LABORSAVING HOME AND VILLAGE TECHNOLOGY FOR FOOD PROCESSING AND PREPARATION

prepared by*

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LIST OF ABBREVIATIONS USED

A.I.D.	Agency for International Development
AIT	Asian Institute of Technology
APICA	Association pour la Promotion des Initiatives Communutaires Africaines
ARCT	African Regional Centre for Technology
ATI	Appropriate Technology International
CEPAZE	Centre d'Eschanges et Promotion des Artisans en Zones a Equiper
CRS	Catholic Relief Services
EDI	Energy Development International
FAO	Food and Agriculture Organization (of the United Nations)
FRG	Federal Republic of Germany
IFPRI	International Food Policy Research Institute
GATE	German Appropriate Technology Exchange
GTZ	(Deutsche) Gesellshaft fu Zusammenarbeit
ICRISAT	International Center for Research in the Semi-Arid Tropics
IDRC	International Development Research Centre
ILO	International Labor Organization
IMF	International Monetary Fund
ITDG	Intermediate Technology Development Group
KITLIFE	League for International Food Education
LESO	Laboratoire d'Energie Solaire
MINVA	Ministerio de Vivienda y Asentamientos Humanos
BODNRI	Overseas Development National Research
TDRI	Tropical Development Research Institute

SKAT	Swiss Center for Apporpriate Technology
SODERZA	Societe de Development Rural du Zaire
TPI	Tropical Products Institute
UK	United Kingdom
UNFM	Union Nationale des Femmes du Mali
UNIFEM	United Nations Fund for Women
UMN	United Mission to Nepal
UNATAUNCSTD	United Nations Conference on Science and Technology for Development
USDA	US Department of Agriculture
VITA	Volunteers in Technical Assistance
VPI	Virginia Polytechnic Institute

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1.0 INTRODUCTION AND SUMMARY

1.1 Summary

The purpose of this study was to identify village and home level technologies which could save time and effort of women in developing countries in the processing and preparation of food for home consumption. A further purpose was to give some suggestions as to where and how the technologies might be introduced.

The study rests on the premise that the majority of women are overburdened. Yet most of the human development programs, such as promotion of better nutrition and health care practices, are directed to them. These activities further tax women's limited time and energy. The potential for success of such interventions is therefore reduced. Further, in addition to lack of time and energy, human abscrptive capacity for multiple activities is also limited. This can also constrain the woman's capacity to add and sustain new activity, where no other task is subtracted or reduced. For these reasons, in order to increase the likelihood of getting the mother to provide better nutrition and health care for her children, other demands on her time and energy must be addressed. One very important constraint is the substantial time and energy she devotes to food processing and preparation.

To identify promising food processing and preparation technologies, criteria were developed for selecting and evaluating technology. These criteria included the questions: Does the technology address a major time and effort constraint? Does it fit with cultural, ecological, and economic conditions? And is the technology itself, efficient, easily maintained, and capable of local manufacture?

Two principal approaches were used to identify, assess, and select technologies: First, U.S. based organizations which are leaders in the introduction of village and home level technologies in developing countries were identified, and members of these organizations were interviewed in person or by phone. Second, literature pertaining to relevant technologies was reviewed. Citations were obtained from standard review and also from additional suggestions received as a result of querying approximately 60 overseas organizations engaged in the development or transfer of appropriate technology.

A total of seventeen technologies are described. The description of each technology also includes a summary of the traditional task which the technology has the potential to alleviate and, where possible, an estimate of the time the technology will save. The technologies treated may be summarized as follows:

For the the task of processing millet and sorghum, a dehuller and grinder was selected; for maize processing a mill capable of local manufacture, a water-powered mill, and a hand held sheller; for cassava a grater and screw press; for rice, a manual dehuller; and for quinoa, a thresher, cleaner, and polisher.

In addition to the processing of grains and tubers, a second major task conducted by women in developing countries is the processing of seeds and nuts to obtain oil. For sunflower, sesame, and other oilseeds, a manual press was identified; for groundnuts, a sheller; for palm fruit, an oil expeller; and for the shea nut, a multi-function fat extraction unit.

A third area requiring time and effort is the gathering of fuel for cooking, as well as the tending of the fire and similar functions during cooking. An improved three-stone hearth stove, which is considerably more fuel efficient than the traditional hearth, is described. In addition, two fuel efficient stoves, one using charcoal and the other wood, are described. Also, a fuelless solar box cooker is included, and a fuel efficient, village level smokehouse for the processing of fish. Finally, a technique to reduce the cooking time of beans is described.

These technologies represent a set of approaches which, within the three month span of this study, could be readily identified as particularly effective or promising. While it is believed that they represent a good choice, it should be recognized that other alternatives do exist, and that in some cases they may provide an even better fit with particular local needs.

Four additional technologies are also included in this report: a concrete threshing floor, two "convenience" foods--sori and yam flours, and a water catchment technology. These technologies do not fully fall within the main focus of the study on food processing and preparation. However, they are flagged as unusual approaches which also have the potential of making significant contributions to relieving household labor, and which may, therefore, be of interest.

In addition to selecting promising technologies, an effort was made to identify a few suggested sites which would be appropriate for transfer. Consideration was also given to how such transfer might be effected. This was accomplished through discussion with the organizations contacted to obtain advice on identification of technologies and through discussion with other organizations which are somewhat less active in the technology transfer field, but have strong community based field activities. A description of some suggested sites is included as part of the description of each technology.

In Table 1, a summary of the evaluated technologies is presented. This table provides an overview of the time and effort problems of food processing adressed by the study, the population and general areas where the problems are most prevalent, traditional processing times, the suggested technologies, estimated time saved by the technologies, and illustrative sites for transfer.

A final part of the report offers some ideas as to various next steps the Office of Nutrition might wish to consider as follow-up to this report. This includes recommendation of a pilot trial to test, and hopefully demonstrate, how introduction of laborsaving technology can have direct impact on improvement of nutrition and child care.

TABLE 1

SUMMARY OF SUGGESTED TECHNOLOGIES

TIME/EFFORT PROBLEMS ADDRESSED BY STUDY	POPULATION AND AREAS WHERE PROBLEM MOST PREVALENT+	TRADITIONAL PROCESSING TIME	SUGGESTED TECHNOLOGY	ESTIMATED NET TIME SAVED BY TECHNOLOGY	ILLUSTRATIVE SITES FOR TRANSFER
Processing of Staples					
sorghum/millet milling	189 million people in Africa, China, and India	3 hrs/4 Kg	PRL Dehuller/Grinder	2 hrs/4 Kg*	Ghana, Togo, Niger, Senegal
maize					
milling	213 million people in Africa, Latin America, and many other areas	4 hrs/6 Kg	Anguh Mill	3 hrs/6 Kg*	Zimbabwe, Mali, Nepal
shelling		20 min/3 Kg	TPI Sheller (home level)	10 min/3 Kg	Ghana, Zaire, Togo, Nepal, Thailand, Honduras, Mexico
cassava processing grating component of cassava processing	400 million people in Africa, India, Indonesia, and Oceania eat cassava	2 hrs/10 Kg	SIS Grater	1 hr/10 Kg*	Nigeria, Honduras, Belize, Indonesia, Bangladesh, Brazil
rice hulling	2,500 million people in Asia, the Pacific Region, Central America	1-2 hrs/ 10 Kg	UMN Huller (home level or extended family)	20-80 min/ 10 Kg	Nepal, India
quinoa threshing, cleaning, polishing	Andean Latin America	4 hrs/ 2 meals	CeCoCo Thresher, Polisher/Hance Cleaner	3 hrs/ 2 meals*	Latin America

+Population figures, where this information is known, are based on broad geographical regions where the crop is a major staple. Specific data on the number of people consuming these crops in countries where they are not major staples and on the number of women worldwide processing these staples by hand are not available.

*This figure includes an estimated one hour for travel and queue time (see time saving discussion, Section 4.0, page 34). Because in most cases mechanized processing requires only several minutes at most, travel/queue time was the only time that was subtracted from traditional processing time in order to obtain an estimate in round numbers of net time saved.

TABLE 1--CONTINUED

SUMMARY OF SUGGESTED TECHNOLOGIES

TIME/EFFORT PROBLEMS ADDRESSED BY STUDY	POPULATION AND AREAS WHERE PROBLEM MOST PREVALENT+	TRADITIONAL PROCESSING TIME	SUGGESTED TECHNOLOGY	ESTIMATED NET TIME SAVED BY TECHNOLOGY	ILLUSTRATIVE SITES FOR TRANSFER
Processing of Oils					
sunflower/sesame	Africa, Asia, Latin America	4 hrs/ 2.5 L	Bielenberg Oil Press	2.5 hrs/ 2.5 L*	Zambia, Tanzania, Gambia
groundnut shelling	Africa, Asia, Latin America	40 min/ 10 Kg	Sheller (home level or extended family)	35 min/10 Kg	Togo, Senegal
palm fruit	Sub-Saharan Africa, Asia, other areas	4 hrs/ 1.8 L	Caltech Expeller	3 hrs/1.8 L*	Tanzania, Zaire, Sierra Leone, Indonesia
shea nut	Sub-Saharan Africa,	see # below	CEPAZE System	see #	Ghana, Tanzania, Zaire, CAR, Mali, Senegal
Smoking and Cooking					
Fish Smoking	Africa, Asia, Latin America	varies	Smokehouse with Detached Firebox	not available	Ghana, Cameroo, Laos, Thailand
Cooking	Asia, Africa, Latin America	6-10 hrs per wk to fetch wood	Improved Three-Stone Hearth	2-3 hrs/wk in wood gathering@	Niger, Senegal, Ghana, Mauritania, Mali, Benin, Burkina Faso
			Jiko Cookstove	" "	areas where charcoal is used for cooking fuel
			LESO Cookstove	" "	Togo, Southeast Asia
			Solar Box Cooker	" "	Niger, Mali
			Bean Technique	half of traditional time	Thailand, South Asia, Peru, Honduras, Bolivia

+/*See note on previous page.

#The time required for all the steps in the traditional process is not available. However, trampling alone--to separate the oil from the ground shea nuts--takes several hours. This time, in addition to that for drying and grinding the nuts, is practically eliminated by the CEPAZE system.

@The estimate is based on stoves reducing the amount of fuelwood required by roughly one-third. In the case of the solar box cooker, the estimate is based on the cooker being used for at least one-third of cooking requirements, as a complement to a

In the remaining parts of this section, the problems of time and energy related to household level food preparation tasks undertaken by Third World women are documented, the purpose and limitations of the study are presented, and the methodology used to conduct the study is set forth.

1.2 The Problem

Rural women in the developing world spend as much as sixteen hours per day farming, processing and preparing food,taking care of their children and home, and earning cash to supplement family income. Many women, particularly in Africa, see lack of time as a major barrier to optimum family welfare (Carr and Sandhu 1988).

Women are overburdened. The results are often low productivity and compromised health, which not only negatively affect the woman, but everyone in her household. Richards in her classic study of the Southern Bantu of South Africa (1939:102) speaks of women "sitting about hungry with millet in their granaries and relish to be found in the bush." These women--and consequently their families--were hungry because the women were too tired to do all that was required to prepare the meal--an investment of three hours in time and arduous effort.

In another study of Luo women who combine agriculture, wage labor, and domestic work, Boserup (1970:165) reports that to cope with their work women must feed children as quickly as possible. To accomplish this, they practice a system of force-feeding with a helper holding the child's hands and feet--a system that does not endear itself to those who advocate the importance of effective child care and feeding.

Although these examples are dated and may appear extreme, not a lot has changed for many women in the developing world with respect to workload. The fact is women's roles, for the most part, have remained the same. They are still farmers and cooks: in Africa, women produce over half of the food grown (Niethammer 1981:1) and are almost universally responsible for the processing and preparation of food for home consumption (Boserup 1970:16).

If anything, women's workloads have increased. Development in many parts of the world has meant diverting male labor and choice land from subsistence agriculture to the production of export crops and mineral wealth. This has left women, using little more than cutlasses and hoes, to grow food on worn, smaller parcels of land and in many instances, with the loss of a productive member of the household (Rodney 1974; Seidman 1981). Consequently, in many areas women have more work, more financial responsibilities, and less access to the means of production: land, labor, and capital (Niethammer 1981:1).

All of this means that, more often than not, women have less time to undertake traditional agricultural and domestic tasks--to the detriment of nutrition and child care.

To alleviate conditions which burden women and compromise their effectiveness, development organizations have placed emphasis on increasing women's productivity, income, and health through the introduction of improved, appropriate technologies.

While many of these technologies are designed for women's farm work, most have been developed to ease the time and effort that women spend on repetitive, food-related household tasks. These technologies include wells, improved stoves, and grinding mills.

Although the introduction of appropriate technologies for home food production has been a priority for some development organizations, there have been problems relevant to women's access to these improved technologies. Carr and Sandhu (1988:2) report:

> Research has shown that often, women are not consulted by engineers about the design or location of a new technology. As a result, many technologies have proved to be socio-culturally unacceptable or have failed to show an improvement time- or energy-wise over existing traditional technologies. In addition, many studies have illustrated how improved technologies are often beyond the financial means or skill levels of village women who usually have less access than men to cash and training.

Clearly, more work needs to be done to help ensure that women have the time and energy to undertake new enterprises that they deem beneficial. This is particularly relevant in Africa where semi-subsistence agriculture practiced by women is common and as Eide and Steady state (1980:64), women are indeed the "true guardians of the family's nutritional needs."

1.3 The Assignment

This study was commissioned by A.I.D.'s Office of Nutrition to identify home and village level technologies that have been documented as technically sound and appear to have significant potential in alleviating the time and effort spent by women on food processing and preparation. The further purpose of this report is to identify new sites where these technologies might be appropriate in terms of cultural acceptance, socio-economics, and ecology. The intent: to provide information which may be of use in encouraging the transfer of laborsaving technologies so that women in the developing world have the time and energy to devote to activities that potentially lead to greater well-being--particularly nutritional well-being.

1.4 The Methodology

This study was carried out over a three month period. To conduct the study, a number of approaches were employed. To select promising technologies, tasks considered most time and effort demanding were identified. A set of basic criteria were then used to select and evaluate technologies. These criteria included such questions as : does the technology address a major time and effort constraint, does it fit with cultural, ecological, and economic conditions, and is the technology, itself, efficient, easily maintained , and capable of local manufacture? Assessment of the technologies also included consideration of such factors as acceptability of the product after processing, effect on work patterns, energy which must be expended by the woman to operate, and level of community organization needed to sustain. (A general guide to the considerations we sought to take into account in assessing technologies is contained in Appendix A--Laborsaving Technology Criteria.)

In every case, and effort was made to base assessment of the technology's functioning on evaluation by an individual independent of the organization which developed the technology.

Two principal sources were used to gather information on technologies. First, U.S. based organizations which are leaders in the introduction of village and home level technologies were identified and members of these organizations were interviewed in person or by phone. (See Appendix B--Organizations and Individuals Consulted). Second, literature on appropriate technology was reviewed. This was obtained principally from readily available published sources. In addition, additional references were obtained from querying approximately 60 overseas appropriate technology organizations. (See Appendix C--Appropriate Technology Organizations Surveyed.)

To determine where the technologies might be transferred, the major approach used was to interview area experts. This was accomplished in part through discussion with organizations active in technology introduction and in part through meeting with other organizations with strong community based field activities.

As a result of this effort, we believe we have identified a promising set of technologies. At the same time, it should be recognized that this selection emphasizes technologies which could be readily identified as promising within the short period of this study and is not, of course, fully inclusive.

1.5 Organization of the Report

The report is organized as follows: Section 2.0, Major Food Processing and Preparation Tasks, contains information on the major food consumed in the developing world, tasks required to process these foods, and the amount of time that women spend in food preparation tasks. In Section 3.0, General Principles of Technology Transfer, an overview of general principles guiding the transfer of technology is presented.

Section 4.0, Recommended Technologies and Benefits Expansion, contains descriptions of home and village level technologies which we believe have potential for making substantial impact on women in developing countries in terms of numbers reached and time and energy saved. The descriptions also include some suggested sites where, to our knowledge, the evaluated technologies have not been introduced but may ease the burden of rural women, together with some additional site selection criteria for further field verification.

Finally, Section 5.0, Next Steps, reviews possible approaches the Office of Nutrition may wish to consider in follow-up to this study. This review includes the description and recommendation of a specific approach to test, and it is hoped, demonstrate the proposition that laborsaving technology can have direct impact on improvement in nutrition and health care practices.

2.0 MAJOR FOOD PROCESSING AND PREPARATION TASKS

One of the most time-consuming of all tasks undertaken by Third World women is food processing and preparation. After spending much of the day growing food for the family, and in some areas for cash sale as well, women have to go home and cook.

Cooking requires a great deal of time and effort. In many areas, women must process food--grinding, husking, pounding--before it's cooked, and they must process this food by hand. In addition, women must fetch water and gather wood for cooking fuel. These activities vary according to the type of food used, how it is prepared, and the quality and availability of fuel.

In this section, a broad overview of staple foods and fuel availability in Africa, Asia, the Pacific Region, Central America, and South America is presented. In addition, to better understand the technologies that women need to process these foods, an overview of processing and preparation techniques is provided. And the time required to conduct these tasks is also given, where this information is available.

2.1 Staple Foods

A staple food is one that people eat often and rely on for a large part of their energy needs. In the developing world, these foods are primarily roots, tubers, and grains, such as maize, rice, wheat, and sorghum and millet. This effort focuses on staple foods because they almost always have to be processed for storage and preparation, and this processing takes up a great deal of the time that women spend in food preparation.

People in practically all of Asia and the Pacific Region rely on rice as the staple food. In fact, rice is the basic food of more than half the world's population--about 2,500 million people--and supplies more dietary energy than any other single food (FAO 1984:13).

Most people in Central America, with the exception of the Caribbean Basin, also rely primarily on rice. In the Caribbean, like South America, people consume a mixture of staples. Rice is most popular, followed by wheat and maize. In Africa, rice is eaten from Gambia to the Ivory Coast and Madagascar. Most people, throughout the world, prefer to steam or boil white polished rice from which the outer husk and bran have been removed by milling.

The African continent is the most diverse in terms of staple foods used. All are represented. In North Africa from Morocco to Egypt, people primarily eat wheat, although this crop is not the staple food in most of the developing nations. Just to the south, in a broad horizontal band from Mauritania on the west coast to Ethiopia on the east, people eat sorghum and millet. Sorghum is also an important food in China and India.

Worldwide, some 189 million people rely on sorghum and millet to meet basic energy needs (FAO 1984:17). Millet is generally used in the form of meal (for making breads), paste (from pounded soaked seed), or boiled gruel. Sorghum is eaten primarily in the form of bread and porridge.

Sorghum and millet, along with roots and tubers, provide the main energy requirements for most of Africa's population. Populations who primarily rely on roots and tubers--cassava, yams potatoes, sweet potatoes, and taro--live in central west and south west Africa from the Central African Republic to Namibia and constitute some 71 million people. In Latin America, west Africa, the smaller islands of Oceania, and in some parts of southern India, Indonesia, and the Philippines cassava is the principle source of carbohydrates. About 400 million people worldwide eat cassava (FAO 1984:18). Roots and tubers are generally boiled, roasted, or baked.

On the east coast from Somalia to South Africa, maize is the most popular staple. It is also the leading staple food in parts of Latin America. Maize is grown in most parts of the world and is eaten by approximately 213 million people (FAO 1984:16). Maize is more often than not used for making flour, although some varieties are eaten directly as a vegetable.

It should be noted that this discussion serves merely as a very broad overview of what staple foods people eat and where. For example, although many people in Cameroon rely on sorghum and millet as the staple food, a significant number, particularly in the north west and south west, rely on maize and roots and tubers to meet the bulk of their energy needs.

