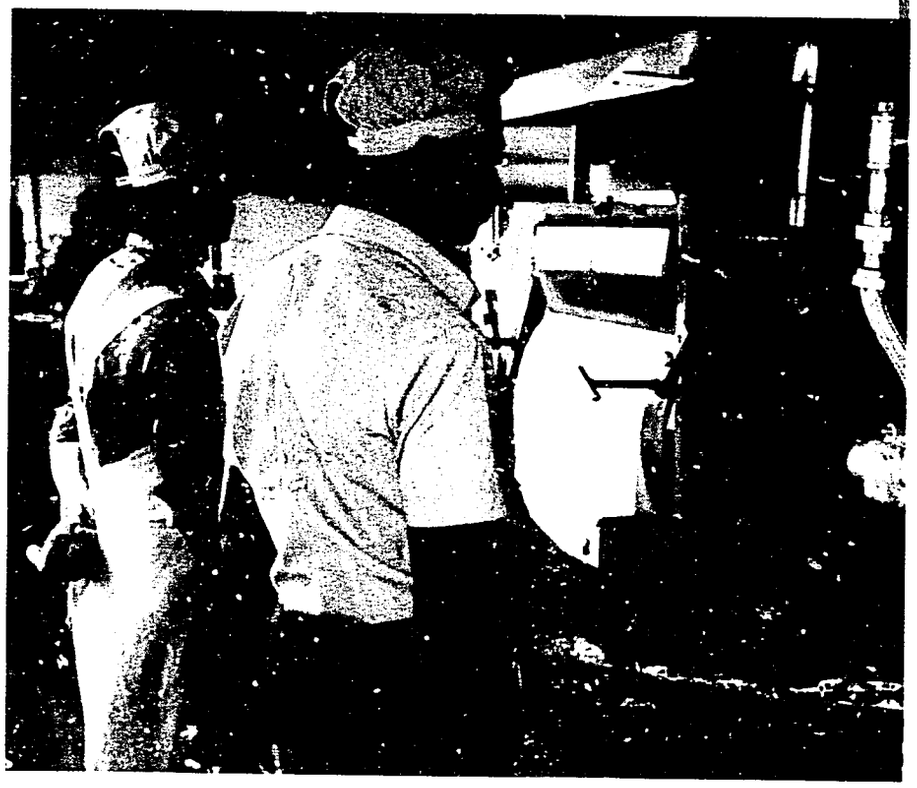

The most widely used soy product in Sri Lanka is the children's feeding supplement marketed under the name Thriposha.



and other small Caribbean and South American nations.

In the Asian country of Sri Lanka, low-cost extrusion cooking has been used since the 1970s. INTSOY helped spur the development of this technology by providing technical assistance for the government's Soyabean Foods Research Centre in Gonnoruwa. The extrusion pilot plant has become a major center for research on new soyfoods and provides a limited supply of products for small businesses in other parts of the country.

The most popular extruded product in Sri Lanka is the food supplement known as Thriposha. Most Thriposha is distributed to infants, preschool children, and pregnant or lactating women through a variety of health centers in both urban and rural areas. Each 50 gram serving provides 10 grams of protein, about 200 calories, and a full daily complement of minerals and vitamins. As a result, this soy-based product is today a household name throughout the country.



INTSOY's involvement with the Soyabean Foods Research Centre in Sri Lanka has helped spark development and production of numerous extruded soyfoods.

With the new system developed by INTSOY, the extruder can be linked directly with a mechanical oil press to produce a high-grade natural oil and a partially defatted meal suitable for both animal feed and a number of human food products.

## Combination Extrusion Cooking and Expelling

During the last 50 years, mechanical oil expelling equipment for processing soybeans has been completely replaced in developed countries by large-scale solvent extraction facilities. Solvent extraction technology, however, has proved unsuitable for individual farmers and entrepreneurs in the United States and for many smaller developing countries.

Because of relatively low oil yields from soybeans, the expelling industries in developing countries have generally continued to rely on traditional oil-bearing materials, such as peanuts, coconuts, sesame, and palm kernel.

But, recent research by INTSOY shows that the problems associated with using soybeans in a mechanical oil press can be overcome by first conditioning the beans through extrusion cooking. The extruder offers a convenient way of cooking the beans and breaking down the oil-bearing tissues in a fraction of the time required for conventional conditioning methods.