In addition to these vegetable staple foods, animal proteins and vegetable oils are critical to the well-being of many communities. Animal proteins commonly consumed around the world include poultry, fish, and in many areas grazing animals such as cows and goats. Vegetable oils include seed oils (such as sunflower and sesame), palm kernel oil and sheanut oil (widely consumed in Africa), and coconuts consumed primarily in Asia and the Pacific.

2.2 Food Processing and Preparation

Most of the time and effort required to prepare a meal in the developing world is allocated to processing the staple food crop, and it is here that appropriate technology can perhaps be most useful in terms of time and energy savings at the household level. For this reason, it is important to understand just how women have traditionally processed and prepared staple foods. These tasks are outlined in the following sections.[1]

2.2.1 Threshing and Shelling

Threshing is the removal of the grains from the rest of the plant. Cereals--rice, wheat, maize, millet, and sorghum--are the major staples that are threshed. Most women manually thresh cereals by spreading them on the floor and beating them with a stick or hinged flail. These tools are simple and cheap, but laborious to use.

Maize is shelled mainly with the bare hands, by rubbing one cob against the other or removing the corn with the fingers. Other traditional methods of threshing include the use of animals to trample the sheaves on the threshing floor, but this may

[1]The following discussion of major food processing tasks is drawn from three UNIFEM/ITDG documents: Cereal Processing (1988) Oil Extraction (1987), Root Crop Processing (1988).

result in loss of unseparated grain.

2.2.2 Winnowing

Winnowing involves separating the chaff from the grain. If there is plenty of wind, the threshed foodstuffs are tossed in the air using forks, shovels, baskets, and the like. The lighter chaff and straw blow away, while the heavy grains fall more or less vertically. Finally, cleaning is usually done with a winnowing basket, which is shaken until any chaff and dust separate at the upper edge. Separating impurities from threshed grain can require almost as much labor as the original threshing.

2.2.3 Drying

During drying the moisture content of the grain is reduced. This helps prevent germination of seeds, the growth of bacteria and fungi, and considerably retards the development of mites and insects. In addition to the drying of cereals, fish, beef, other animal proteins, and root crops (usually sliced or shredded) must be dried for preservation. With traditional methods of drying--sun drying or smoking with wood--the rate and uniformity of drying is difficult to control because it depends on environmental conditions or the availability of wood. These are important factors because it is essential that foods be dried quickly and effectively to reduce postharvest losses.

2.2.4 Grinding, Milling, and Sieving

Three forces are involved in milling cereals, and roots and tubers, to make flour: rubbing (abrasion or shear), impact (hitting), and compression (squeezing). Traditionally, most women in the developing world pulverize foods with a wooden mortar and pestle or by grinding between stones. After grinding, flour is sieved by forcing it through various types of sieves to remove any large particles. Often, it is then ground again.

2.2.5 Pounding

Pounding changes the texture of previously prepared root crops to a more palatable, paste-like consistency referred to as foofoo in most of Africa. The root is first peeled and softened by boiling or soaking. It is then pulverized, usually with a large, wooden mortar and pestle.

2.2.6 Grating

Grating into fine shreds is a common step in the processing of many roots and tubers. This facilitates other steps in food processing, such as de-watering and drying. Traditional grating methods range from simply rasping the roots or tubers on the trunk-spines of palms, as practiced in the Amazon Basin, in South America to the use of simple metal hand-held graters used throughout the world.

2.2.7 De-Watering

De-watering, as the name implies, involves the removal of liquid from roots and tubers by pressing. The process is most common in cassava processing because it reduces toxicity. Traditionally, heavy weights are placed on the prepared (generally peeled and grated) root crop, and the expelled liquid is allowed to drain away. In other traditional methods a squeezing process is involved.

2.2.8 Fermentation

Fermentation is the most important step in the processing of cassava and certain high alkaloid-containing varieties of potato. In both cases, fermentation results in reduction of toxicity. In the case of cassava, two methods are commonly practiced: the dry and wet methods.

The dry method is used in the production of "gari" and is essentially fermentation of grated cassava simply by air and is mainly practiced in Africa. The wet method, carried out in certain areas of Africa and Latin America, is sometimes referred to as "retting." Wet fermentation takes place when cassava roots, either peeled or whole, are soaked in water for several days until softened. The material is then broken up, sieved, and finally squeezed to remove the water.

2.2.9 Oil Extraction

Oil seeds (sunflower, sesame, and the like) are processed to produce cooking oil in developing countries. They are still commonly processed using traditional methods which are very time-consuming and strenuous. In most cases, seeds are ground manually to a paste without removing the husk or outer covering, although in some instances sunflower seeds are husked. The paste is then heated, alone at first and then with boiling water. The mixture is stirred and brought to a boil. It is then allowed to cool during which time the oil rises to the top and is scooped off. In traditional methods of processing oil seeds, the extraction efficiency--the percentage of oil extracted based on the total theoretical content--is about 40 percent.

The processing of palm kernel nut and sheanut--which provides approximately 60 percent of the cash income for women in the Sahel (UNIFEM 1987:10)--is similar to the process described above for oilseeds. Palm nuts, an important source of oil in Sub-Saharan Africa, are cracked open manually, and the nuts are then grilled for one to four hours which may, depending on the method used, be over an open fire or in a variety of containers--sheet metal, iron, earthenware. Cracking is the most tedious part of the practice, and waste through poor separation of the nut and shell can be as high as 50 to 60 percent. As with oilseeds, the palm nuts are reduced to a paste, usually through pounding, and boiled to extract the oil.

Sheanuts are dried, pounded, and ground in wooden mortars to a paste which is heated until it becomes soft. It is then kneaded manually, mixed with warm water, and stirred vigorously to break the emulsion and separate the fat. The oil floats to the surface and is skimmed off. Despite the great amount of time and effort involved in this process, the extraction efficiency is extremely low--about 15 percent.

Finally, there are three basic ways of extracting oil from coconut meat--a major source of oil in Asia and the Pacific. The first, and most common, method involves grating fresh coconut by hand; mixing it with warm water and squeezing it by hand or foot at least three times; allowing the resulting milky-looking liquid emulsion to settle for three hours to separate the cream from the water; and finally, skimming off the cream, boiling it in a pan until the moisture has evaporated and a mixture of oil and coagulated protein remains, and separating the oil by straining the mixture when cooled.

The second method is to dry the coconut meat into copra which is then ground. It is then pressed in a wooden press using the principle of leverage to separate the oil from the copra meal. And finally, the third--less widely practiced--technique is the fermentation method. Here, coconuts are grated and the resulting milk is allowed to stand for two or three days, during which time the oil rises to the surface of the milk and is skimmed off. Because of traces of water in it, this oil becomes rancid and thus can only be stored for short periods of time. Using the above methods, the yield of oil from approximately 300 coconuts is approximately 25 liters.

2.3 Time and Energy

Data reveal that in almost all settings in the developing world, women work longer hours than do men (Carr and Sandhu 1988; Boserup 1970). Much of this difference can be attributed to food processing and preparation which requires a great deal of time and effort and is done almost exclusively by women.

Boserup (1970:164) reports that in Central Africa the processing of maize can take as much as four times as long as all the hours spent on cultivating the crop. The time spent in processing and preparing food varies widely by type of crop, equipment used to process, and the particular dish prepared.

In addition to time, energy expended in processing and preparing food is an important consideration when assessing the workload of women. Carr and Sandhu (1988:4) report that the few energy studies available indicate that most of women's subsistence and domestic tasks are very energy-intensive. Furthermore, they report that women may be even more interested in saving energy than time. They site a common example of women who are willing to walk considerable distances and wait in long queues at a grinding mill to avoid the effort, rather than save the time, of manual pounding.

In this section an overview of the time required to process food with and without appropriate technologies is provided. The issue here is how much time women spend on the various steps involved in transforming crops into a prepared meal. Table 2 prepared by Cecelski (1984) indicates the time required for women to process 1 kilogram of a range of crops using various traditional technologies.

As the data in Table 2 show, the most time consuming tasks are shelling and milling of maize, and stripping and cracking palm nuts.

Carr and Sandhu (1988:35) point out that some of women's food processing activities--notably palm oil processing--are seasonal activities. Nevertheless, during the time of the year

TABLE 2

TIME REQUIRED TO MANUALLY PROCESS SELECTED FOOD

Activity	Traditional Method	Labour Use Women hours/unit
1 Shelling of maize for kenkey production	by hand	0.14–0.25 wh/kg
2 Milling of maize	mortar & pestle	0.07 wh/kg
3 Grating of cassava for gari production	hand grater	0.08–0.16 wh/kg
4 Grating of cassava for foofoo production	hand grater	0.08–0.16 wh/kg
5 Stripping of palm fruits	cutlass	0.04–0.06 wh/kg stripped
6 Cracking of palm kernels	using stones	0.3–0.6 wh/kg of nut
7 Pounding of palm fruits	motar & pestle	0.005–0.008 wh/kg
8 Extraction of palm oil	pounding & tramp ling by feet in open pits	0.013–0.026 wh/kg of fruit
9 Milling of palm kernels	mortar & pestle	0.13 wh/kg
10 Threshing of rice	trampling by	0.05 wh/kg
11 Dehusking of rice	mortar & pestle	0.1–0.2 wh/kg

Source: Cecelski (1984).

that processing is undertaken, it represents a substantial drain on women's time.

There are also seasonal variations in the time required to process staples during women's peak labor seasons. For example, although sorghum is ground throughout the year in a rural community in Burkina Faso, during the wet season when women are busy with harvest, it is ground into a courser flour. For women who can tolerate eating this coarse flour, the time to grind 1 kilogram can be reduced from 1.5 hours to about 30 minutes (Hemmings-Gapihan 1981:142).

Table 3 (Cecelski 1984) shows the amount of time saved by various improved food processing technologies, both hand-operated and mechanized.

It should be noted that this section provides a very general overview of time required to process important foods and time-savings as a result of improved technology. In the following section, Recommended Technologies, time is treated in more detail for each of the technologies.

2.4 Fuelwood

Gathering fuelwood is another time-consuming task essential to food preparation that can place a substantial burden on women in the developing world.[2] Some two billion people continue to rely on noncommercial energy resources to cook and

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[2]Fetching water can also be a very time-consuming task for women in the developing world, but is outside the general scope of this effort, although one "household" type of technology, water catchment, has been included.

TABLE 3

COMPARATIVE PROCESSING TIMES OF TRADITIONAL AND IMPROVED TECHNOLOGIES

Operation	Time required to process 1kg of product (minutes)		
	Traditional method	Hand operated improved device	Mechanised device
Grating cassava	10-15	0.5	0.06-0.12
Pressing cassava dough	1-6	30-60 screwpress 1-2 hydraulic press	
Stripping palm fruits from bunch	0.6=2.4		0.03
Pounding to separate palm fruits from kernels	0.3-0.5		0.9-0.15
Cracking palm kernels	24-36		0.15-0.2
Shelling maize	8-15	3-5	0.03
Milling maize	5	3	up to 0.05
Threshing rice	3	0.12-1	0.2
Dehusking rice	6-12	4	up to 0.012

Source: (Cecelski 1984).

smoke food (Tinker 1981:80). Fuelwood is the most important of these energy resources--it is estimated that 80 percent of the wood cut in developing countries is burned for energy (Webley 1986:254).

Webley (1986:254) reports that in 1980 some 50 million people in Sub-Saharan Africa were unable to meet their basic fuelwood requirements; another 130 million managed to gather enough wood to meet the demands of their households, but did so by excessively exploiting wood resources. She states that with projected population growth, these numbers may triple by the year 2000. Fuelwood scarcities are also evident in other parts of the world.

The main issue here, however, is the amount of time that women spend in gathering fuelwood. Of course, this varies widely from community to community. For example, in some areas of Sub-Saharan Africa, the task of gathering fuelwood is relegated to children and thus, although wood may be scarce and time-consuming in its collection, it does not directly affect the women who cook--and more importantly may not be perceived as a problem by these women. This means that the introduction of wood-saving stoves may not be perceived as important--although wood is scarce.

But for many other areas of the world, wood gathering is a time-consuming process carried out by women. Carr and Sandhu (1987:24) report that in the Baroda District of India, women travel distances of 1 to 5 kilometers to gather wood; in Northern

Ghana, women travel 1 to more than 11 kilometers; and in Niger women travel over 25 kilometers to gather wood for household use. Table 4 (Cecelski 1984) shows hours per household per week that women spend in fuel gathering in areas of Africa, Asia, and Latin America.

It should be noted that time spent in gathering fuelwood varies not only by country and community, but within a single community because of seasonal variations in the amount of wood needed (more is required to dry maize during harvest) and the amount of time women must spend in other activities (during the busy harvest period, women may need more wood to dry the produce but actually have less time to gather).

Wherever women are burdened with gathering fuelwood, fuel-efficient stoves can help to alleviate wood shortages and reduce the time that women must spend in gathering wood to prepare food for household consumption. In addition, where they must spend a substantial portion of the household budget on the purchase of fuelwood, such as in many urban areas of the developing world, stoves can also conserve scarce resources.

In the following section, fuel-efficient stoves and a variety of other technologies for staple processing and oil extraction which are recommended for promotion, are described and evaluated.

TABLE 4

TIME SPENT IN FUEL GATHERING

(Hours per household per Week)

Region	Survey location		Travel demand[1)] (h/hh/w)	
Africa	Burkina Faso	...	0.5	(rainy season)
			3.5 - 7.0	(dry season)
	Lesotho	...	14.0	
	Tanzania	Nyakyusa	4.0 - 10.0	
	Kenya	Mbere	2.5 - 10.0	
	Ethiopia	...	21.0	
Asia	India	Pura	18.2	
	Nepal	...	10.5 - 35.0	
	Java	Luwu	1.2 - 4.7	
	Philippines	...	7.0 - 14.0	
Latin America	Peru	Huancarama	3.5	
	Mexico	...	11.6 - 15.0	

1) Figures do not include time for cutting trees, gathering twigs and preparing the bundle

Source: Cecelski (1984).

3.0 GENERAL PRINCIPLES OF TECHNOLOGY TRANSFER

There are a large number of appropriate technologies available to help ease the burden of food processing and preparation in developing countries. Many of these technologies are suitable for introduction in new areas--thus, expanding benefits to a larger number of users around the world. This, however, is not a simple matter.

To help ensure effective technology transfer, three broad factors must be addressed. First, potential users must perceive a need for the technology. Secondly, the technology itself must be feasible (it must work properly and reliably and be capable of being controlled and maintained locally), and it must be appropriate to the specific setting (it must "fit" with prevailing local conditions such as culture, the economy, and ecology). And finally, the technology must be accessible in terms of cost, gender issues, and other factors.

3.1 Perceived Need

Women's needs as food processors and preparers should be considered in light of problems of processing and cooking, which in turn are affected by local conditions and other work women must do (Spring 1986:334-335). Consequently, technology transfer should make use of data about women's roles to guide any benefits expansion effort.

To successfully transfer technology, women must perceive a need for it. A review of case studies indicates that new technologies are accepted more quickly and easily if women themselves participate in the early stages of the identification and design of improved technologies. In addition, the success of new technologies is more likely where they are appropriate to the women who use them, are affordable, and require minimum change in traditional procedures, values, and beliefs.

3.2 Feasibility and Appropriateness

The issues of feasibility and appropriateness of improved technologies are, of course, specific to particular settings. However, when assessing technologies that are appropriate to benefits expansion, a number of broad factors need to be addressed. These factors should be addressed to ascertain the feasibility and appropriateness of technologies, as well as adverse and unintended consequences that may result from introducing new technologies. Some of the issues that must be addressed are listed in the criteria found in Appendix A--Labor-Saving Technology Criteria.

To determine feasibility and appropriateness, a significant amount of research must be conducted on-site with intended users. In addition to the end users, other groups who should be consulted include people in local organizations who have agreed to help introduce and disseminate new technologies, personnel in lending institutions, and government policy makers.

3.3 Accessibility

Before introducing appropriate technologies, development workers must establish effective relationships and alliances with a wide variety of local people and organizations. These include: community organizers, university students and faculty, other educators in both the formal and informal education sectors, the staff of small business and cooperative promotion programs, the staff of local development organizations, members of traditional organizations such as rotating credit societies, women's groups, and the like--and of course, the women who will use the technologies.

By working with these groups, strategies for introducing the technology can be better developed, because here is where the expertise on issues of acceptance can be found. Moreover, a solid strategy is to start with, and build on, locally available skills and materials, based on the initiative and participation of local people and organizations. This helps to ensure that local needs will be more effectively met and that resulting technological and socioeconomic changes are more likely to be compatible with evolving local traditions and culture (Darrow, Keller, and Pam 1981:328).

For women to purchase many of the technologies that help save time and effort, they need credit. Most women--and men--in rural areas of developing countries are poor and have little or no capital. Without capital, economic development is not possible. Village women often need short, medium, or long term credit (Bangun 1981:151) to make technologies affordable and thus, available.

In conclusion, it is perhaps instructive to consider that according to Darrow, Keller, and Pam (1981:329), the largest single factor hindering progress in the development and application of improved technologies is not money--as one might think--rather, it is ". . . the lack of a coherent set of ideas about how funds and human resources might be combined in workable strategies to apply the concepts of appropriate technology, both within and between countries."

In the case of each proposed technology transfer, there is a need to develop a carefully thought out plan which focuses not on an isolated aspect of the transfer, but rather on the full range of factors which must be addressed in order to achieve success.

4.0 RECOMMENDED TECHNOLOGIES AND BENEFITS EXPANSION

This section describes technologies which have the potential to alleviate some of the important time and energy burdens of women.

In each case, we have sought to identify a good choice of technology for addressing a time and effort demand determined to be a major problem. In some cases the technology is, to our knowledge, unique, such as for example the PRL sorghum and millet dehuller. Or the technology may be clearly superior to others on the basis of efficiency, cost, suitability to typical local conditions, or because it can be manufactured in-country, such as, for example, the Anguh maize mill. In others, the technology represents a good example of a type, while recognizing that other similar examples also exist. An example would be the TPI maize sheller or the PMC stove. Overall, we feel these technologies represent a solid starting point for dialogue with agencies interested in technology transfer. At the same time, it should be recognized that alternatives do exist and that under some circumstances some of these alternatives may provide an even better fit with local needs.

The twenty-one technologies described are divided into four broad areas: (1) technologies designed to process staples; (2) those designed to process oils; (3) smoking and cookstove technologies, as well as a technique to reduce bean cooking time; and (4) several technologies which do not fully fit the main focus of the study, but are summarized as also of interest.

The treatment of each technology is divided into two main parts. In the first part, the traditional task addressed by the technology is first presented. Then the proposed technology is described, and, wherever possible, an estimate of the time the technology will save is given. Finally, an indication of where the technology has been introduced is provided, and the status of its introduction, for example pilot test or large scale use, is indicated.

Time Saved

It is important to note here that the estimates of time saved by the suggested technologies are expressed two ways: the actual time saved by the device itself and an estimated time saved by women. For village level technologies, this estimated time was derived by seeking to take into account the time required to walk to the mill or oil press, stand in que, process the food, and return home.

This is a risky business. The time required to travel to and from a technology depends entirely on specific local conditions such as the number of people serviced by a mill and population density. The time required to stand in line waiting for service depends upon these factors and women's work schedules as well. For example, in communities where women start their farming day very early and return late, the queue may be long in the evenings--even with a suitable ratio of people to mills.

These factors, of course, vary widely from community to community--and indeed, in some settings within a single community. Because of this variance, the actual time that women save simply cannot be estimated very accurately. However, because the time to travel to and from the mill is a significant factor, we believe that an attempt to estimate this element as it affects the overall impact of the technology should be made.