High temperatures and the forces of shear and compression within the extruder disrupt the oil-bearing tissues, producing a nearly fluid state in less than 30 seconds. A significant portion of the oil can be recovered when the semifluid, extruded material is immediately fed into a mechanical oil press.

The result of combining the extruder and expeller into a single operation is an oil extraction rate from soybeans approaching 75 percent with only a single pass through the expeller. This oil contains natural antioxidants; therefore, little further processing is required, except for degumming.

Because of the antioxidants, the clear, light-colored edible oil is highly stable and has no off-flavor. This oil would be suitable for use in developing countries where there is commonly little or no refining of vegetable oils used for human consumption. It should also be an important natural product for health food industries or as a dust suppressant in developed countries.

The natural oil from extrusion/expelling also retains virtually all the 7 to 8 percent of alfalinolenic acid or Omega-3

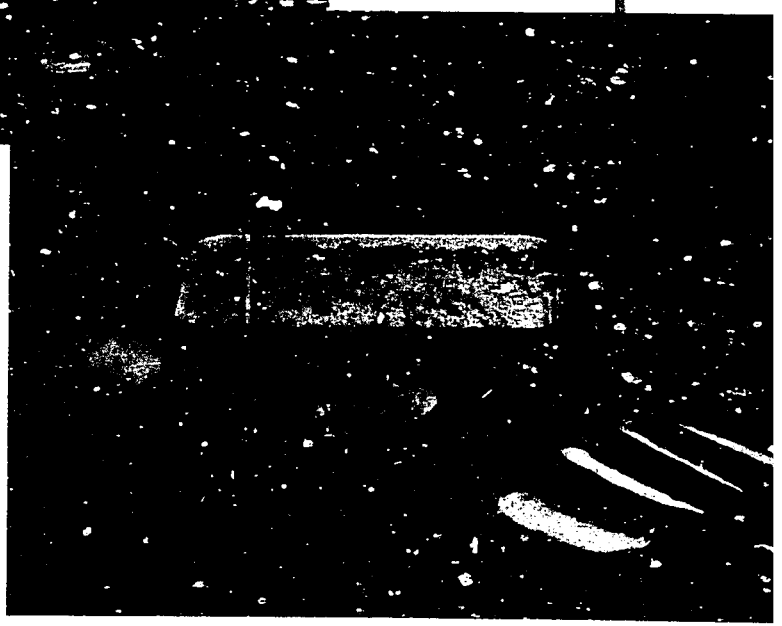
factor found in raw soybeans. This amount is much higher than most common oil-bearing crops, such as maize, coconuts, palm kernel, and sunflowers, all of which have less than one percent. By contrast, the Omega-3 in most cases is partially destroyed in the refining process used to stabilize solvent-extracted oil.

The other major end product from the combination of extrusion and expelling is a high-quality, partially defatted meal that can be used in animal feed or in food products, such as weaning foods and soy flour for breads and tortillas. Because of its low oil content, the meal is much easier to mill than whole full-fat soybeans.

Easy milling is especially important for developing countries where problems with grinding whole soybeans by conventional milling equipment severely limit the production of full-fat soy flour. The partially defatted cake from extrusion and expelling, however, grinds very well in the conventional hammer mills available in developing countries.

As a result, this new combination of extrusion and expelling technology can:

- Improve nutrition for millions of people in both developed and less developed countries.
- Increase the availability of edible oil in regions where it is in short supply.
- Open soybean processing to many individual farmers and entrepreneurs interested in marketing high-quality edible oil along with animal feed and protein-rich soyfoods.
- Promote decentralized processing of soybeans in regions where production is as small as 3,000 to 5,000 hectares.
- Enhance the overall profitability of existing expeller operations.
- Increase new economic activity in the rural areas, and thereby produce a higher demand for soybeans, animal feed, and processed soyfoods.



The edible oil from the expeller requires only minimal filtering and processing for most uses. In addition, the process yields a cake or meal that can be easily ground into flour for use in a wide array of foods adapted to local tastes.

The INTSOY medium-scale commercial soymilk process is based on breakthroughs made during development of a simple system for producing a bland soymilk in the home.

## Soymilk [illegible] Analogs

One of the simplest methods for converting soybeans to a high-quality food is to produce a beverage known as soymilk. This product is free of cholesterol and can be prepared to contain virtually the same amount of protein as cow's milk.