Our solution has been to base our estimate on a set of conditions which would be optimum, but not unrealistic. The result is to provide an idea of what might be the time which could be saved from a well designed intervention in a fairly optimum situation.

As a starting point, we assumed that the ratio of mills to population was roughly at the level required for the mill to be economically viable. For example, a maize mill requires a population of about 350 to 500. Second, we assumed that the mill was placed in a village cluster of at least this size. (This would be as compared to the situation where a single mill might service several smaller dispersed villages.) Given these assumptions, such a mill would normally not be more than a mile from a good portion of the inhabitants. Under these conditions, approximately an hour to walk to the mill, wait for a short time, and return home seems reasonable (Ford; Harper; Demke; personal communications).

Using the above assumptions, we, therefore, concluded that an hour could be used as a rough approximation of time required to go to and from and use a mill, or similar village level technology, under fairly optimum conditions. We recognize, of course, that even under such conditions, individual time will vary considerably.

In addition to providing a rough estimate, or starting point, this calculation also flags, we believe, the importance of considering both the ratio of technology to population needed to sustain the technology and the extent to which that population is dispersed, before determining whether introduction of the technology will truly save time. Thus, in transferring appropriate technologies, it is up to local development workers to ensure that actual time savings resulting from technology are not unduly compromised by unreasonable travel and queue times because there are not enough machines, they are not centrally located, or they are not appropriate to the population's distribution.

A final note is necessary regarding travel and use time: Related to the issue of time savings--and essential to this effort--is energy savings resulting from the adoption of improved technologies. For example, because of the perishable nature of some grains, women more often than not have to travel to the mill at least two times a week, depending on the frequency of consumption and the size of the family. Women who manage large households or rely heavily on the milled staple to feed their families may spend even more time traveling to the mill.

Is the extra time spent in traveling to and from the mill worth it? In many cases, yes, because women save effort. Time allocation data is very difficult to collect, collecting and recording data on the energy that women expend on domestic chores is even more difficult. However, the little evidence that does exist suggests that food processing and preparation in developing countries are very energy-intensive tasks and women are possibly more interested in saving energy than time (Carr and Sandhu 1987:4). For example, in many settings, women are willing to walk considerable distances to stand and wait in long lines to grind grains. They do this to avoid the effort, rather than the time, spent in manual pounding.

While time is an essential factor in alleviating the burden that women must shoulder to process and prepare food for their families in developing countries, energy-savings too must be considered when developing strategies to expand the benefits of improved technologies.

Application of Technology

The description of each technology, is followed by a second application section. Countries where the problem which the technology addresses are believed to be partcularly prevalent are listed in order to provide an overview of potential areas which might benefit from the technology. Then, wherever possible, some specific sites, which have been identified in a preliminary manner as possible locations for transfer, are given. In addition, where feasible, an organization is identified which is operating at that site in cooperation with a local group and which might, therefore, provide a means for transfer.

In each case, identification of a possible site is based on such criteria as the practice of the traditional processing method, the appropriateness of cultural and ecological conditions, and the existence of a local implementing body. In addition, however, these and other conditions would need, of course, to be verified in greater detail by a site visit prior to introduction.

The conditions which would need to be verfied fall into two categories: generic, or generally applicable to most of the technologies, and conditions applicable to a particular technology. The generic conditions include:

1. An area where there are no particular reasons to believe that the technology would be culturally unacceptable.

2. An area where there is a local development organization to provide various types of assistance, such as training people to operate, maintain, and repair the device; conducting or overseeing the conduct of demonstrations to introduce the device; providing information and assistance in business management skills to ensure a viable enterprise; and creating or working with existing infrastructure to develop financing mechanisms.

3. An area where women have some disposable income--such that there seems a reasonable chance that they are able to, or likely to, pay for produce of the technology, such as milled grain and the like.

Additional conditions which are desirable but not essential to introduction are:

4. An area where social, cultural, and economic factors indicate that the technology could be owned and/or operated by women.

5. An area where there is an in-country capability to locally manufacture the technology.

In the description of specific sites, as well as in the final section of the report on next steps, we refer to specific organizations which have indicated interest in the transfer of the technologies described. We would like to emphasize that these references should not be taken as representing a preference or endorsement of these organizations over others which may be equally good candidates for possible implementation activties. Rather, in a short study of this nature, these were the groups with whom we had time to discuss these technologies in some detail, and who, at the particular time of our contact, happened to have an individual, or individuals, available, particularly knowledgeable about the areas in which we were interested.

For each technology, we have referred in the text to published material which describes the technology or experience in its use. In addition, for the individual interested in obtaining additional, more detailed information, Appendix D--Sources of Information on Recommended Technologies--lists for each technology several organizations considered the best general sources of information for that technology.

Staple Processing

4.1 Sorghum/Millet Processing--PRL Dehuller and Grinder

4.1.1 Technology

The traditional method of processing sorghum begins with soaking it in water for 30 to 60 minutes to soften the cortex. The grain is then pounded in a mortar and periodically winnowed to separate the "bran" layer. When sufficient "bran" has been removed, the grain is pounded into meal.

It requires about three hours of arduous labor to process four kilograms of sorghum--enough to feed a family of six for two days. The resulting meal cannot be held for more than two days, because it spoils due to the high moisture content resulting from the wet processing method.

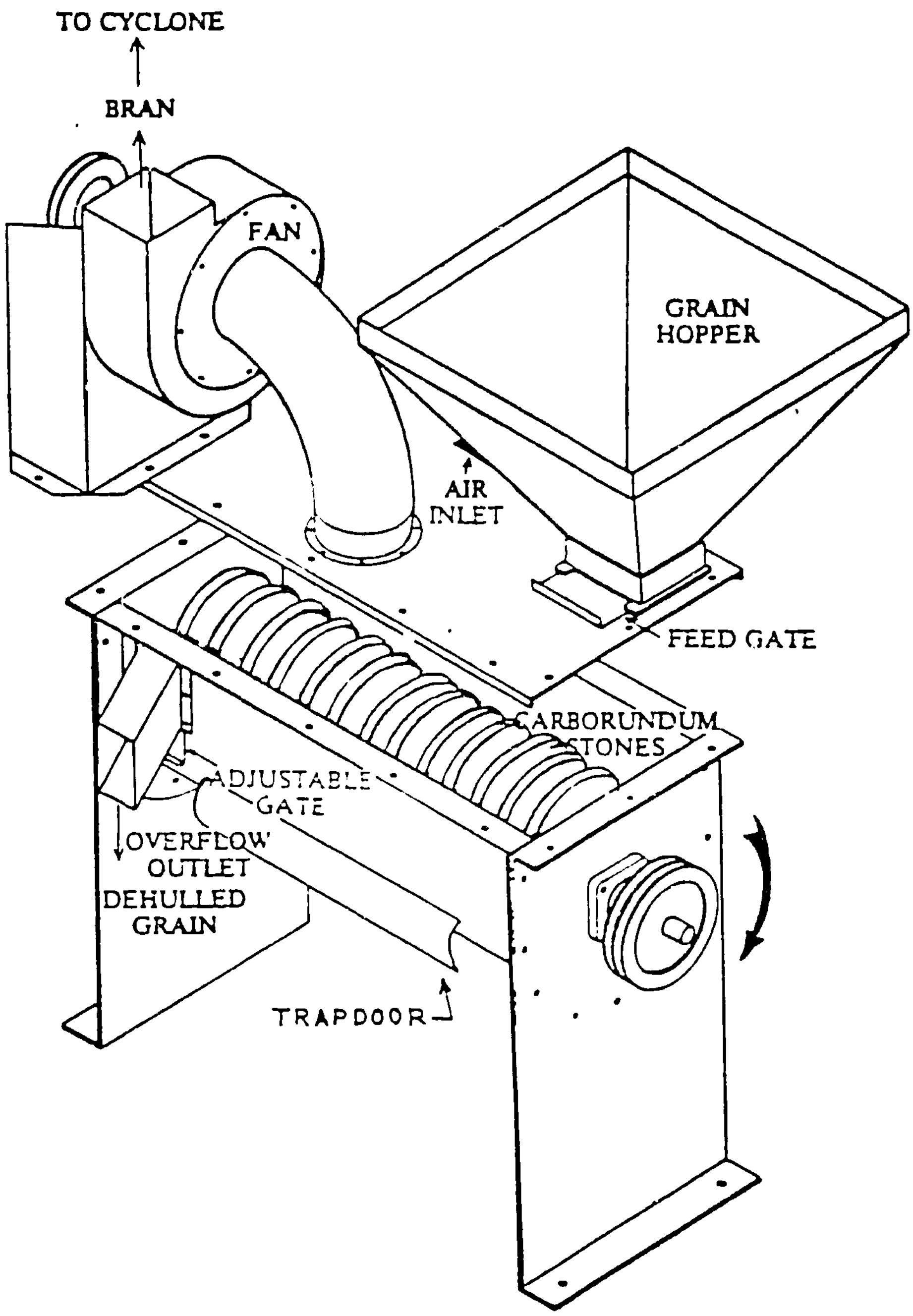
The labor of sorghum processing is considered to be so onerous that women in the Gambia ". . . regard coos (sorghum and millet) processing to be the worst part of being a woman." In some cases, the difficulty of processing these traditional grains has even led to displacement of sorghum and millet by rice. Rice is much easier to decorticate (dehull) than sorghum. Furthermore, rice is widely available in West Africa. Consequently, in some settings, the inconvenience and labor of processing sorghum and millet are resulting in loss of foreign exchange through the purchase of imported rice as a substitute grain. (Nath 1985).

The British-based Intermediate Technology Development Group and Canada's International Development Research Center developed the PRL sorghum mill to provide milling as a convenience for women. The mill is equipped with a dehuller and a hammer mill. The dehuller is an abrasive disk system rotating on a horizontal shaft (see Figure 1). Dry sorghum grains come into contact with the surface of the abrasive disks long enough to remove the "bran" coat, but not so long that yields are unnecessarily lowered. The throughput rate is adjusted by means of the exit gate. This device approximates extraction milling.

The removed "bran" is discharged from the dehulled grain by means of a fan, and is recovered for use in brewing or feed.

FIGURE 1

PRL DEHULLER AND GRINDER*



*The IDRC/PRL dehuller illustrated here is larger and has an aspiration system, but is based on the same principles of operation as the smaller model proposed for this effort.

Drawing courtesy of International Development Research Centre of Canada--End To Pounding.

(Bran on sorghum is more difficult to winnow than is the bran on other grains, apparently because the bran tends to separate in large flat flakes. Consequently, there could be a tendency to plug screens [Shepherd 1979].) The grain is then loaded into the hammer mill and reduced to the required fineness. (Eastman 1980.)

Currently, (1989) the cost of the mill is 6,250 £ (US $9,688) of which 2,250 £ (US $3,488) is the cost of the diesel engine.

The dehuller can process 400 to 500 kilograms of sorghum or millet per day. This means that four kilograms of grain--a two-day supply--can be processed in a few minutes. The time required by the traditional method is about three hours. This time is thus virtually eliminated by the operation of the technology. If the rough estimate of travel to and from the mill under fairly optimum conditions of about an hour is applied (see previous discussion), the saving of time for the processing of a two day supply of millet or sorghum would be approximately two hours.

The PRL dehuller has been laboratory tested in Burkina Faso, Guatemala, Mali, Thailand, Ethiopia, Egypt, Philippines, and Tanzania. The usefulness of the device for small village applications has been explored in Gambia and Ethiopia and pilot tested in Mali (1986) and in Cameroon (1988). By the end of 1981, seventeen mills of this type (larger, with an aspiration system) were being operated throughout Botswana and in 1985 two pilot mills were introduced in Tanzania. There have been inquiries from Mozambique, Malawi, and Zambia regarding the dehuller.

4.1.2 Application

Millet and sorghum are the main staple foods of 13 countries in an area extending from West Africa to the Arabian Peninsula: the Republic Of Cameroon, Chad, Ethiopia, Mali, Mauritania, the Niger, Nigeria, Senegal, the Sudan, Togo, Uganda, and Burkino Fasa, and the Yemen Arab Republic (FAO 1984:17).

Technoserve, a private voluntary organization, is currently working in three areas where women are processing sorghum and millet by hand--the northern region of Ghana, northern Togo (the Karan Region, north of Sokode), and southern Niger (Maradi). A Technoserve official indicated an interest in considering introducing this technology. In both Ghana and Togo, Technoserve might be willing to work with local lending institutions to help establish necessary credit mechanisms. In addition, Technoserve might work with local women's groups which are already a part of their development network to introduce and promote the dehuller.

Technoserve also suggested that introduction of the PRL in southern Niger be explored. This is an area where the U.S. National Cooperative Business Associating is currently making loans to cooperatives--including women's cooperatives. It is possible that this organization might be interested in helping women's groups buy the dehuller.

In addition to Technoserve, Africare is interested in exploring the possibility of introducing and promoting the dehuller through a project in Niger (Goure, Zinder Department). There is also the possibility that Catholic Relief Services (CRS) may be interested in working with established local organizations in Senegal to develop micro-enterprise for women based on the PRL dehuller.

In the case of this technology, as well as those which follow, the suggested sites were selected on the basis of readily available information which indicate a good fit between the technology and local conditions. However, this information and other critical criteria should, of course, be verified through a site visit prior to introduction of the technology. The conditions which should be verfied by site visit include the generic criteria listed on page 38 and the following conditions which are specific to this technology:

1. An area where sorghum and/or millet is a staple food crop--that is, where it is either eaten often or provides a large part of the population's energy requirements.

2. An area where women customarily spend time in manually dehulling, or pounding, sorghum or millet and consider this a time or energy consuming task.

3. An area where there is a tradition of dehulling sorghum or millet for consumption.

4. An area where the dehuller would serve at least 600 to 800 people--the minimum size for commercial viability.

4.2 Maize Processing--Anguh Mill

4.2.1 Technology

In Cameroon and other parts of Sub-Saharan Africa, to prepare the porridge, "foofoo", maize is traditionally ground manually using a stone mill. The grinding stone is typically somewhat saddle-shaped, about 60 cm in length and 40 to 50 cm wide. The grain maize is distributed over the stone, and it is rubbed with a smaller rounded stone until the desired degree of fineness of the meal is achieved. The meal is then collected in a basket located at the end of the grinding stone.

Such grinding is done by women on their knees. About 1.3 kilograms of maize can be processed per hour by an energetic woman. In Latin America, similar maize mills are used with about the same output. The Mexican "metate" and "mano" are, respectively, the saddle-shaped stone and the smaller stone under which the maize grains are ground. The "metate y mano" are often used on a table top.

In the 1950s in Cameroon, and in other areas of Africa as well, manually operated "penny merchant mills" became available. These were manual mills rented to women for a penny. Two women were required to operate the mill, but they could mill 16 to 18 kilograms of grain per hour--which is six times the volume of grain per hour milled with the traditional stone. Stated another way, this meant that women could grind the same amount of corn in one-sixth of the time. Eventually, the manually operated mill was introduced to women's cooperatives and by 1961 more than 300 were in use in Cameroon.

These manual mills were gradually supplanted by diesel-powered imported plate mills and consequently, the ownership of the merchant milling trade passed from the control of poor rural women to the urban wealthy. With the advent of diesel mills, women had to pay greater fees for service and thus, very poor women still had to manually mill their maize.

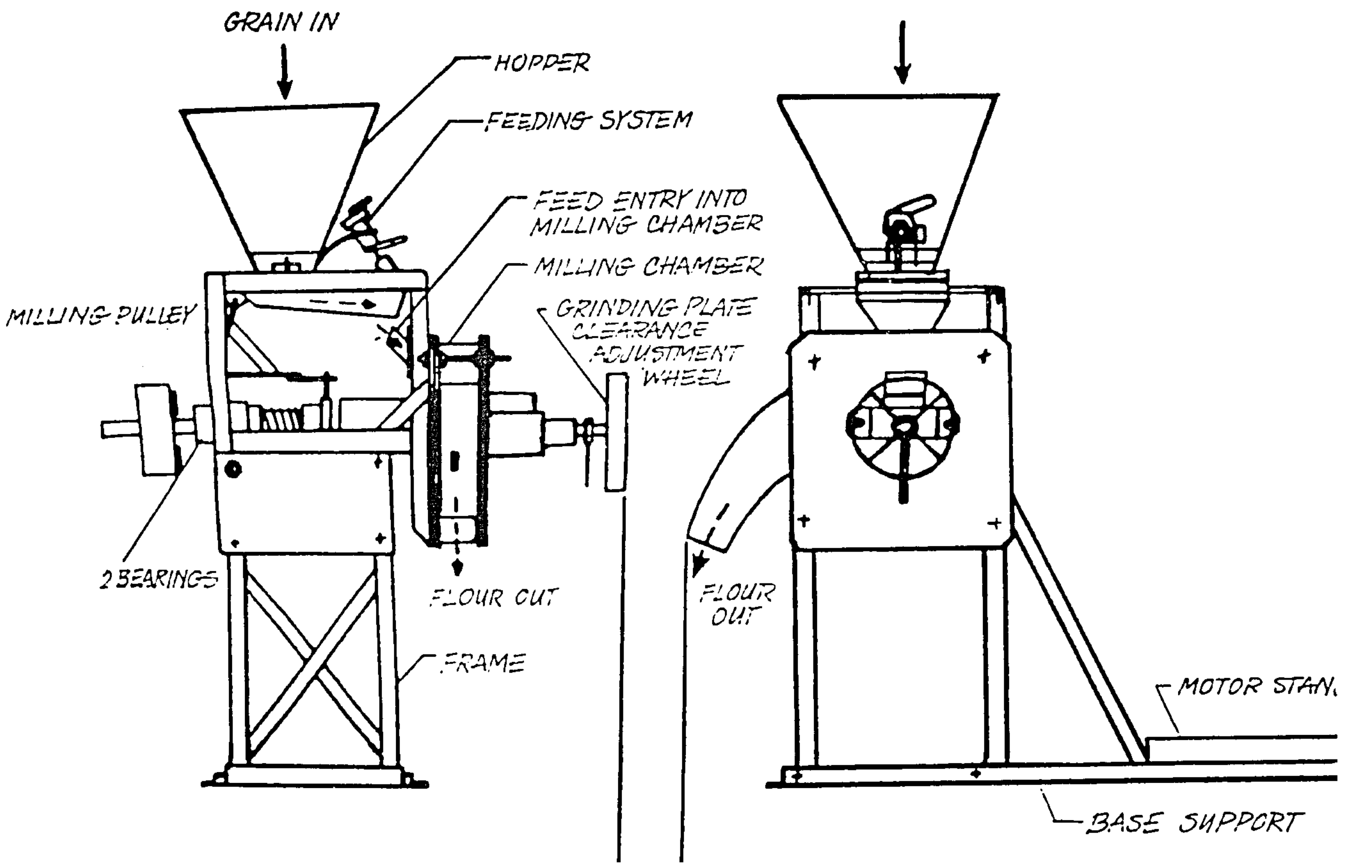
The Anguh maize mill, recommended here, was developed by APICA (Doula, Cameroon), in cooperation with B. A. Anguh Agricultural Tools Manufacturing Company (Bamenda, Cameroon). The Anguh mill is a plate mill in which the imported cast-iron plates have been replaced with cold-rolled steel plates (see Figure 2). The machine is based on the "Premier 2A" model of plate mill manufactured by R. Hunt and Company, Ltd. in England

The Anguh mill is made from all locally available materials--and costs 20 percent less than the comparable imported model made of cast-iron plate. The principle of the plate mill is simple: maize is forced by a spiral auger between two cast steel grinding plates, one fixed and the other rotating. The plates are pressed together by variable tension springs, which can be easily adjusted to accommodate consumer preference.