Soymilk is especially important for people who are allergic to the lactose in cow's milk. Although not prevalent in the United States or Europe, the inability to digest this milk sugar lactose occurs widely in developing nations. Rates from 50 to almost 100 percent for lactose intolerance have been recorded among many populations in Asia, Africa, and Latin America.

Because soymilk contains no lactose and is relatively inexpensive, it offers an attractive alternative to cow's milk for hundreds of millions of people in both developing and developed countries.

Unfortunately, the traditional soymilk, which has served as a staple in the Orient for many centuries, has a distinctive beany flavor that is unacceptable to most consumers outside the Orient. However, many of the problems associated with producing an acceptable, bland soymilk have been solved by food scientists at the University of Illinois.

In the early 1970s, they developed a process for cooking and grinding the beans in a way that inactivates the enzyme responsible for causing the objectionable beany flavor. The soy beverage made with this process, despite its bland flavor, was not widely accepted because it left a chalky feeling in the mouth.

These problems, however, have been corrected by subsequent improvements in the process. Recently, the process has been scaled up from the laboratory to the medium commercial scale by continuously extracting the soymilk from the ground slurry with the roller extractor from a tofu-making machine.

An excellent soymilk containing more than 5 percent protein has already been prepared using this relatively inexpensive commercial process. At that concentration, about 10 kilograms of dehulled soybeans are needed to produce 50 kilograms of soymilk.

This product contains about 10 percent total solids. That figure compares favorably to the 10 to 12 percent solids, including about 4 percent protein, found in cow's milk. This soymilk is well suited for making both yogurt and ice cream. It also is exceptionally good as a base for commercial soft-serve products.

Yogurt is a tasty and nutritious product made by fermenting cow's milk to form an acidic gel. Soy yogurt contains less acid than regular yogurt and should have widespread consumer appeal. A small amount of added sugar promotes the fermentation. The use of different sugars or sugar mixtures produces somewhat different flavors in the final product.

Soy ice cream is prepared from soymilk and added vegetable oil. It is formulated and manufactured in the same way as conventional dairy ice cream. This soy ice cream stores well and has good meltdown characteristics. Current research on tofu manufacturing is focusing on ways to improve yields and to eliminate the beany flavor.

The okara or residue from the commercial soymilk process can be used immediately in baking or dried for later use as a high-fiber flour. The okara contains about 8 percent protein on a wet basis or about 40 percent on a dry basis.

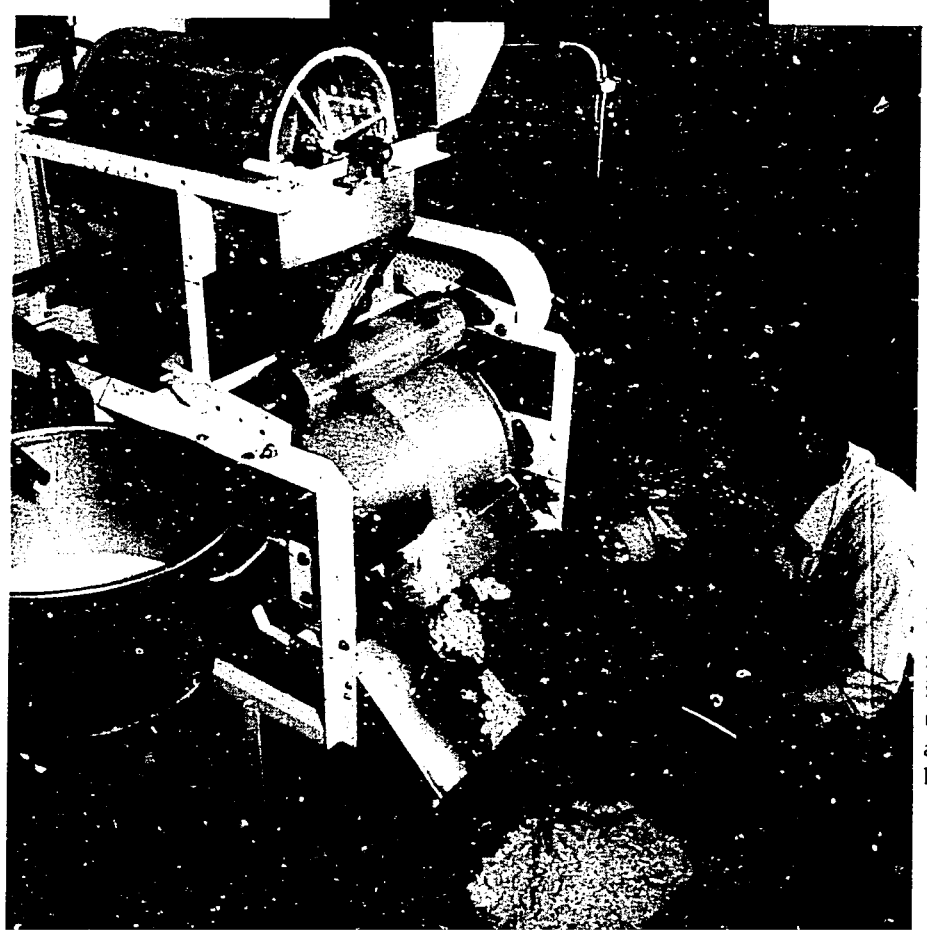
The new process developed by INTSOY is especially important because building costs for currently available turn-key, soymilk processing facilities can amount to several million dollars, a figure that is far beyond what most developing countries can afford. By contrast, the equipment used in the INTSOY soymilk process is relatively inexpensive and widely available.