The mill can process 150 kilograms of maize per hour in small batch sizes and is simple to operate. This represents a very large time savings over the traditional stone milling technique. Using the traditional method, it takes over two hours to process enough maize, about three kilograms, to prepare foofoo

FIGURE 2

ANGUH MILL



Drawing courtesy of ATI/APICA/CATMI.

for a family of five. Using the Anguh mill, this amount can be processed in less than three minutes. The four hours which would be required to hand process a two day supply is thus virtually eliminated by the technology. If the rough estimate of one hour is used for travel to and from the mill to have this amount ground, the net time saved is still three hours, not to mention the energy saved from relief from the labor of hand grinding.

Using the "penny mills", a woman could mill three kilograms of maize in about ten minutes--not counting travel time to the mill. However, this is an arduous task and requires a helper.

In 1989, the Anguh Maize Mill cost the equivalent of US$ 4,500. The actual milling fee can be as low as 3 cents per kilogram.

Production of the Anguh Maize Mill started in early 1988. It is currently being introduced in Northwest Cameroon, where as of Spring 1989, eighteen women's groups had bought mills under a lease/purchase plan and were operating them.

4.2.2 Application

Maize is grown in most parts of the world and is the major staple for some 213 million people (FAO 1984:16). Countries where maize is a staple food and thus, where this technology has potential impact include: Costa Rica, El Salvador, Ecuador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Paraguay, Venezuela, Benin, Kenya, Malawi, Somalia, Tanzania, Zambia, Zimbabwe, and a number of other countries--particularly in Sub-Saharan

Africa--where women routinely process maize for household consumption.

It should be noted that a large number of diesel-powered maize mills have been developed and are being used throughout the developing world. However, the Anguh model is recommended because of three factors. First, it can be manufactured locally and repairs can be made without importing parts. Secondly, as stated, it costs about 20 percent less than prototype imported mills and can result in greater access to capital equipment by poor women. And finally, although diesel mills are quite common in towns and larger rural communities in Africa, many women living in small rural villages do not have access to this technology and continue to mill corn manually.

Africare personnel see a great need for maize mills in Zimbabwe and Mali where they are currently implementing projects, and where women are still grinding corn by hand. Africare's approach is to work with a cluster of small rural villages--as opposed to one village--to make technology more accessible and affordable to smaller populations of women who live in these villages. This appears a good approach for the maize mill if enough of them can be operated so that women do not have to walk very far or stand in a queue too long. Where the size of the small village is less than 50 families, so that one mill would need to service several villages, the estimate of time saved under optimum conditions would, of course, have to be increased.

In addition, an Asia area expert at the World Bank

(Bennett 1989) suggested that women living in the highlands of Nepal might benefit from the Anguh mill.

Although Zimbabwe, Mali, and Nepal appear to be areas where this technology would be appropriate, the generic conditions (see page 38) and the following technology-specific conditions should be verified by site visit prior to introduction of this technology:

1. An area where maize is a staple food crop--that is, where it is eaten often and provides a large part of the population's energy requirements.

2. An area where women customarily spend time in manually grinding maize and consider this a time or energy consuming task.

3. An area where the mill would serve at least fifty to seventy families--the minimum size for commercial viability.

4.3 Grain and Cassava Processing--Hydro-powered Hammer Mill

4.3.1 Technology

Another mill for grinding maize, as well as other grains and cassava, is the hydro-powered hammer mill. Using hydro-power and a turbine developed by SKAT of Switzerland, SODERZA, a Zaire development organization, has coupled a hammer mill with a cross flow, hydro-turbine to establish a low-cost mill fabrication industry. The cross flow, hydro-turbine is the highest level of development for small scale hydro-power use.

Some artisanal training is required to locally produce the turbine blades. However, a manual written by C. Bielenberg describes how a punch press can be fabricated to manufacture these blades from sheet steel, and fabricate these on to the turbine shaft.

The hydro-powered mill has an output similar to the diesel mill and thus, this device can save significant time in grinding corn to prepare foofoo and other dishes (see time-saving data in Section 4.2.1). In addition, it can save time in grinding cassava--a root crop widely consumed in the developing world (see Section 4.5).

The hammer mill can be designed to mill a variety of grains and cassava at a wide range of rates depending on the local market and availability of local hydro-power.

Appropriate Technology International (ATI) is currently working on an effort to introduce the mill through a pilot project in Eastern Zaire.

4.3.2 Application

Hydro-power is available in varying degrees in parts of Oceania, parts of southeast Asia, North and Central Asia, Andean Latin America, and central, southern, and east Africa. If controls are in place to avoid substance pollution, the hydro-powered hammer mill could be of considerable benefit in areas of expensive fuel.

In addition to the general conditions (page 38), specific conditions which also need to be verified by site visit prior to introduction of this technology include:

1. An area that is mountainous with hydro-power potential.
2. An area where maize is a staple food crop--that is, where it is eaten often and provides a large part of the population's energy requirements.

3. An area where women customarily spend time in manually grinding maize and consider this a time or energy consuming task.

4.4 Maize Shelling--TPI Hand-held, Wooden Sheller

4.4.1 Technology

Traditionally maize is shelled by hand--an arduous, and sometimes painful, task. About 8 to 10 kilograms per hour can be shelled manually by grasping the cob and stripping it of kernels using the fingers, primarily the thumb, or by rubbing two cobs together. Virtually no broken kernels result from using these manual methods and the efficiency rate is 100 percent.

Several models of shellers are available, including hand operated shellers which are designed so that the cob is twisted through a hole fitted with lugs which loosen and remove the kernels. These shellers range from simple wooden devices (such as the TPI Type II), to cast aluminum (Decker Type II), to PVC plastic pipe shellers.

Hand operated shellers can increase productivity to about 20 kilograms per hour. This means that a woman can shell twice the amount of corn that she usually does by hand in any given time period. Efficiency is about 100 percent, but a small percentage of broken kernels do result from using these shellers.

Prices of hand operated shellers are extremely low as some can be fabricated at home. Hand cranked mechanical shellers can shell as much as 52 kilograms of maize per hour (with a 92 to 98 percent efficiency). TDAU in Zambia has designed a machine priced at K. 150 (US $20.50) intended to compete with imported machines of the same type selling for K. 5,115 (US $700) (ARCT 1986).

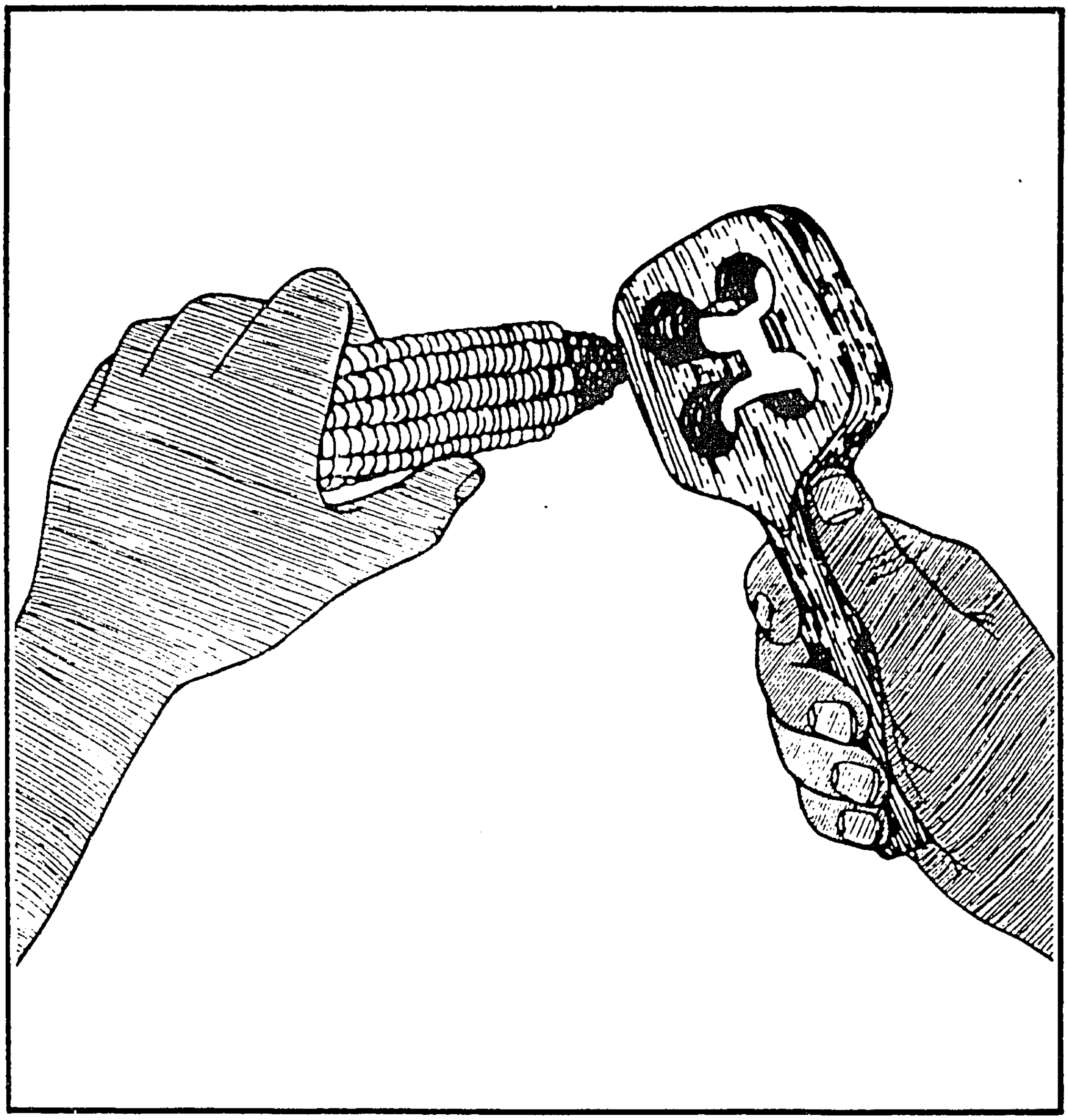
Here we will describe the TPI maize sheller which is attractive because of its extreme simplicity and low cost. This sheller is a hand-held device made from suitably hard and durable local timber (see Figure 3) and requires the minimum of carpentry tools for its construction. The device is appropriate for household level, daily maize shelling and is very simple to use: the end of the dry maize cob is pushed into the large hold in the sheller and by working the cob around the ridges, the grain is removed. A particular advantage of this sheller is that it can be locally made, using locally available wood and is inexpensive to purchase.

Generally, the sheller is best used during a short period of time--15 to 30 minutes--during which time up to 10 kilograms of maize can be shelled. About three kilograms of maize are needed to prepare corn foofoo for a family of five. Shelling this amount manually requires about 20 minutes. With the TPI sheller, the task takes approximately 10 minutes. This savings in time may not seem great; however over an average week, in areas where women frequently process maize meal, as much as an hour can be saved in relatively small households--much more in larger ones where more maize must be shelled for household meals.

The sheller is currently being manufactured and used in over 20 developing countries.

FIGURE 3

TPI MAIZE SHELLER



Courtesy of International Women's Tribune Center/Intermediate Technology Development Group; Grace Young, artist--Tech and Tools Book.

4.4.2 Application

Countries where maize is a staple food and thus, where this technology has potential impact include: Costa Rica, El Salvador, Ecuador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Paraguay, Venezuela, Benin, Kenya, Malawi, Somalia, Tanzania, Zambia, Zimbabwe, and a number of other countries--particularly in Sub-Saharan Africa--where women process maize for household consumption.

A number of specific sites have been recommended for transfer of technology relevant to the maize sheller. Technoserve suggests that the sheller would be effective in saving women's time in Ojobi, Winnebo District and Kaira, Kpalime District, Ghana. It should be noted that Technoserve has had an office in Ghana for over twenty years. Currently, Technoserve is working with maize production cooperatives in Ghana and Zaire and believes that local carpenters could easily produce this sheller.

Catholic Relief Services (CRS) is currently implementing a project in Togo (Sokode and the Atapame Region in the south) to work with local artisans who are interested in considering technologies that they could produce for sale. The sheller might be suitable for incorporation in this project. Finally, Africare--currently working in 20 countries--believes that the hand-held maize sheller could be manufactured and introduced through many of its programs.

This technology can be produced in-country by local artisans and introduced through the established women's networks that both CRS and Technoserve work with at the recommended sites.

In addition, the maize sheller has been recommended by an area specialist (DeWalt 1989) as particularly applicable in Honduras and Mexico. It may also benefit women in Thailand who use maize to prepare dessert (Van Esterik 1989) and in Nepal where women living in the highlands prepare corn for houshold consumption (Bennett 1989).

In addition to the general conditions (page 38), specific conditions which also need to be verified by site visit prior to introduction of this technology include:

1. An area where maize is grown and dried on the cob for storage.

2. An area where women customarily spend time in manually removing dried corn from the cob and consider this a time consuming task.

3. An area where the principal need is for a device which can be used in the home for short periods of time, the purpose for which the sheller was designed, as opposed to higher volume and duration commercial application.

4. An area where there is an in-country capability to locally produce the sheller (local artisans who can work in wood).

4.5 Cassava Processing--SIS Grater and Screw Press

4.5.1 Technology

Cassava is consumed after peeling either in stews as a boiled vegetable; boiled and pounded (to prepare foofoo such as that popular in Ghana); or peeled, fermented, mashed, sun dried, and ground into flour (to prepare the foofoo favored in Cameroon). Cassava can also be deep fried, roasted, or further processed through fermentation and roasting to make gari, or grated and pressed into cakes or sheets and baked or grilled to make cassava eaten in Haiti or crispbread eaten in Belize.

For the latter two applications, the peeled cassava roots need to be grated finely. This is customarily done manually with fabricated metal graters (perforated sheet steel), although an artful device used in Belize consists of a mahogany board studded with sharp quartz stones.

For gari production, the grated cassava is placed in rice sacks or gunny sacks, and the sacks are loaded either with weights or simple presses to express moisture and to allow fermentation. The fermented meal is roasted on a griddle or pan (garification), the cooled material forced through a sieve, and packaged. Gari is prepared for consumption by cooking with water, flavorings, and vegetables.

Data from Sierra Leone and Ghana indicate that traditional processing of fresh cassava is a time-consuming process: three to 15 minutes per kilogram to peel cassava, ten to 15 minutes per kilogram to grate, and one to six hours to press with a rope and stick or stacked stones. Pressing gari reduces moisture 50 percent--from 60 to 30 percent. This time cannot be reduced if the flavor of long fermentation is desired. (ILO 1984.)

Cassava root peelers have been designed for fabrication in developing countries and these usually consist of rotating drums with perforated interior surfaces. The peels are abraded from the surface and carried away with a water wash. Peelers are generally batch type devices. However, because of the extremely irregular shape of cassava roots, such peelers have not proven satisfactory. (Nwokedi 1984.)

But cassava graters are effective. They are generally motor driven and consist of rotating vertical or horizontal drums or wheels bearing either perforated metal surfaces or toothed blades which rasp the cassava into the required fineness (Kreamer 1986). A good example of a grater which can be used to process gari is the SIS cassva grater. This device is mechaniz-ed, but can be manufactured locally.

Complementing the grater is the SIS press. Gari presses consist either of wooden or metal racks which are tightened upon the grated cassava in sacks by means of threaded rods and handnuts, or by screw presses. As noted, the time needed to press the gari cannot be reduced without sacrificing the tradi-tional flavor resulting from long fermentation. However, the press relieves users of the awkward and arduous task of pressing through such traditional methods as the stacking of stones.

This SIS grater costs approximately US $600 in 1989 and the screw press costs about US $40 (Kreamer 1989).

The cassava grater reduces the time spent by women from ten to 15 minutes per kilogram, as noted, to less than a minute per kilogram (Cecelski 1984). Because pressing gari is so time-consuming, women generally process larger quantities than is needed for a single meal. This means that women who spend about two hours grating ten kilograms of gari manually can save considerable time: the mechanized grater processes the same amount in less than ten minutes. And if the rough estimate of one hour for travel to and from the grater is used, the two hours required by the traditional method is halved to about one hour.

The SIS and similar graters and the screw press have been introduced and used quite widely in Ghana. In Figure 4 an illustration is provided of a typical grater and press.

4.5.2 Application

Cassava is the principal source of carbohydrates in a number of developing countries (FAO 1984). These countries, with a total poppulation of 71 million, include Namibia, Burundi, the Central African Republic, the Congo, Gabon, Ghana, Mozambique, Rwanda, and Zaire.

Africare is interested in considering the cassava grater and screw press for introduction in Emo State, Nigeria. In addition, a Latin American area specialist suggests that these technologies may be appropriate for the north coast of Honduras and Brazil, particularly the tropical rainforest area (DeWalt 1989). Finally, they may be appropriate in Indonesia and Bangladesh (Van Esterik 1989).

The conditions that must be considered before introduction of the technologies include the general conditions listed on page 38 and the following specific conditions:

1. An area where cassava is a staple food crop--that is, where it is eaten often and provides a large part of the population's energy requirements.

FIGURE 4

SIS GRATER AND SCREW PRESS

Motorized Grater

Screw Press

Photographs courtesy of Ross Kreamer.

2. An area where women customarily spend time in manually grating and pressing cassava and consider these time or energy consuming tasks.

3. An area where there is a tradition of grating cassava before it is dried.

4.6 Rice Processing--UMN Huller

4.6.1 Technology

Rice, as previously noted, is the basic food of more than half the world's population. At the same time, our information suggests that one of the most important laborsaving technologies, rice mills, are already widely used. However, there is a need for milling technology in more isolated areas. One such technology is a simple device for husking rice which is manually operated and small enough to be used in a large household or by a small group of cooperating individuals. This is the UMN huller (see Figure 5).

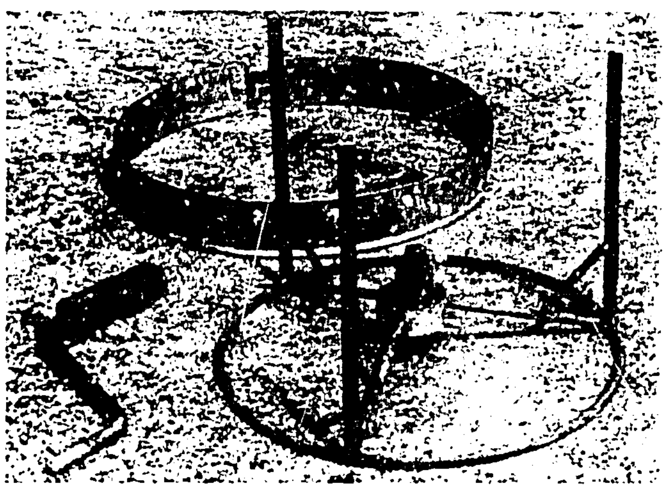
The huller is fabricated from concrete with either steel or concrete legs, and is built in place. It consists of cone shaped rubbing surfaces which are cast from concrete, then covered with sections cut from truck tire inner tubes. The rubber surface prevents undue breakage and waste of rice. (Unruh 1989.)

Husking rice by hand requires an estimated one to two hours per 10 kilograms. A manual huller can process this amount in roughly 40 minutes, representing a time savings of 20 to 80 minutes (Cecelski 1984).

FIGURE 5

UMN HULLER

Huller in use



Frame and iron parts

Photographs courtesy of Intermediate Technology Publications-- Women and the Food Cycle.

The device costs approximately $5 and has been introduced through a pilot project in Nepal.

4.6.2 Application

Countries where rice is a staple food and thus, where this technology has potential impact include: Bangladesh, Burma, India, Indonesia, Malaysia, Nepal, Philippines, Sri Lanka, Thailand, Gambia, Guinea, Ivory Coast, Liberia, Madagascar, Mauritius, Sierre Leone, Brazil, Columbia, Dominican Republic, Guyana, Panama, and Suriname.