The process could be easily adapted to a commercial operation with a volume of 100 to 200 liters per hour. With a larger extractor, the capacity could be expanded to as much as 600 to 800 liters per hour. This figure compares with an average capacity of 2,000 liters per hour for most available commercial soymilk operations.

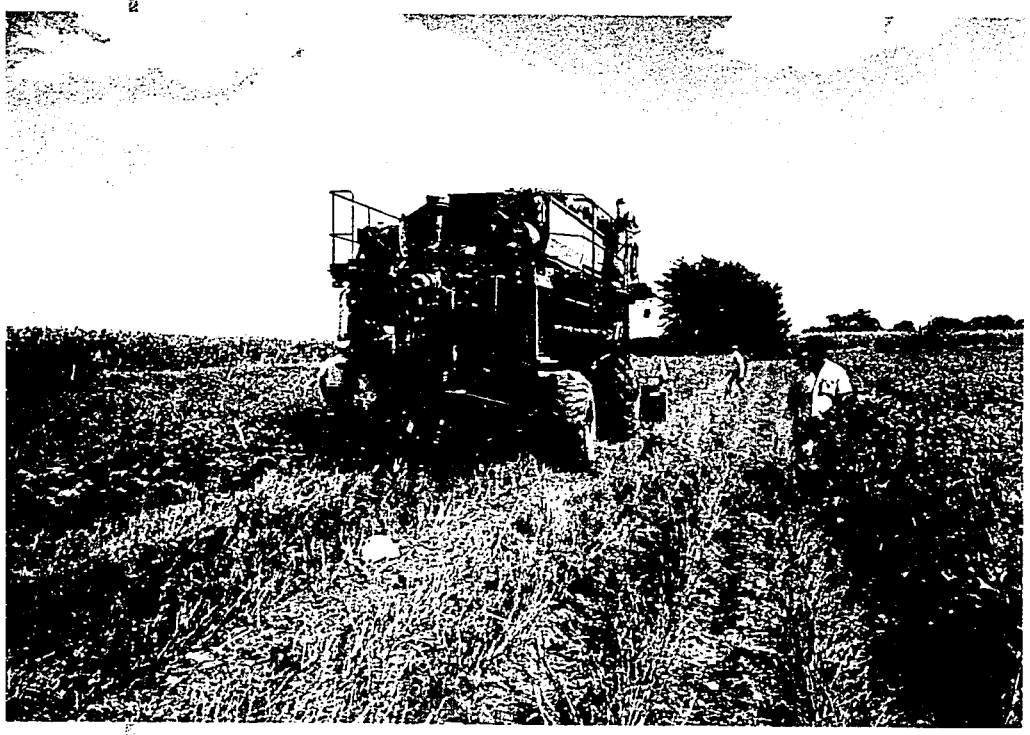
Therefore, the new commercial-scale process being developed by INTSOY is a major step toward effectively meeting the huge worldwide need for soymilk. For example, a soymilk plant producing 100 to 800 liters per hour would be much less expensive than the available turn-key operations. Smaller processing plants that prepare pasteurized products for local rather than nationwide distribution would not need costly aseptic packaging equipment.

And, most importantly, the result should be a major expansion of soymilk production wherever there is a strong need for a high-protein beverage but only a limited amount of investment capital.