This technology may also have application for introduction in Nepal and India (Bennett 1989).

In addition to the generic conditions (page 38), conditions that need to be verified by site visit prior to introduction of this technology include:

1. An area where rice is a staple food crop--that is, where it is eaten often and provides a large part of the population's energy requirements.

2. An area where women customarily spend time in manually hulling rice and consider this a time or energy consuming task.

4.7 Quinoa Processing--Thresher, Cleaner, and Polisher

4.7.1 Technology

Quinoa is a major grain in Andean Latin America. This ancient grain, enjoyed since pre-Columbian times, is one of several grain crops and legumes suited to the agricultural ecology of the area, marked by diurnal temperature extremes, spare rainfall, sudden storms, and shallow, rocky soils.

Quinoa contains a high level of protein and has an excellent amino acid profile for human nutrition. It is a small seed, about two to three mm in diameter, and therefore difficult to handle. Further, the pericarp contains a bitter, somewhat toxic substance, saponins, at the rate of about 2 to 6 percent. Although this material protects the standing grain against bird predation, it must be removed prior to cooking. It is not only unpalatable, but the saponins can interrupt normal blood clotting.

In the altiplano, farmers usually harvest the ripe grain by cutting it in 2 to 4 foot stalks and stacking it near the cottage. Even though there is some grain loss through shattering, quinoa is traditionally stored in this way because farmers feel it dries better, the intact heads (bearing the saponins) may be more resistant to rodent predation (though not necessarily resistant to insect infestation), and the stalks will go for fuel after cleaning.

For meal preparation, the wife pounds or rubs off the grain by hand, picks it free of straw, stones, and other foreign material, and winnows it to remove the chaff. She must then soak the grain in water (usually from an icy stream), hand rub the grain, often in running water, to dissolve away the saponins, and give the grain a final rinse. The quinoa is then cooked over a dung or straw fire for 20 to 30 minutes. Total time of active preparation is about two hours, exclusive of management or water transport, if necessary.

Work done by the Pillsbury Company to find inexpensive cleaning and polishing equipment was partly predicated on the premise that cleaned grain could be stored more efficiently (fewer losses to shattering, insect, bird, and rodent infestation and predation) in the cleaned condition, in sanitary, pest-proof and weather-proof containers or bins. Hand operated, portable equipment was sought. The outcome of the research was the identification of a threshing-cleaning system consisting of three machines:

1. The CeCoCo foot operated thresher (modified to contain a baffle) priced at US $576.

2. Seedboro (Hance) seed cleaner (w/ 7/64"; 1/16"; and 1/18" round hole screens) priced at US $418.

3. CeCoCo hand rice polisher (w/ 1 mm round hole screen) priced at US$ 616.

With modification costs of US $600 and US $1000 in shipping costs, the system cost (FOB Minneapolis) is US $3210. See Figure 6 for illustrations of this equipment.

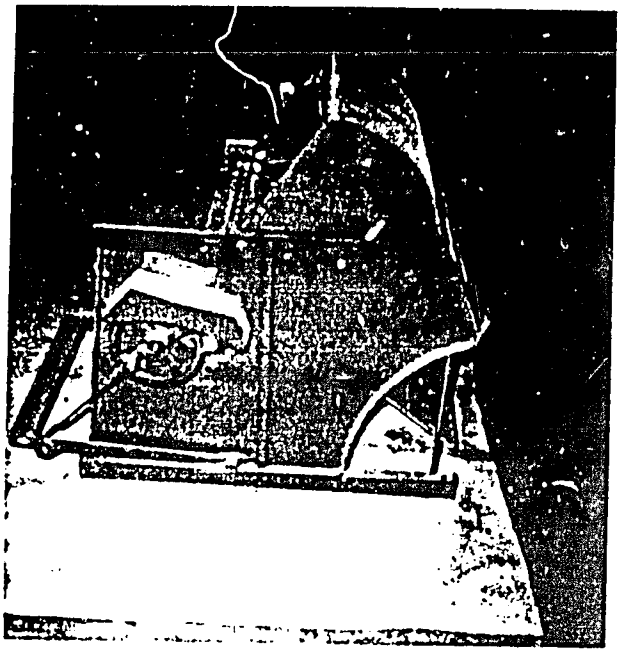
The costing schedule reflects the experience of the Pillsbury Company scientists who carried out the work and is actual costs, exclusive of research and development costs. This is not to say that Pillsbury might not modify equipment for shipment abroad.

Output capacities of the equipment with quinoa are as follows:

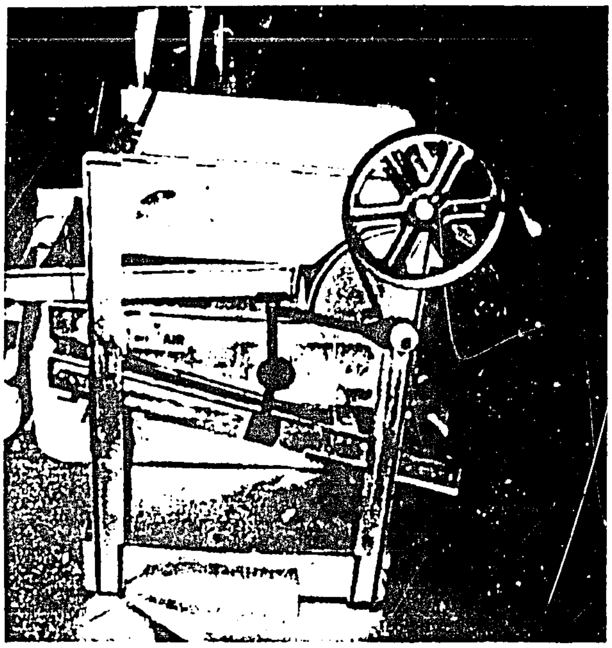
Machine	Pounds of Quinoa per Hour
Thresher	200
Cleaner	500
Polisher	60

FIGURE 6

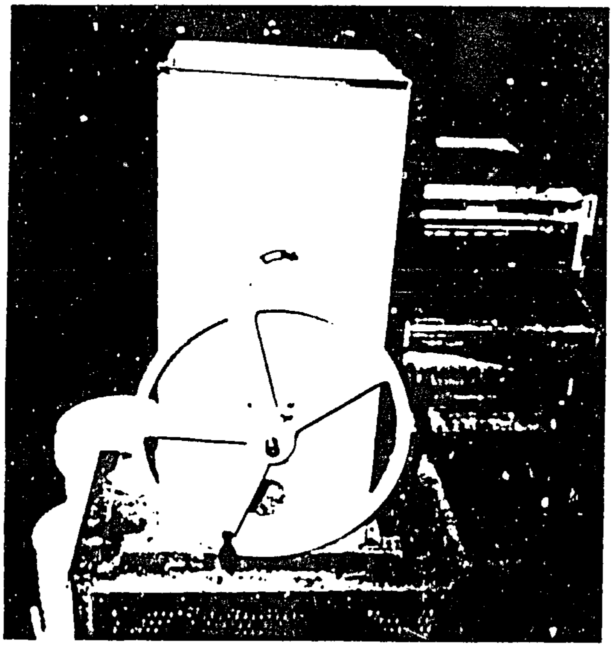
QUINOA THRESHER, CLEANER, AND POLISHER



THRESHER - SIDE VIEW



SEED CLEANER - SIDE VIEW



RICE POLISHER - DRIVE END

Photographs courtesy of Pillsbury Company.

These figures show that quinoa for household use can be processed in a matter of minutes using the thresher, cleaner, and polisher. The equipment would require three to four people spelling each other, as these machines are arduous to operate continuously.

4.7.2 Application

Quinoa is grown in many parts of Andean Latin America and is a major staple for many highlanders. The technology has been introduced in the Bolivian Altiplano and may be appropriate for other areas in Latin America.

In addition to the general conditions listed on page 38, the following should be verified by site visit prior to introduction of this technology:

1. An area where quinoa is a staple food crop--that is, where it is eaten often and provides a large part of the population's energy requirements.

2. An area where women customarily spend time in manually processing quinoa and consider this a time or energy consuming task.

Oil Processing

4.8 Sunflower/Sesame Seed Oil Processing--Bielenberg Oil Press

4.8.1 Technology

Traditionlly, unhulled sunflower seeds and sesame seeds are parched in a pan over a fire, then pounded in a mortar. The paste is suspended in hot water and the oil is ladled off.

The Bielenberg ram-type press was invented in 1985 and virtually supplanted all other press designs used for sunflower seed processing in East Africa (see Figure 7). This press was

FIGURE 7

BIELENBERG OIL PRESS

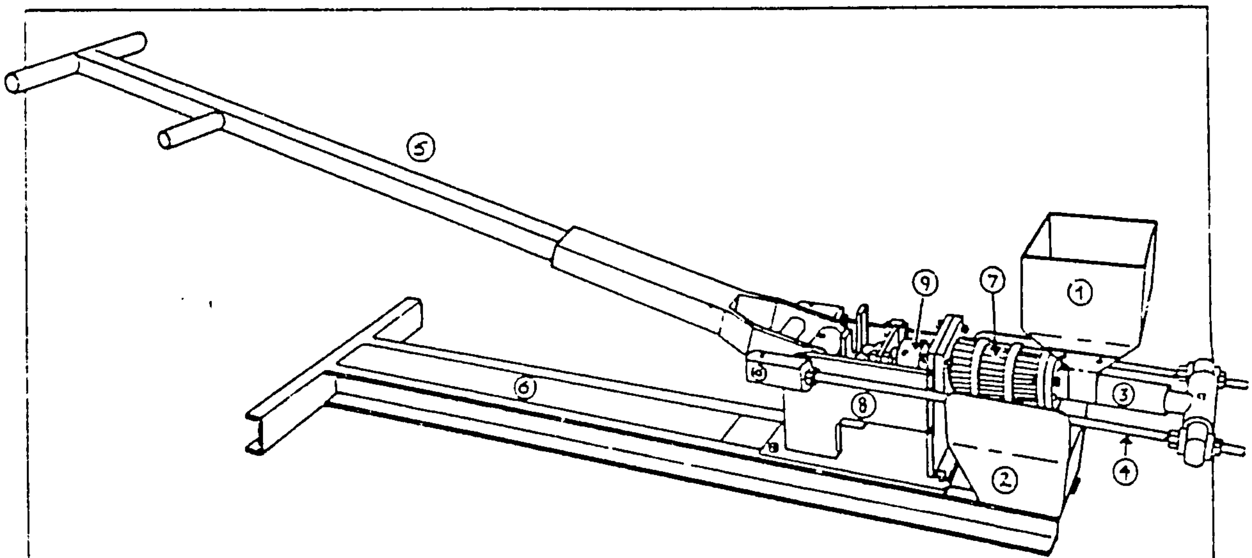


Figure 9: General view of the oil press

1) Seed hopper	4) Draw bar (two)	7) Expelling cage
2) Oil Collection Tank	5) Removable handle	8) Main frame
3) Cylinder and piston assembly	6) Base frame	9) Back-pressure plug

Drawing courtesy of CARE, Inc.

first manufactured in Tanzania, and today is also manufactured in Kenya, Uganda, Zamabia, and Zimbabwe. (Allen, 1989a).

Pre-treated (dried, unhulled) seeds are loaded into the intake hopper of the press and the handle operated. The handle drives foreward the piston which exerts pressure on the seeds in the cage, crushing the seeds and disrupting the oil cells to release the oil. This is recovered in a pan below. As the ram moves to the rear, the new charge drops in place, and upon forward motion of the ram again, the old charge is expelled past an adjustable back pressure plug. The oil is clarified by settling in a tank, and by passing through screens and filter cloth.

The machine can process 10 kilograms of seeds per hour, yielding about 2.5 liters of oil. It would take a substantial amount of time to process this amount manually--as much as half a day of work. The extraction rate is about 78 percent. The press can also be used to process other oilseeds, in particular the widely used sesame seeds. The current (1989) price of the press in Kenya is US $1,250. (Allen 1989a.)

The press has been introduced in Kenya and is widely used in Tanzania and Zimbabwe to process sunflower seed.

4.8.2 Application

This technology would be of use to women in areas where cooking fuels are in short supply and/or there is a market for locally produced oils that can be processed by the press.

Africare is interested in exploring the use of press in the Southern Province of Zambia because of the severe shortage of cooking oil in the country. CRS personnel believe that the press might be appropriate to introduce in the Arusha Region of Tanzania and perhaps in Gambia.

In addition to the general conditions (page 38), specific conditions for transfer of this technology include:

1. An area where sunflower seed and other appropriate foods--sesame seed, dried coconut meat, shelled almonds, and shelled castor--are cultivated and extracted for oil.

2. An area where women customarily spend time in manually expressing seeds and nuts and consider this a time or energy consuming task.

3. An area where the press would serve at least thirty to fifty households and where at least six hectares of sunflower (at 1.0 tonne/ha) would be grown.

4.9 Groundnut Shelling

4.9.1 Technology

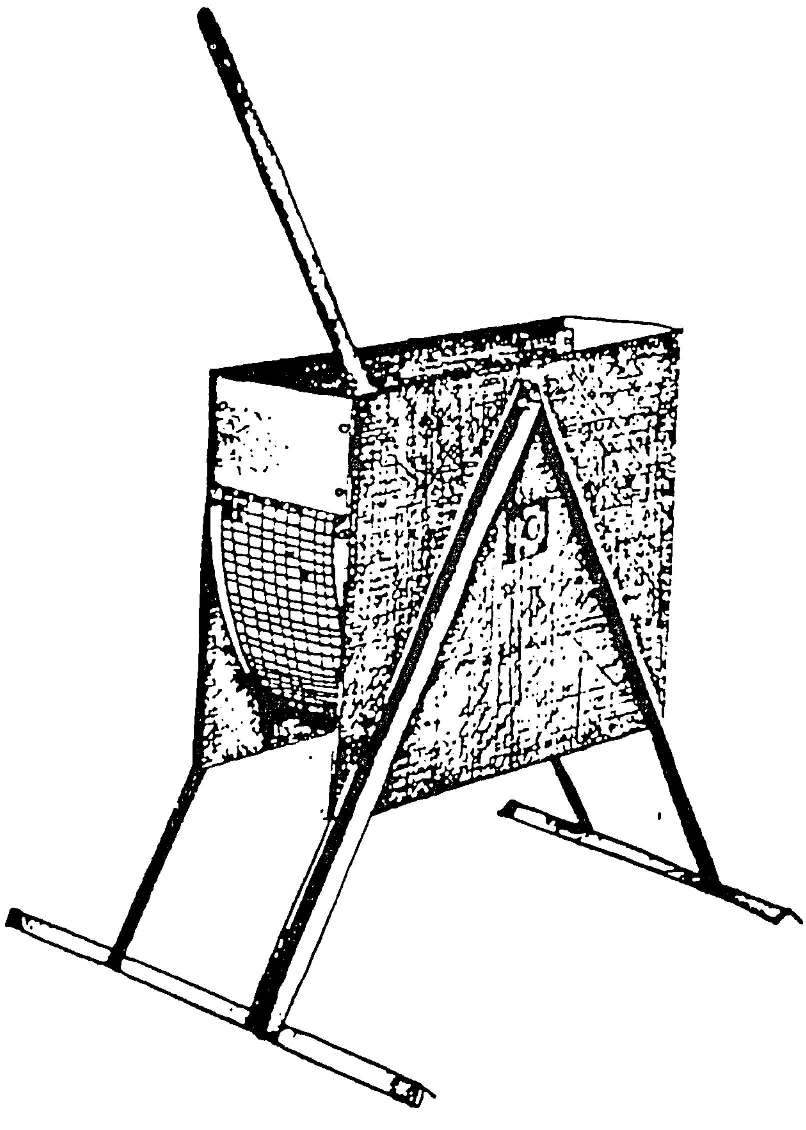
Shelling of groundnuts is vital to the quality of the groundnuts because broken or damaged seed coats allow the absorption of moisture which usually leads to mold formation and the generation of aflatoxins which are extremely toxic and carcinogenic by-products of moldy grains. Shelling represents only a small portion of the total time required to convert groundnuts to butter or oil. However, a mechanical sheller can still save a significant amount of time. Thus, where hand shelling requires about 40 minutes to process ten kilograms of nuts, manually operated mechanical shellers can perform the same function in about four to seven minutes. Hand shelling yields the maximum whole-sheller count, but it is a slow and arduous process. Mechanical shellers (decorticators) can damage 15 to 40 percent of the kernels.

Mechanical shellers all have a similar fundamental design, usually consisting of a cylinder, a concave section, and shelling bars. In some shellers, the concave remains stationary while the drum swings, not unlike a pendulum, under the impetus of an operating handle. In other designs, the shelling concave is made to oscillate about stationary shelling bars. The fundamental operational design remained unchanged for perhaps fifty years until attention was again paid to it in the 1950s when rubber coverings were applied to the shelling bars and to the concave. An enormous body of research has been accumulated on the quality and processing characteristics of various groundnut cultivars. The rotary cylinder design proved most efficient in terms of through-put and in terms of minimizing damage to the kernels. It is available from Senafrica, Kano. (Musa 1975.) An illustration of the specific sheller recommended was not available. However, a similar sheller where the moving component is operated by a lever rather than a rotary crank is illustrated in Figure 8.

FIGURE 8

GROUNDNUT SHELLER

(Model shown here is with lever.)



Drawing courtesy of UNIFEM--Oil Extraction.

4.9.2 Application

The Groundnut Sheller can be of potential benefit in much of Sub-Saharan Africa and other parts of the world where this crop is cultivated.

CRS feels that the groundnut sheller is a technology which might be considered for introduction in Togo (Sokode and the Plateau Region) and Senegal, where they currently have projects. CRS has established a network and could work with existing women's groups to introduce the sheller.

General conditions that need to be verified by site visit prior to introduction of this technology are listed on page 38. A specific condition that should be verified is existence of a situation where women customarily spend time in manually shelling groundnuts and consider this a time or energy consuming task.

4.10 Palm Oil Processing--Caltech Expeller

4.10.1 Technology

Regardless of whether a traditional or contemporary process follows, oil palm processing begins with the harvest of palm fruit bunches by cutting the bunches from oilpalm trees with knives fastened to long poles, for cultivated varieties of trees. Wild palms are often too tall to reach with pole-knives, and need to be climbed. This is a difficult and dangerous task. The spiny bunches are gathered together into piles and covered with a tarpaulin or plastic sheet or large leaves for fermentation for several days.

In the traditional process, the fruit is then removed manually from the spiny bunches. It is then cooked and the cooked fruits are trampled or pounded. Pounding can fracture the shells of tenera and pisifera palm nuts thereby liberating more oil-bearing materials, but dura palm nuts have considerably thicker shells (two to eight mm) (Rehm, S. and G. Espig 1984) and are not likely to be broken in such an environment.

The mashed oil-bearing materials are mixed and kneaded manually in water to separate the fiber and nuts. The floating material is now principally oil and is ladled off and boiled. Essentially pure palm oil collects at the surface, and the palm oil is again ladeled off from the surface and separated from the remaining plant materials. The nuts, which have been separated and dried, are cracked and may be pounded and added to the boiling process for extraction of more oil. As the type of oil extracted from the nut is valued differently, oilpalm nuts will be processed separately by roasting after cracking for one to four hours, then pounded in a mortar. Oil is separated by boiling and ladled off. (ILO 1984b) Often these palm nuts will be sold to a commercial oil expelling operation.

Data collected in Cameroon indicates that 128 kilograms of oilpalm fruits require 52 person hours of labor for processing into oil. Although the process may vary somewhat depending on the region, the traditional process is marked by excessive use of water, arduous physical labor, low yield of oil (not more than 50 percent), and excessive fuel wood use.