Wet grinding of soybeans is used to prepare a slurry that can be made into a soymilk with almost the same protein content as cow's milk.



An extractor can produce soymilk at a rate of 200 liters per hour or more. The residue or okara is an important byproduct that can be ground into a high-protein flour for baking.



Recent field trials have confirmed that a combine-type green pea picker can depod immature green soybeans in the field. This is a major step in development of green soybeans as a commercial frozen vegetable with major value-added potential.

## Immature Green Soybeans

Another important part of the INTSOY research program is the development of immature green soybeans as a commercial frozen vegetable. Certainly no other vegetable can match soybeans for nutritional value. Green soybeans, for instance, have an average of 12 percent protein on a wet basis, compared to 7.6 percent for lima beans and 5.4 percent for peas. These soybeans are also an excellent source of unsaturated fatty acids, including the Omega-3 factor. In addition, they are rich in most essential vitamins and minerals.

Green soybeans are already popular as a food in the Orient. In Japan, they are served in the pod as a snack food. Frozen soybeans in the pod are regularly imported into Japan from Taiwan. Green soybeans are even imported into the United States to meet the demand from Oriental speciality food markets.

The potential for this product, however, has been largely untapped outside the Orient. Nevertheless, numerous highly positive taste tests of green soybeans that were cooked after being frozen indicate that the product could have wide appeal eaten alone, used in frozen dinners and vegetable mixes, or marketed as a specialty Oriental food product.

The main obstacles to the development of green soybeans as a major commercial product in the United States and other larger countries are problems in harvesting and breaking open the pods during processing. In the Orient, green soybeans are generally picked by hand or with simple harvesting equipment and are frozen in the pods. These methods, however, are inadequate for harvesting and processing green soybeans on a commercial scale of several hundred million kilograms.

As a result, research at INTSOY has centered on developing improved harvesting and processing techniques. Preliminary results from field trials now indicate that immature green soybeans can be effectively picked using a combine-type green pea harvester. This machine not only cuts and harvests the beans. It also depods and cleans the beans in the field, thereby eliminating most of the processing problems

encountered with other harvesting techniques.

Depending on the variety and the planting date, green soybeans can be picked from 60 to 90 days after planting. The beans are optimum for harvesting during a one- to two-week period. This harvesting period compares with only a few days for peas.

The combine picker effectively removes all stalks, leaves, and pods. It leaves only small debris mixed in with the seeds. Ordinary field varieties, rather than vegetable types, appear best for commercial harvesting. The average yield for the preliminary field trials was about 2,000 kilograms per hectare. This rate is close to that found in commercial pea, green bean, and lima bean harvesting operations.

After removal from the field, the beans are cleaned in a reel-rod washer and blanched in boiling water for at least four minutes. They are then re-cleaned and quick-frozen at minus 40 degrees Centigrade. The packaged frozen beans can be prepared for serving in about one minute in the same way as any regular frozen vegetable.

Frozen immature green soybeans offer a new use for soybeans that does not compete with existing soy products. In the United States alone, potentially hundreds of thousands of acres would be needed to fill the demand for this value-added product. Farmers producing green soybeans also would have an early cash crop similar to lima beans or peas. In addition, green soybeans have major potential as an export to Japan and other Oriental countries.

The beans are quick-frozen at minus 40 degrees Centigrade. They can be prepared for serving in about one minute in the same way as any regular frozen vegetable.

After removal from the field, the green soybeans are cleaned in a reel-rod washer and blanched in boiling water for at least four minutes before freezing.

In Sri Lanka, principles first developed by INTSOY have been used to train more than 25,000 housewives and extension workers in home preparation of soybeans.

The spread of soyfoods outside the Orient has been limited by the beany flavor associated with most traditional products, by the long cooking time required to tenderize the beans, and by the need to inactivate antinutritional agents in the beans. Initial research at the University of Illinois showed that all three problems could be overcome simply by blanching the soybeans during home preparation.

Dropping dehulled beans into already boiling water permanently prevents the development of an off-flavor by inactivating the lipoxygenase enzyme. Blanching also inactivates major antinutritional agents, such as the trypsin inhibitors. Moreover, the time it takes to tenderize the beans can be cut at least in half by breaking the beans into grits and adding a small amount of baking soda to the blanching water.

The use of soybeans in the home offers a practical approach to improving the diets of those in need of more and better protein. Expensive equipment is not needed. The relatively short cooking time is convenient and helps conserve scarce energy supplies. The primary product is a bland, highly nutritious soy base that can be easily combined with other ingredients in traditional local dishes.