Three areas for process improvement were identified and these are: mashing by trampling or pounding, separation of oil and oil-bearing materials in water, and liberation of oil by cooking. (Wiemer and Altes 1989.) In addition, an improved method for removing palm fruits from the bunches by means of mechanical bunch strippers has been available for several years.

The mechanical bunch stripper consists of an octagonal drum fabricated from wooden slats. The drum is mounted on a horizontal shaft and fitted with handle and crank for rotating the drum. Oilpalm fruit bunches are fermented then loaded into the drum. As the drum is rotated, the tumbling action separates the fruits from the supporting stems and the fruits fall between the slats and are recovered for further processing. The stems are discarded or used as fuel. The palm fruits are steamed and, while still hot, are loaded into presses of various designs.

Considerable work has been done in refurbishing old presses (Colin-APICA press, West Africa), in adapting various hydraulic or screw designs, and in designing new machines (Caltech). Refurbished manual Colin-APICA presses can process 100 kilograms of stripped fruits hourly. The Caltech machine can process 90 kilograms of oilpalm fruits per hour. The Caltech press was selected here as a good example of a well-functioning, moderately priced machine.

The Caltech is built in two models: horizontal and vertical. The former was priced at CFAF 988.711 (US $3700) in 1987 for the manual model, and CFAF 1,753,422 (US $6567) for the 2-hp gasoline model. The vertical model is available only in the manual style and is priced at about CFAF 386,645 (US $1448) (see Figure 9). Either machine can be operated by two or three persons. Motorized versions increase capacity approximately threefold.

The Caltech Expeller, as mentioned previously, can process 90 kilograms of palm fruit per hour. Thus, a ten kilogram supply of palm fruit that would take about four hours to process manually, and which would yield a little less than two liters of oil, can be processed by the Caltech Expeller in about seven minutes.

The press has been introduced through a pilot project in the Republic of Cameroon.

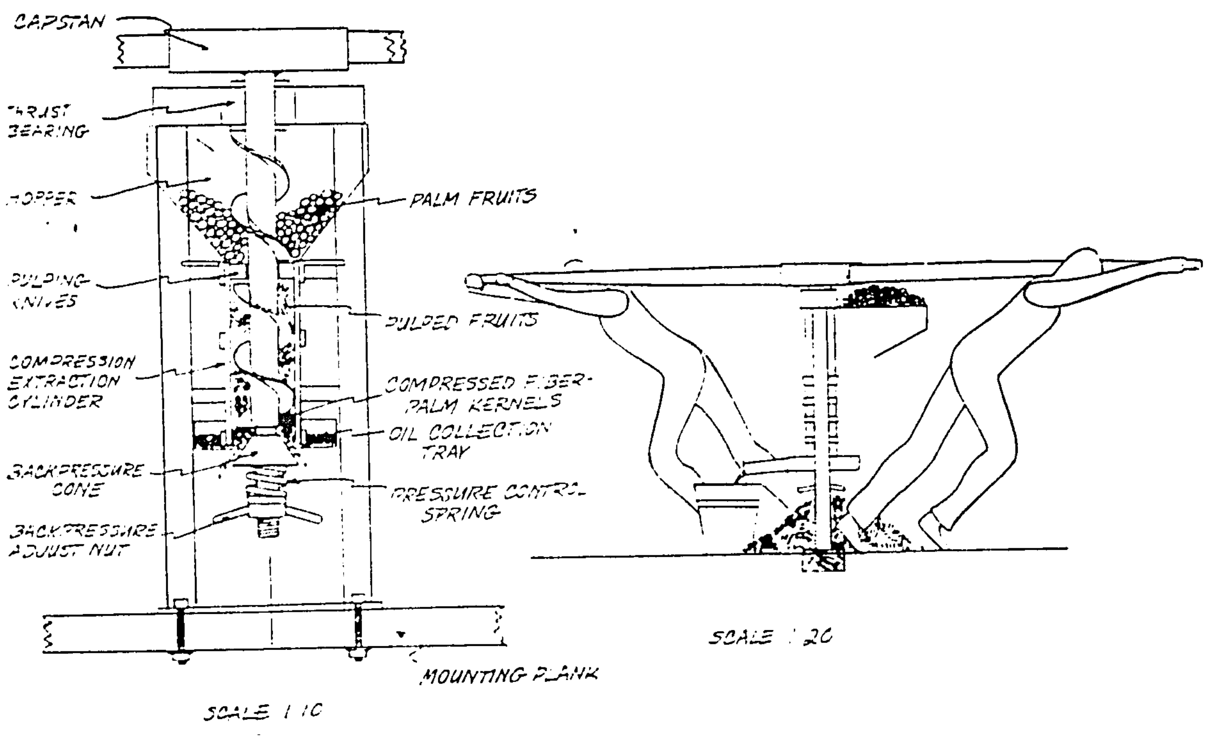
4.10.1 Application

Technoserv has explored possible sites for a similar oil press in the Kigoma region in northwest Tanzania and the Bandundu region, northesat of Kinshasha in Zaire. In both of these areas, women process plam oil by hand. There are also local organizations in both areas that could help to promote and introduce this type of technology.

In addition, Africare may be interested in introducing this technology through its ongoing projects in Sierra Leone. Finally, this technology may be appropriate for parts of Indonesia (Van Esterik 1989).

These sites appear appropriate for the introduction of the oil press, however the generic conditions listed on page 38 and the following specific conditions should be verified by site visit prior to introduction:

FIGURE 9
CALTECH EXPELLER



Drawing courtesy of ATI/APICA.

1. An area where Dura or Tenera palm fruit is produced.

2. An area where women customarily spend time in manually expressing palm fruit and consider this a time or energy consuming task. Or, an area where there is a demand for locally processed palm oil because of shortages, excessive cost, and the like.

3. An area where there are no particular reasons to believe that this technology would be culturally unacceptable. For example, in some parts of Africa, people may shun walking in a circle to turn a capstan because they associate this type of work with draft animals.

4. An area where owners have access to at least 10 hectares of Dura or 3 hectares of Tenera to make the expeller profitable.

4.11 Shea Nut Butter Processing--CEPAZE Extraction Unit

4.11.1 Technology

The shea nut tree grows throughout the Sahel in areas receiving 800 to 1400 mm rainfall annually. It bears 15 to 20 kilograms of fruit, of which 40 percent by weight is dried nuts, and these yield about 1.6 kilograms (8 percent) shea butter per tree. (Wiemer)

The traditional process begins with collection of the fruits and burial underground covered with large leaves to ferment and soften the pulp for removal. The fruits are sun dried and then roasted over wood fires. The parched fruit material is manually separated. The nuts are again sun dried, then pounded in a mortar to produce a coarse paste. This paste is finely ground manually between a wooden rolling pin and a stone plate.

The brown colored ground material is trampled or kneaded in cool water for two to three hours until a white oil-in-water emulsion forms and tends to float. The white emulsion is skimmed from the surface and mixed with warm water. The shea butter floats to the surface, is decanted, and impurities tend to remain in the water phase. This process is repeated several times. The shea butter is then heated in a cauldron to evaporate the remaining water, and to settle the remaining impurities to the bottom. The shea butter is allowed to cool to ambient temperature and tends to become buttery at about 20 to 25 degrees C. Portions are traditionally wrapped in leaves, bound, and offered for sale. (Anonymous 1985c).

Considerable variation is seen in yield estimates. Wiemer estimates the traditional method to produce about 20 percent based on total fat content of the dried nuts. CEPAZE, a French technology organization, claims extraction rates of 22 to 28 percent for the traditional process. Earlier estimates give about 15 percent (Fleury 1981) and a recent estimate was 25 to 40 percent extraction on the same basis (UNIFEM 1987).

Labor inputs are not adequately reported. Fuel wood consumption in the traditional process is estimated by CEPAZE to be 8.5 kilograms per kilogram of processed shea butter. (CEPAZE 1985).

The upgraded process developed by CEPAZE, Mali, mechanizes nearly every step of the process, but closely parallels the traditional process. It preserves some of the familiarity of traditional processing, and at once allows a transition to mechanization. This provides a substantial alleviation of labor and reduces total time for processing. It also makes possible enormous savings in fuel wood consumption with the comcommitant reduction in labor, expense, and natural resouces exploitation. As tested in Daban, Mali, the shea butter extraction unit, which would be suitable for a village level enterprise consists of:

1. A solar dryer for rapidly drying the fermented and husked nut.
2. A manual or motor driven decorticator/winnower.
3. An animal or motor driven shea nut grinder.
4. A manual or motor driven centrifuge.
5. A cauldron for drying the shea butter.
6. A manual or motor driven churn.
7. Improved packaging using transparent film.

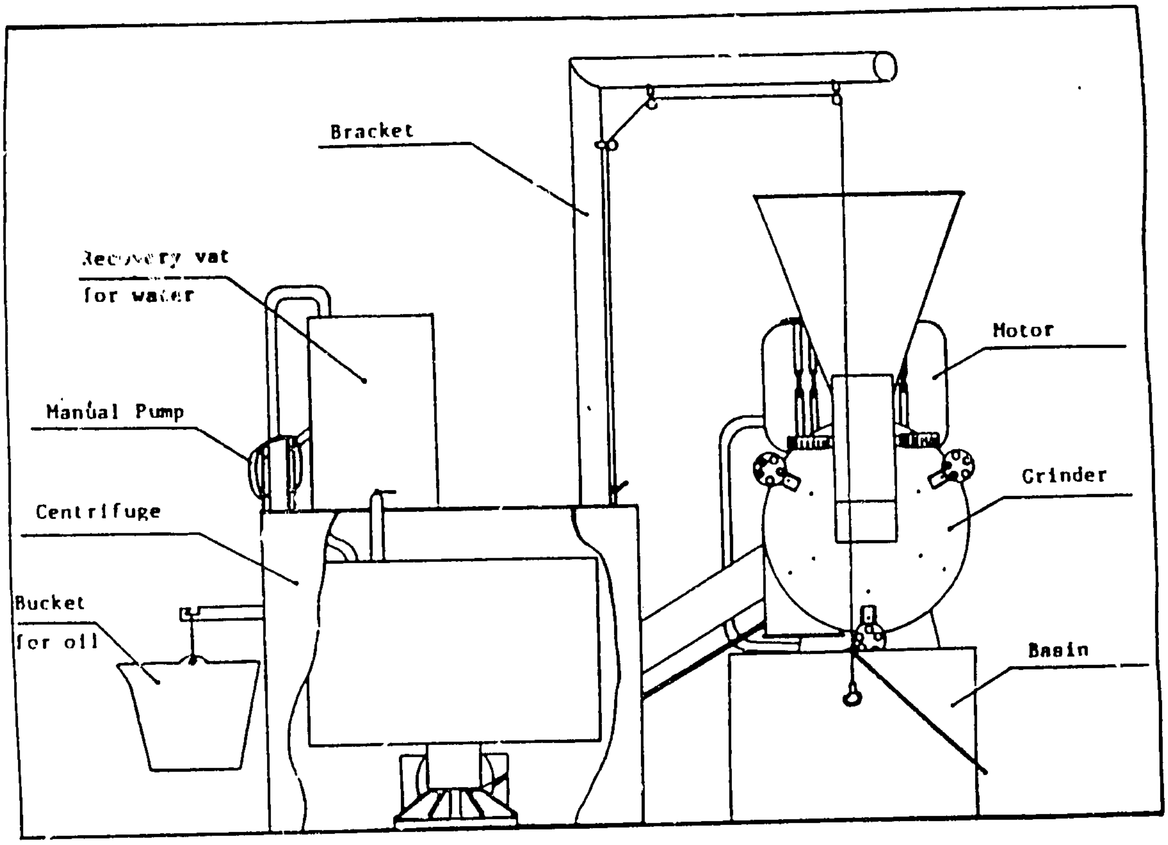
Figure 10 illustrates the extraction unit's main components: a grinder, motor, and centrifuge. In 1989, the cost for these components was approximately US $10,,000.

Following fermentation, 12 kilograms of nuts are loaded into the 1 by 1.5 M solar dryer. The solar dryer is fabricated from sun-dried mud bricks laid up on a cemented stone base and insulated with straw. A polyester window completes the dryer. About 12 dryers would serve the animal driven grinder, and 30 dryers would serve the motorized grinder. Interior temperatures of about 100 degrees C. reduce the moisture content to 6 to 7 percent and materially improve oil extraction because this temperature is considerably higher than traditional sun drying. Normal retention time is one day.

FIGURE 10

CEPAZE EXTRACTION UNIT

(ginder, motor, and centrifuge)



Drawing courtesy of ATI/APICA.

Improved solar dryers (Islam et al. 1987) would substantially reduce drying time, thereby increasing throughput.

The dried nuts are loaded into the decorticator/winnower which has a capacity of 300 kilograms per hour. This unit consists of a rotor on a horizontal axis which rotates in close proximity to a wire screen. The nuts are abraded against the screen and the dried cortex is rubbed off. A fan attached to the shaft blows the loosened chaff out of the machine. The nuts are then returned to the solar dryer to heat them to be ready for grinding. (The solar box cooker [see page 98] could be a material improvement over using a solar drier because it can attain a substantially higher temperature. It would have to be tested in the field to determine if its "come up time" (time it takes to attain operational temperature) can be integrated into the more efficient process.)

Whether animal or motor powered, the grinder consists of two pairs of steel rollers set one pair above the other. The rollers of the upper pair are set wider apart as they perform the task of coarse crushing of the shea nuts. The second set of rollers is set much closer together in order to accomplish grinding the material into a very fine paste in order to achieve maximum oil extraction. Maximum output for the animal driven grinder is 30 kilograms per hour. The motorized machine can process 60 kilograms per hour.

The finely ground paste is mixed with hot water, then loaded into the centrifuge where separation of the oil from the water is accomplished[1]. The separated oil is heated to evaporate any remaining water, and the oil is filtered to rid it of impurities. After standing over night, the oil is churned for four to five minutes per kilogram of oil to recreate the consistency of butter. It is then cut into pre-weighed blocks, wrapped with transparent pachaging film, and offered for sale.

The extraction rate (based on dry weight mass of nuts) is 38 percent. CEPAZE assumes a 25 percent extraction rate for the traditional process in Mali. The mechanized extraction proccess would therefore improve productivity of a shea nut collector by 52 percent.

The unit has been introduced through a pilot project in central Mali.

4.9.2 Application

While some further testing of the extraction unit is required, Technoserve might be interested in the technology for the Winnebah district of northern Ghana, the Kigoma region of Northwest Tanzania, and the Bandundu region, northeast of

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[1]A recent report indicated that the CEPAZE centrifuge had not operated as expected. Efficiency had not attained design expectations. Since the trials discussed in that report, the machine has undergone a design, construction, and quality control improvement process in which higher rotational speed was attained, and higher temperature water was used. This resulted in a higher extraction rate even with low quality kernels, and based on trials carried out in early 1989, CEPAZE predicts extraction rates of 40 percent with high quality kernels. (Hyman 1989). While further verification of the centrifuge performance will be required, it is expected that this design problem has now been solved. (It should be additionally noted that the Shea Butter Extractor remains a highly productive device, even when the centrifuge component is not used.)

Kinshasha, Zaire. In addition, Africare personnel expressed possible interest in promoting the technology in the Central African Republic, and in the Dioro and Duelessebougou districts of Mali. Finally, CRS is working on a project in Senegal to develop village level enterprises and might be interested in considering introduction of the extraction unit.

In addition to the general conditions (page 38), specific conditions for transfer of this technology include:

1. An area where the shea nut tree grows in abundance.
2. An area where women customarily spend time in manually expressing shea nuts for home consummption and consider this a time or energy consuming task.
3. An area where there are 150 to 300 potential users for the animal-driven unit and an area where there are 300 to 500 users for the motorized unit.

Smoking and Stoves

4.12 Fish Processing--Smokehouse with Detached Firebox

4.12.1 Technology

A number of workers have reported that substantial volumes of fuel and considerable effort are expended globally in the processing of fish by women. (Clucas and Chamasonde 1976; Sandhu 1989; ILO 1984). Some of this processing is for commercial sale, but a substantial portion is also for home consumption. Thus, in many instances, fish smoking is conducted as a community enterprise where women bring their fish to a smoker and do their own processing. Often, the women must also supply the firewood needed for the smoking. An efficient smoking facility can save the time of women in gathering fuelwood, as well as providing other advantages.

Studies conducted in Sierra Leone, Ghana, and Senegal showed a seven-fold increase in profitability through the use of an improved smoking oven design. The savings were attributed almost solely to reduction of fuelwood consumption. However, the studies also reported that smoking time was also reduced to approximately one-quarter of the time with a concommitant reduction in attention and labor and exposure to the smoke and heat. (ILO 1984.)

Fish processing also includes sun-drying and salting. Occassionally, women find a portable smoking or drying device to be desirable, but generally the smoking operation is set up near the source of supply, namely the seaside or a lake shore. Portability is rarely the controlling factor. (Clucas 1976.)

Fish smokers are making a useful contribution. However, to our knowledge, a smoke house (or oven) with a detached fire box has not been widely used, although a need has recently been recognized (UNIFEM 1988). This design could result in shortening of processing times and significant savings of fuelwood, and the time and effort required to gather it.

With the detached fire box, the smoke and hot air are conveyed to the smoke house through an underground pipe. This design permits better temperature control and, therefore, enables better fuel consumption and more even cooking. It also protects women from heat and smoke, and is more sanitary, because the area where the fish are placed is no longer directly over the fire box.

A smoke house which uses the detached fire box is therefore recommended. Figure 11 illustrates a design developed by the USDA Extension Service and Virginia Polytechnic Institute. The design has been selected to illustrate the use of the detached fire box, while recognizing that adaptation may be required to permit fabrication in a developing country setting where low-cost local materials should be used.