Blanched soybeans, for instance, can be sun-dried in tropical climates and made into flour with simple grinding techniques. The flour can be incorporated into a variety of unleavened, cereal-based products made in the home: flat breads, "pan cakes", gruels, cookies. For people with diets based predominantly on cereal grains, this soy flour adds much needed protein and calories.

Protein and calorie deficiencies in weaning children are serious nutritional problems in many developing countries. Children are often weaned from their mother's milk to an adult diet that is very low in protein. As a result, there is a great need for a weaning food containing high amounts of protein and calories. Soy-cereal combinations provide ideal weaning foods that can be easily prepared in the home on a daily basis.

The traditional Oriental product known as tofu is

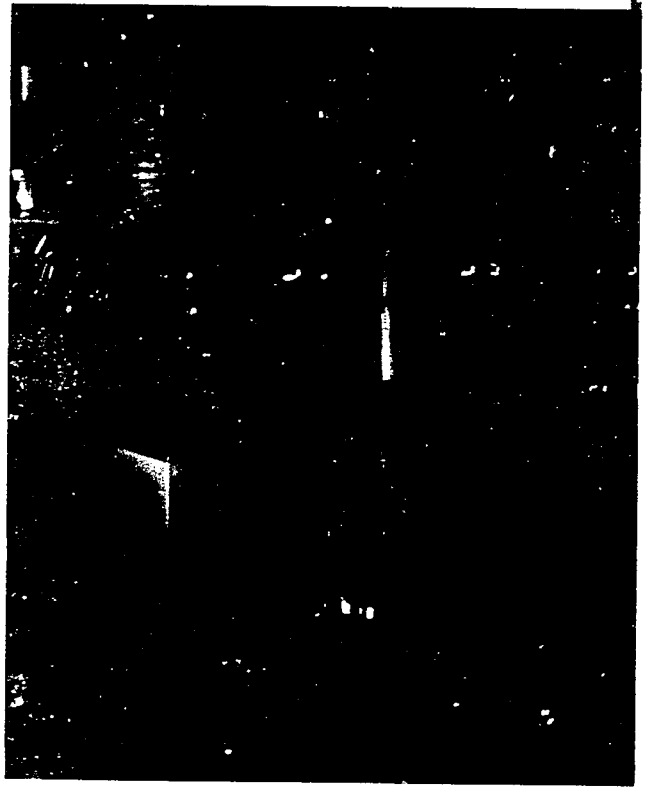
The home preparation of soybean foods remains a major topic of instruction at the annual INTSOY processing short course.

especially suitable for small-scale production at the village level. Fried tofu can be easily cooked into curries in much the same way as meat and provides an inexpensive, highly nutritious alternative to it.

Tempeh, a fermented soyfood traditional to Indonesia, is made using a fungal culture. When dry, tempeh develops a flavor similar to dried fish. Like tofu, it is suitable for small-scale production. This product could have wide appeal in countries where dried fish is an important source of protein.

Soymilk is another important product with great potential for expanded use. INTSOY's simple home processing methods produce a soymilk with no trace of an off-flavor. It can extend the limited supply of cow's milk or serve as an alternative for the hundreds of millions of people who are lactose intolerant. It can also be used as a cooking medium for many traditional food preparations.

Roasted and fried soybeans are highly nutritious snack foods that can be prepared in the home with simple methods. Soybeans also can be easily incorporated into many of the curries that are traditionally consumed by Asian peoples. Even sweet preparations made in the home from cereal flours can be enriched with soybeans.



In countries such as Zambia, extension workers have found that INTSOY's basic concepts for home preparation can be readily adapted to conform to local tastes and cooking methods.

The International Soybean Program (INTSOY), which is headquartered at the University of Illinois, has served as an international soybean resource base since its inception in 1973. Its primary goal is the improvement of human nutrition around the world through increased use of soybeans as both human food and animal feed. The program is based on the premise that increased soybean utilization can help meet the nutritional needs of the world population and, at the same time, benefit those who produce soybeans.

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INTSOY operates as a program in the Office of International Agriculture at the University of Illinois. Primary support for INTSOY programs is provided by the United States Agency for International Development (USAID). The views and interpretations in this publication are those of INTSOY and should not be attributed to USAID or any other organization providing support for INTSOY.

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