4.12.2 Application

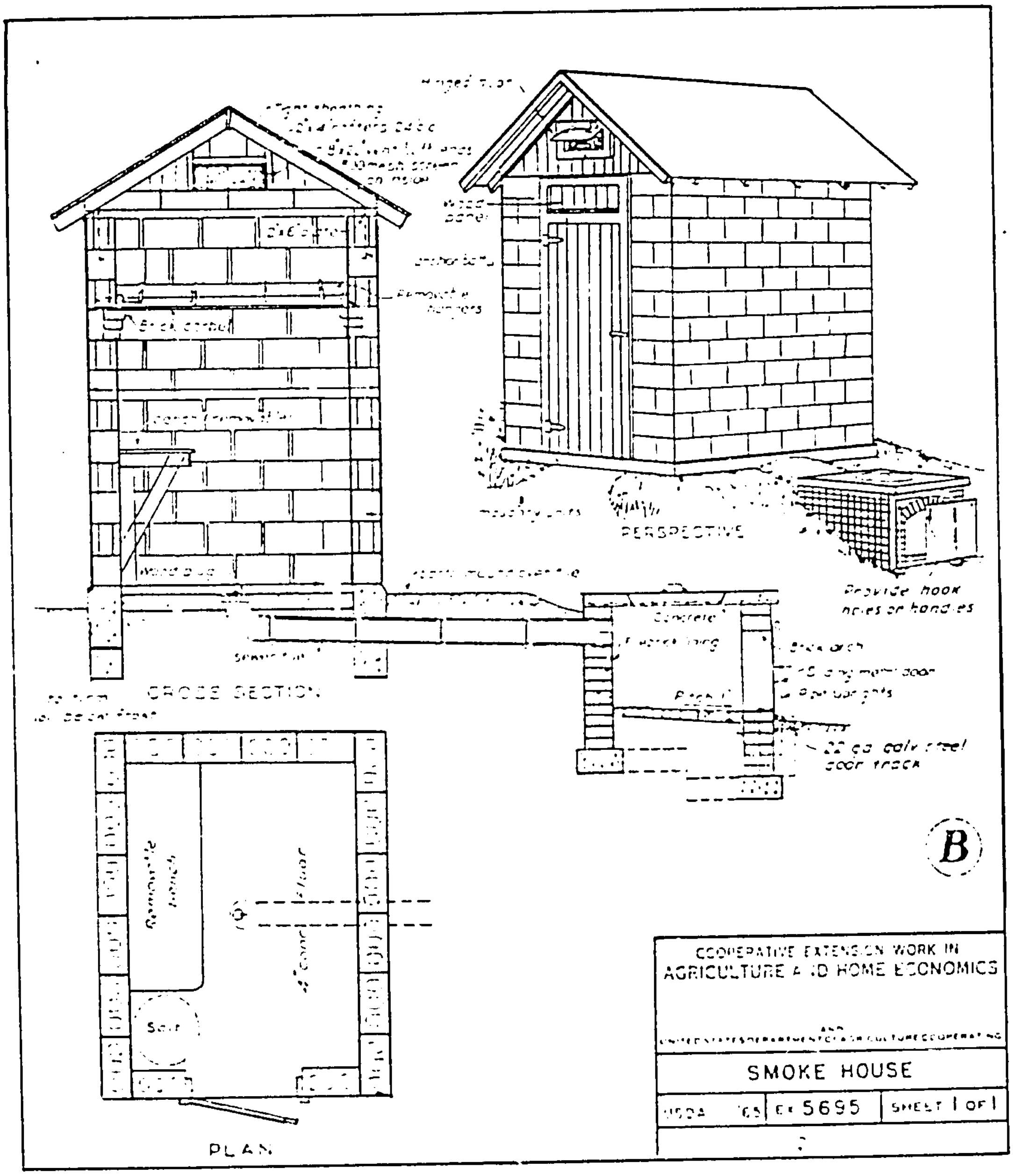
Technoserve might be interested in promoting this technology in the Winnebah district of Northern Ghana. Another possibility to be explored would be Cameroon, where technical assistance is being provided by Auburn State University to the Peace Corp on fish processing projects. In addition, Laos and areas in northeast Thailand may be appropriate to introduce this technology, since these areas rely heavily on smoked fish as the primary protein and are also wood shortage areas (Van Esterik 1989; Bennet 1989).

For general conditions of transfer see page 38. Specific conditions for transfer of this technology include:

1. An area where fresh fish is plentiful and is dried for storage.
2. An area where women spend time in gathering fuelwood and smoking fish for home consumption and perceive these tasks as time or energy consuming.

FIGURE 11

SMOKEHOUSE WITH DETACHED FIREBOX



Drawing courtesy of USDA/VPI.

Stoves

A large amount of effort has been devoted to the development of fuel efficient stoves, and a large number of varieties exist. Four stoves have been selected for this report: The Improved Three-Stone Hearth represents an approach which has the advantage that it can be built in rural areas from locally available materials at virtually no cost. The stove does, however, require considerable maintenance. As an example of such a stove, a model developed by the Peace Corps in Togo is described.

The Jiko and the LESO cookstove, described below, have been selected as good examples of stoves which are durable and have been successfully introduced. At the same time, they do require an expenditure by the household (US $5 to US $10). As a result, introduction to date has been mainly in urban areas where the woman must pay for fuel and can clearly see the advantage of purchasing the stove as a way of reducing this outlay. In rural areas, however, where time rather than money is involved, the use of these stoves may require a special educational effort or a subsidy. A further possibility might be to introduce a low-cost loan program as a way of stimulating use of such stoves.

The Jiko has been successfully introduced on a large scale in Kenya and is now also being used in other East African countries. The LESO stove has been introduced in Mali. The Jiko was designed for use with charcoal and the LESO for wood.

A fourth type, the solar box cooker was selected as representing a completely different fuelless approach.

As previously discussed, time to gather wood for fuel varies greatly. To provide a rough estimate of the time which might be saved by introducing an efficient stove, we first sought to consider what would be the range of time required to gather fuel where fuel wood is quite scarce. For the five African countries listed in Table 4, Section 2.0, the high range for time spent per week in gathering fuel is respectively, 7, 14, 10, 10, and 21 hours. From this set of ranges we have taken a range of six to ten hours as reasonable for conditions where there is a serious fuelwood problem.

Second, reports of fuel conservation by efficient stoves indicates that a one-third reduction in the amount of fuel consumed in comparison to an unshielded open hearth would not be unreasonable (Jamison and Bolander 1987; VITA 1980). If, accordingly, a one-third reduction is used, the total time for gathering fuel wood would be reduced from six to ten hours per week in fuel scarce areas to four to seven hours, or a saving of about two to three hours a week. (Under very severe conditions, even greater savings might be expected, such as five hours or more [Wheeler 1989].)

4.13 Improved Three-Stone Hearth

4.13.1 Technology

The example of the improved three-stone hearth which we have selected was developed by Barry Wheeler, Peace Corps, Togo. Fuel efficiency is said to have been considerably improved by laying up a mixture of mud and sand (in some locations portland cement is added for strength) around a traditional three-stone hearth. A cast iron pot is seated in the wet mud mixture, and mud is laid up to meet the maximum diameter of the pot. The pot is rotated about its vertical axis to form a very close fit of the pot to the stove. There is no clearance between the pot and the stove, except of course at the front. This open front circle is said to represent a dramatic improvement in fuel conservation over the three-stone hearth, shielded or unshielded.

When completed, the stove has a front fuelwood-loading opening which is usually set facing the prevailing breezes. This opening represents perhaps 18 to 20 percent of the circumference of the stove. It is through this opening that fuelwood is loaded, combustion air enters, and smoke and combustion gasses escape. The stove is so designed to limit heat loss. After a period of time, fuelwood combustion heats the mass of the stove and heat transfer from the stove mass to the pot begins. The pot is, of course, initially heated by convection and radiation of burning fuelwood.

Fuelwood savings for the Togo model are said to be 33 to 50 percent, although no data were available. Fuelwood economy of 27 percent was reported for an improved three-stone hearth in Burkina Faso, but details of construction were not given (Kabore, 1989). Much more data are available in Jamison and Bolander (1987), which show dramatic improvements in efficiency of a variety of improved stoves, including those based on the three-stone hearth.

There are a large number of "improved" stoves based on the three-stone hearth. These are generally known as three hump stoves, and consist of three stones with mud-sand (and sometines portland cement) mixtures laid up to provide a wind break, heat reflection, and to add mass to the stove. The evolution of the Togo stove continues, with the addition of vent holes opposite the fuelwood loading hole provided for improved draught. At this stage installation of such improved stoves indoors is not necessarily recommended. A fair amount of maintenance is necessary (adding a wash of mud as the surface cracks and deteriorates because mud, sand, and portland cement are not good refactory materials) (Wheeler 1989.) See Figure 12 for an illustration of the stove.

4.13.2 Application

About 12,000 stoves have been built in Togo where the government's extension service has been active in promoting this apporach. Other countries which may be candidates include Niger (Dojondoutchi and the Tillabry area), the eastern region of Senegal, Mauritania, Northern Ghana, Mali, Burkina Faso, and Benin (Wheeler 1989).

General conditions for transfer of this technology are listed on page 38, a specific condition is an area where women perceive fuelwood collection a problem.

FIGURE 12

IMPROVED THREE-STONE HEARTH

Photograph courtesy of Peace Corps.

4.14 Jiko Cookstove

4.14.1 Technology

Based on bucket stoves in use in Thailand, this stove was designed by Energy Development International (EDI) in Nairobi, with support provided by the U.S. Agency for International Development. Promoted heavily, the stove has gained considerably wide use in Kenya.

The sheet steel body contains a ceramic liner having a perforated bottom to act as a grate (see Figure 13). Intended for charcoal, the efficiency is rated at 30 percent. Testing was carried out by ITDG, Rugby. (Kinyanjui 1983). Some difficulties with liner life were experienced, as these were built-up by hand and the clay was not selected scientifically. These were identified as clay composition and fabrication quality control failures. Inprovements in clay composition, jiggering for uniform dimensions, and firing temperature control are said to have produced a superior product. A heavily capitalized project has been set up in Nairobi to put into practice the latest improvements. (Allen 1989b.) In 1987, the retail price of the Jiko in Nairobi was about US $4 (ITDG 1984).

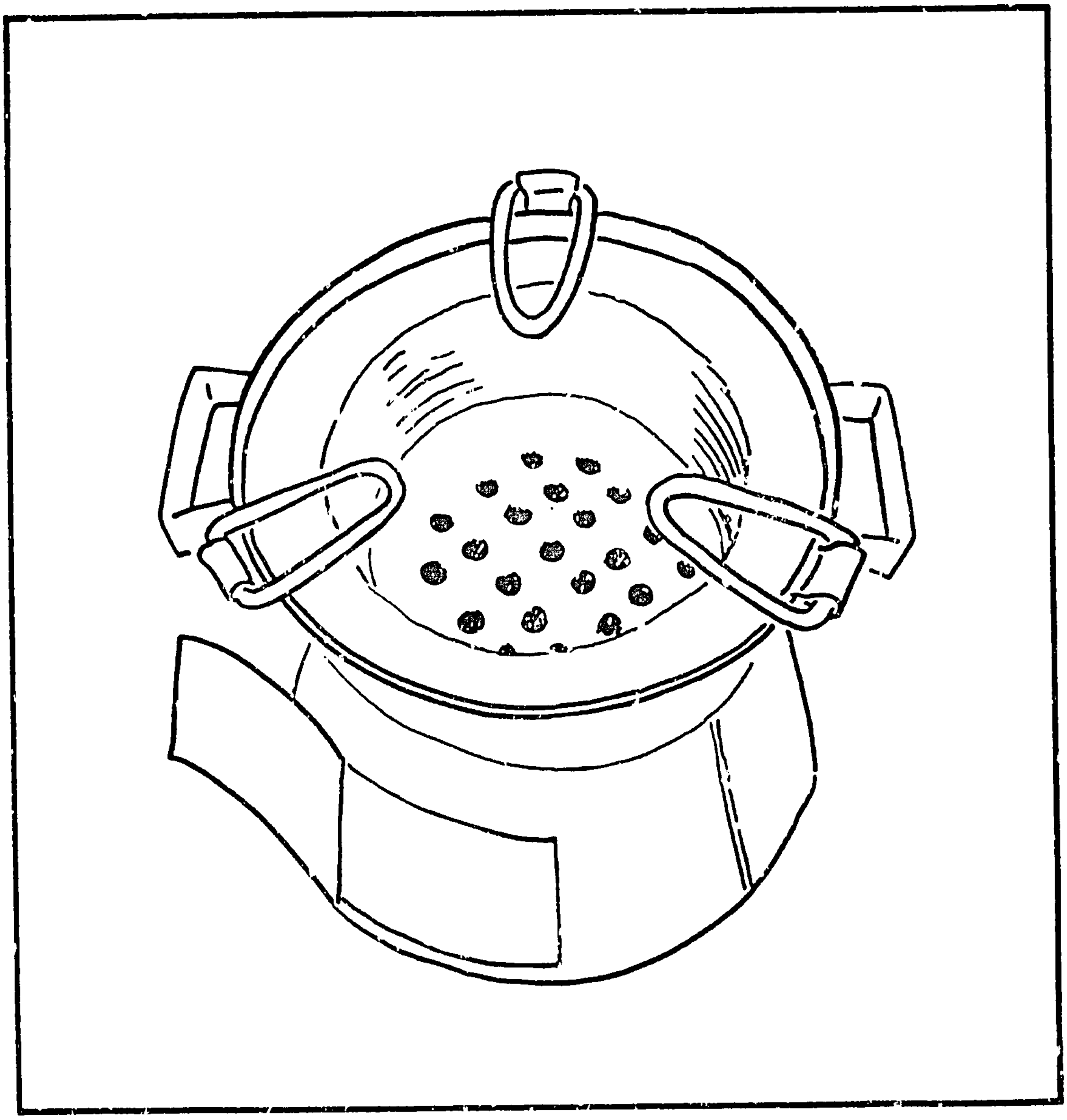
As noted, the stove has been introduced widely in Kenya, other areas of East Africa, and Haiti.

4.11.2 Application

In addition to general conditions (see page 38), the following specific conditions need to be verified by site visit prior to introduction of this technology:

FIGURE 13

JIKO COOKSTOVE



Drawing courtesy of International Women's Tribune Center/Intermediate Technology Group; Grace Young, artist--Tech and Tools Book.

1. An area where charcoal is widely used as cooking fuel.

2. An area where procuring of fuel is perceived by women as a significant problem.

3. An area where women have some disposable income--such that there seems a reasonable chance that they are able to, or likely to, pay for the cookstove.

4. An area where there is an in-country capability to locally manufacture the cookstove, particularly the capability and materials to produce the ceramic liners.

4.15 LESO Cookstove

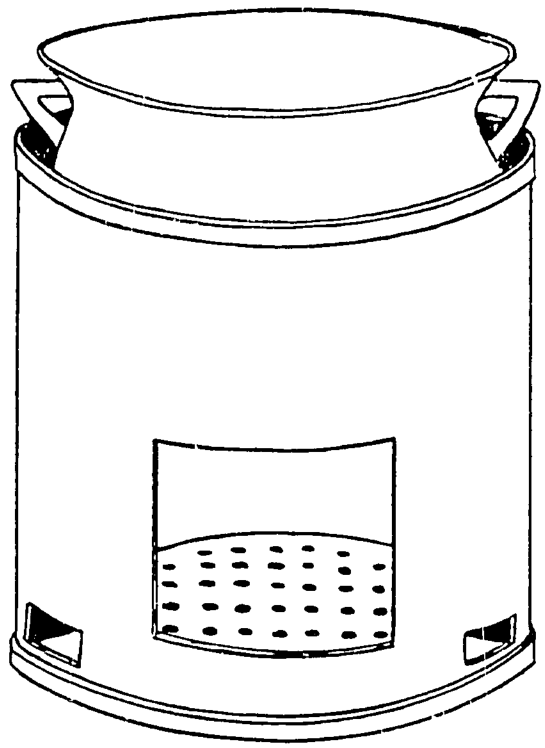
4.15.1 Technology

The Laboratoire d'Energie Solaire (LESO) of Mali developed this stove. Promotion was developed by VITA. The UNFM (Union Nationale des Femmes du Mali) endorsed and proclaimed the stove the standard for all of Mali. The stove consists of a sheet steel cylinder, pot supports, and a metal grate (see Figure 14). Manufacture of this stove by unskilled persons with supervision can be capitalized for less than US $500 (tools, fixtures, and templates).

The stove depends very heavily on close tolerances between the inside stove wall and the pot wall to achieve 30 percent efficiency of fuel wood consumption. Not only must the gap be tailored to the pot size, but the pot must be centered in the opening. As much as a 10 to 15 percent efficiency loss can occur if the pot is not centered. Therefore, the pot size must be matched to the stove, and workmanship must be of a high order. If more than one pot is required, then another stove must be

FIGURE 14

LESO COOKSTOVE



Drawing courtesy of VITA.

purchased. Consumers in Mali were already used to standardized pot sizes. Fuel savings are said to pay back the price of the stove in two months. (Charette 1987.)

Pot sizes and stove prices follow:

Pot Number	Pot Diameter (inches)	Retail Price Range	
		CFA F.	US$
1 - 4	8 - 12	1500 - 2650	$5 - $8
5 - 8	13 - 15	2900 - 3800	$9 - $12
10	17	5259	$16

Fuel wood consumption is said to be reduced by 35 percent and cooking time reduced 45 percent. Significant reduction of smoke is reported by users. (VITA 1988.)

The stove has been introduced through a pilot project in Mali.

4.15.2 Application

The LESO stove should be applicable in many areas where fuelwood is scarce. The town of Sokode in Togo is an example of a specific site where it might be considered for introduction. Here, CRS is interested in expanding current work with local artisans and might be interested in encouraging manufacture of the cookstove, as well as working with women in this community to introduce and promote it. In addition to areas in Africa, the LESO stove may be appropriate for introduction in rice-cooking southeast Asia (Bennett 1989).

General conditions for introduction are listed on page 38. Specific conditions that need to be verified by site visit prior to introduction include:

1. An area where women perceive the collection of fuelwood a problem or the purchase price of fuelwood too expensive.

2. An area where women have some disposable income--such that there seems a reasonable chance that they are able to, or likely to, pay for the cookstove.

4.16 Solar Box Cooker

4.16.1 Technology

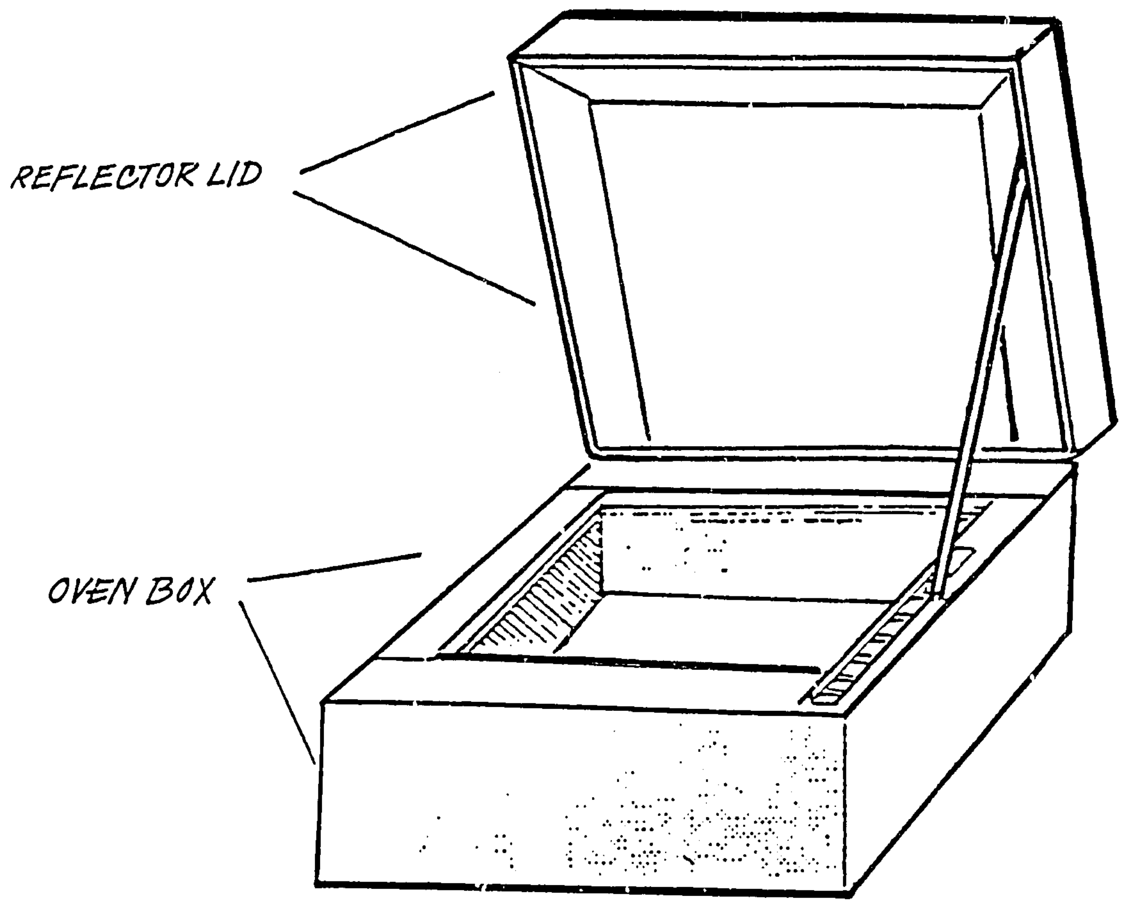
This device is an insulated box lined with a reflective material such as aluminum foil. It has a glass lid (see Figure 15). A reflective panel which can reflect sunlight into the box is hinged on the outside. To use, the box is oriented for maximum solar exposure and the panel is adjusted for maximum reflection into the box. The foods to be cooked, parched, or dried, or water to be pasteurized, are then loaded into the box in tightly lidded containers. The absorbed thermal energy can raise the internal temperature of the box to as high as 300 degrees F.

Constructed from kits available from a California firm, the cost is $50. The cooker can be made in the U.S. for $20 when constructed from local materials. In a developing country setting, the glass window of the cover, which costs about $7 in the U.S., would probably represent the largest cost. Credit mechanisms, and other incentives, might be considered to encourage use of the cookers.

The device can be used in countries having a large number of cloudless days in the lattitudes between 25 degrees North and South. The cooker would serve as a complement to a fuel-using

FIGURE 15

SOLAR BOX COOKER



Drawing courtesy of USDA/OICD.

stove, since some cooking would be conducted at hours such as in the evening, when there would be no sunlight.

It appears that this device should find broad acceptance as a means for free-of-fuel cost cooking. It should perform well for rice parching, for example. (Higgins 1985). In addition, because the stove is both fuel-free and requires almost no tending, it may provide a special incentive for the boiling of drinking water along with the cooking of foods.

The cooker has been introduced as a pilot project in Guatelmala and is currently being tested in Sierra Leone.

4.13.2 Application

Africare is interested in considering the solar box cooker for promotion in Niger and Mali, where they are currently implementing projects and where wood is very scarce. Technoserve also believes that the cooker would be helpful to women in Niger and thinks the Church World Service, which is working there, might be interested in helping local women's groups promote the cooker.

Specific conditions that need to be verified by site visit prior to introduction of this technology include:

1. An area where there is sufficient sun to heat the cooker.

2. An area where women perceive the collection of fuelwood a problem or the purchase price of cooking fuel as too expensive.

3. An area where women have some disposable income--such that there seems a reasonable chance that they are able to, or likely to, pay for the solar stove. Or alternatively, or in addition, an area where it may be feasible to put special credit mechanisms or

other incentives in place to encourage use of the cooker.

4.17 Technique to Overcome Hard to Cook Phenomena in Beans

4.17.1 Technique

Beans cannot be consumed raw due to the presence of antinutritional factors of various kinds. Raw beans cannot be stored unless they dry thoroughly on the vine. Dried beans, depending on the duration of time in storage, are more or less difficult to cook; that is, they require a long cooking period in order to attain the degree of tenderness which is found to be organoleptically acceptable.

Since beans and related legume grains are a major source of protein in the diets in developing countries, various avenues of research have been followed to find a solution to the problem. Reducing cooking time, in addition to the obvious fuel savings and the saving of time, also has another benefit, namely increased nutritive value, as excessive heat (roasting) or prolonged heating (long cooking) apparently reduce the nutritive value of grain legumes. (Pushpamma 1975).

In Andhra Pradesh, India, other legumes absorb as many as 28 hours of time in pretreatments (soaking, drying, roasting, or other treatments) prior to cooking with the concommitant attention and labor of women. (Pushpamma 1983). A study of the comparative use and cooking methods in Burkina Faso, Burundi, and Sierra Leone found that up to 13 hours were expended in preparation and cooking, while 5 to 6 hours were expended in the Dominican Republic and Paraguay. Lack of knowledge was found to be the reason for the failure to use additives (potash, soda, salt) which could hasten the cooking process. (Moen 1987.)

Yam Bean

Research has shown that it is not sufficient to only soak the beans in water for long periods. It is still necessary for certain components in the structure of the beans to be broken down by heat or by a combination of heat and some chemical reaction before the beans attain sufficient tenderness to be acceptable. Work done on the African yam bean showed that a 12 hour soaking in 1 percent potash or a 4 percent salt solution reduced the cooking time by 50 percent with the concommitant savings in time of attending the pot and in presumed fuel savings. (Njoku, H.O. et al. 1989.)

Chickpea

The chickpea accounts for about 13 percent of world production of all pulses. Twenty-seven developing countries produce nearly 10 million tonnes of chickpeas. The total tonnage of chickpea production is doubtless under-reported as this crop is much intercropped and rarely sees its way to export. Therefore, the crop is far more important as a subsistence crop than as a cash crop. (FAO 1982). The simple expedient of soaking for two to three hours will reduce cooking time from 260 minutes to 25 to 30 minutes.

Aside from India and Pakistan, the chickpea is consumed in relatively large quantities in Afganistan, Chile, Ethiopia, Iran, Iraq, Mexico, Nepal, Peru, Spain, Sudan, Egypt, Syria, Lebanon, Jordan, Algeria, Tunisia, Turkey, and the USA and Canada. (Pushpamma, 1987)

As noted in the examples above, cooking time of legumes and pulses can be reduced very substantially by soaking in water to which a small amount of potash and salt has been added. These are substances which are readily available to households. A solution with 1 percent potash and 4 percent salt was found effective. And cooking time of beans which were soaked for 12 hours, have been reduced by 50 percent. This technique, therefore, has the potential of saving substantial time and labor in gathering fuel for cooking, as well as in tending the cooking process.

4.17.2 Application

This technique can save time for women throughout the world who prepare legumes for household consumption. Among the areas where this technique may be appropropriate may also be South Asia, particularly in Thailand where women are very innovative (Bennett 1989), and Honduras, El Salvador, Peru, and Bolivia--areas where beans are widely consumed and require long cooking times (DeWalt 1988).

In addition to the general conditions listed on page 38, a specific condition which should be verified by site visit prior to introduction of this technology would be where legumes and pulses are eaten in fairly significant quantity.

4.18 Additional Technologies

In the remaining sections, additional technologies and approaches are summarized. These do not fall squarely within the objectives of this study, but may be of interest. The first falls under the large area of food preservation, as opposed to food processing and preparation, but does appear to have significant time saving potential. Two fall in the area of village level "convenience foods." And a final technology addresses the fetching of water. Techniques for providing water are, for the most part, outside this report's focus on food processing and preparation. However, a brief discussion of the problem of fetching water has been included, together with an example of one household type of technology which addresses this problem, water catchment.

4.18.1 Food Preservation--Concrete Threshing Floor

Considerable attention is paid to finding suitable flat rock surfaces, roof tops, and paved areas to spread grains and other foods for threshing, parching, and drying. And considerable time is spent in transit to and from such choice locations when remote from homes. Construction from portland cement, aggregate, and sand is often too dear for such a simple structure, but soil stabilized with cement might prove to bring into the realm of affordability a conveniently located threshing-drying floor.

Site selection and preparation are the most critical tasks and would require expert consultation. Testing the soil for clay content (easily done with appropriate samples, water, a jar, and a metric scale) is the next most important job. Soils containing less than about 10 percent clay are suitable for stabilization with portland cement. (MINVA 1980.) A threshing-drying floor about two inches (5 cm) thick and with the surface scored at one or 1.5 m intervals would be able to stand weathering for some years. A soil-cement of 1:10 portland cement to soil ratio would provide adequate stability for threshing and drying. It would not withstand vehicle traffic or very heavy static loads, such as large grain bins. It would not likely be a suitable surface for supporting machinery, such as grain grinders or winnowers. (Lola 1989.)

4.18.2 Convenience Food--Sori

Developed at the Cereal Quality Laboratory, Texas A&M University, and field tested at the Institute of Rural Economy, Sotuba, Mali, sori is a parboiled, hulled sorghum product. The intention was to produce a "convenience food"--that is, a ready to cook sorghum product with a long shelf-life for use in sorghum dishes or as a boiled rice substitute. As the product is already decorticated, preparation time is nil. In all varieties tested, the cooking time was reduced. Consumer acceptance was outstanding for flavor and texture.

The process, easily adapted for small scale production, involves either soaking overnight followed by boiling, drying, and abrasive decortication, or boiling, soaking overnight, boiling again, and drying and abrasive decortication. Both treatments resulted in higher yields following dehulling. The process also results in a lighter colored product regardless of whether the highly pigmented sorghums are used or not. More cost effective processing processes are now being researched. (Rooney 1989.)

4.18.3 Yam Flour

Introduction of a new product with higher nutritional value than commonly consumed yam varieties is exemplified by the work of Martin, et al. in the Cameroon. African yam has a yield in ordinary soils of three to seven times that of common varieties, higher nutritional value in protein and minerals, and more digestible starch. Post harvest stability is not very good in that the tubers harden within a few days post-harvest and become inedible. Therefore, the roots must be promptly processed.

A simple method of sun-drying cooked slices followed by grinding the chips into flour provided an enriched porridge and fufu with very high acceptance level in four villages. After demonstration of processing and preparation to volunteers in 25 households, consumption frequency was followed for 12 weeks. All but three households ate the yam flour regularly, and would substitute the flour for others if available, especially for infant feeding. (Martin 1984.)

4.18.4 Water Catchment

Water is essential to the processing, preparation, and cooking of food. A typical family of five needs approximately forty liters of water every day for cooking and drinking. For the vast majority of rural women in Africa, Asia, and Latin America, water must be fetched from a steam, river, or well, generally by women and children. The availability of reliable sources of water is a problem for many of these women, particularly in areas where there are distinct wet and dry seasons.

Fetching water can be an arduous task. Many women use large containers to carry water in an effort to save time travelling to and from the source. In addition, in some areas women must travel long distances to fetch water, particularly during the dry season when nearby streams or other water sources dry up.

Where water is more readily available, fetching can be more energy than time consuming. For example, in five villages that were surveyed in Mali (Koenig 1986), the average time people spent fetching water ranged from 15 minutes to almost 45 minutes. Because people did not spend inordinate amounts of time fetching, this means that water was fairly accessible in all of the villages. However, the task of just getting water out of the wells was formidable: 75 kilograms of water (165 pounds) had to be lifted an average distance of ten meters.

Collection of rainwater in containers is a simple technology which can be used by a household or extended family to help overcome the problem of fetching water. In sub-desert areas (such as Mali and Botswana) or areas of low rainfall (such as northeast Thailand), rainwater collection could play a substantial role in alleviating women's labor. Even if potable water is available at stand pipes, rainwater could be used for irrigation or washing, thus relieving the pressure on the potable water supply.

Above-ground rainwater catchment for roof run-off in ferro-cement containers is the topic of considerable research in several areas of the semi-arid Tropics. A substantial body of information is maintained at the Ferro-cement Information Center at the AIT in Bangkok. Detailed drawings of a variety of storage tanks, made from a variety of materials (corrugated iron, ferro-cement, reinforced brick, PVC foil) have been prepared by GATE. (Hasse 1989.)

Bamboo-reinforced water tanks of 11,300 liters capacity have been successfully used by extended families in northeast Thailand since 1979. From 1979 to 1984, more than 7,000 tanks were constructed; an additional 7,500 to 10,000 tanks were planned to be built by 1987. As many as 200,000 people were expected to be provided with sanitary drinking water by 1989. Fabricated of portland cement and reinforced by bamboo strips, these very large jars are constructed by specially trained technicians on reusable wooden supporting forms. Although the tanks are quite massive, they can be transported if adequate lifting equipment and hauling devices are available.

5.0 NEXT STEPS

In the foregoing pages we have sought to identify technologies which have the potential to address major time and effort constraints and to give some suggestions as to where they might be transferred and how this might be done. We believe this information, and the experience acquired in obtaining it, provides a useful basis for next steps. This final section will offer some ideas as to what those next steps might and suggest a possible course of action.

One possibility would be to proceed directly with further exploration of the sites identified with a view to transferring the technologies listed. While this is certainly a possibility, we think it would be better to treat identification of these sites as providing a feel for transfer possibilities, but to consider transfer to these sites within the context of some broader approaches outlined below. We believe this is the preferred course, in part because in this short study it has been feasible to identify only a few of the many possible opportunities for introduction and to do so in only a preliminary manner. More importantly, we believe there is an approach, which we will recommend, which will have higher pay off in terms of Office of Nutrition goals.

We will review below three basic approaches: a problem oriented approach, an approach emphasizing targets of opportunity, and, finally, an integrated approach, the one which is recommended. (It should also be noted that these approaches are, of course, not mutually exclusive.)

5.1 Problem Oriented Approach

This approach would consist of a series of steps along the following lines: First, one or two of the traditional food processing or preparation tasks demanding particularly heavy expenditures of time and effort by women would be selected. For example, one of these problems might be the processing of sorghum and millet. The problem selected would be both an important one and one where the amount of attention already being devoted to a solution was not already very high.

The next step would be to seek to develop a model of what could be done to alleviate the problem through a coordinated approach. A country, or several candidate countries, or large regions, would then be tentatively selected as candidates for the demonstration. Selection of a country would start with the problem, but would also be based on size of the population which might be helped by introduction of the technology and, of course, by the likelihood of an adequate fit between the technology and the various factors needed for successful introduction and sustainability. Indication of likely host country interest in participating in an effort to alleviate the problem would, of course be one of these factors.

Following tentative selection of some candidates for demonstration, organizations with the potential capability to introduce the technology would be identified. These could be U.S. PVOs which had local offices in the country or had ties with counterpart groups. In addition to PVOs, other organizations could be identified, such as, for example, the U.N. Development Fund for Women (UNIFEM). The groups selected would, ideally, consist of several organizations which appeared to have an interest. Alternatively, it is recognized that there might be only one group which would have real interest.

The Office of Nutrition might then meet with the organizations identified to discuss the possibility of developing an integrated approach aimed at having a substantial impact on the country or large region. The various players could discuss their roles and what they would perceive as their needs in order to mount such an effort. For example, one might envisage one or two PVOs which had in-country field staffs, requiring technical assistance to undertake a detailed needs assessment or to introduce the technology. In addition, it might be necessary to identify financing for women's cooperatives. And perhaps the AID Private Enterprise Bureau, through its revolving loan fund for commercial institutions, could help here. At another level, assistance might be needed to develop an in-country capability to manufacture the technology. An input, here, might be made by Appropriate Technology International (ATI), with perhaps assistance, also, from the AID Office of Rural Development with which ATI works.

The role of the Office of Nutrition in this planning process would be two-fold. One function would be to suggest a coordinated approach and to seek to bring together the various actors needed to effect such an approach. The other would be to offer inputs as one participant in the approach, such as funding a needs assessment or helping to provide technical assistance for introduction of the technology.

Once a tentative coordinated approach had been discussed, the next step would be for a development team to visit the countries selected as possible candidates in order to select a country, or large region, and to discuss a preliminary implementation plan with the AID Mission.

As a possible next step, one might envisage an in-country workshop where representatives of the various groups could meet with host government, local non-government organization, and AID Mission personnel to develop an integrated stategy in more detail.

The final step would be to develop a detailed implementation plan through further site visits and close collaboration with local personnel.

The overall objective would be to see if, by pulling together a set of inputs, one could make a truly significant impact on a fairly large population which faced a serious time and effort problem. Such an approach might then serve as a demonstration for others to follow.

5.2 Targets of Opportunity

The objective, here, would be to see where the Office of Nutrition could be most helpful in tying in with specific interests or activities of other groups in order to promote the transfer of time and laborsaving technology. This approach might well be combined with the above, but would emphasize starting with some readily identifiable needs of organizations engaged in development work, more than it would with general problems. A number of examples follow:

1. The Office of Nutrition could identify a large and active PVO and ask that organization to send a description of promising technologies to its field offices to determine their interest in developing programs which would use one or more of the technologies. As part of such an approach, it would be helpful if the Office of Nutrition could offer to participate to some extent in the implementation of such initiatives as were identified, such as by providing some technical assistance.

A variation of the above is a specific suggestion made to us by the CRS officer responsible for micro-enterprise development. He is developing a program in Togo for village smiths and other artisans to manufacture implements for sale. He expressed interest in the possibility of encouraging these individuals to produce a low-cost fuel efficient stove. In Senegal, the focus is on village level micro-enterprise. One or more of the technologies we have identified might be incorporated into this activity. We discussed the idea of a demonstration effort which might have three participants: CRS could provide the community based introduction which might include women's coops. The Office of Nutrition could provide technical assistance for introduction of the technology. Appropriate Technology International could furnish assistance for establishment of a local facility to manufacture the technology, with aid, if needed, from the AID Office of Rural Development. The combined effort could represent a cooperative undertaking which other PVOs and other development organizations might emulate.

2. The above example refers to work with an organization which is strong on community operarations, but which is not specializing in technology introduction. A second alternative would be to explore how the Office of Nutrition might work with an organization which is active in the technology transfer area. Two examples follow:

a. UNIFEM has identified promising technologies and is working on their dissemination, primarily in Africa. One of the key bottlenecks they have encountered in their work is lack of adequately trained extension personnel to disseminate information on the technolgies and train women in their use. These extension workers typically are charged with duties in other areas in addition to technology, such as nutrition. Perhaps, AID could in some way coordinate some of its ongoing activity in the training of workers in the health and nutrition areas so as to incorporate an appropriate technology component in areas where UNIFEM is working.

(UNIFEM has been very helpful in sharing some of their experience with us. Appendix E--Requests Received by UNIFEM for Food Processing Technologies--provides a chart of requests which they have received. UNIFEM offered to prepare this chart in response to our query as to where there are needs for expanded introduction of laborsaving technologies. The chart provides some useful additional insight into the types of need which exist.)

b. Technoserv is active in a number of countries in Africa. Their work includes development of women owned cooperatives for maize production in Ghana. Their Africa program officer expressed interest in possibly incorporating into this project use of one of the technologies we identified, the TPI hand held maize sheller. He also expressed some interest in using the PRL sorghum dehuller in a region of Ghana where sorghum is consumed. The Office of Nutrition could provide information to Technoserv on these technlogies and, if needed, assist them in simple trials.

3. On the front line of much of the technology transfer work are in-country appropriate technology organizations. Work with these organizations would be a part of many of the suggestions made above. In addition, however, one might envisage an effort directed more particularly toward this group. Some of the leading overseas organizations could be visited and ways by which the Office of Nutrition could assist them could be explored.

4. There may be a role for promoting greater information dissemination. It was of interest to us that as experienced an organization as Technoserv was not aware of some of the technologies which we have identified.

In addition to disseminating information to U.S. organizations, in-country workshops might be held to help one or more U.S., or local organizations, to disseminate information on technologies they have tested.

5.3 Integrated Approach

This approach might draw in part from the other two, but would most sharply focus on the Office of Nutrition's ultimate objective. The purpose would be to demonstrate that introduction of laborsaving technology can have a direct impact on improvement of nutrition and child care. (McGuire and Popkin 1989.) To accomplish this end, a pilot project could be implemented which would consist of the following steps:

1. A group of women would be selected where one of the desired aims was to influence feeding and other child care practices.

2. An analysis would then be undertaken to determine the totality of pressures and constraints operating on these women which would make it more difficult for them to implement a child care message. This analysis would presumably include lack of time and energy due to food processing or preparation burdens. (Selection of the group should, in part, be based on this being the case.)

The analysis would further seek to indentify a specific food processing tasks, or tasks, which could be alleviated by a culturally appropriate, affordable technology. (Again, a group could be selected where it was believed likely that a substantial burden could be alleviated by such an approach.)

3. The group of women would be subdivided into two subgroups. The first group, the control, would be provided education to modify one or two specific child care practices. The second group would be given the identical nutrition education. But, in addition, this group would be provided access to the technology which had been identified as appropriate to relieve the time burdens identified. (If necessary, seperate pre-trials could be run on a small third group to ensure that the technology offered would likely be accepted and would reduce time and energy, so that the effect of this input in the test would not be in serious question.)

4. The two interventions, nutrition education, and nutrition education with technology, would be implemented. Then the resulting changes in child care behavior would be evaluated and compared. (If possible, change in children,s nutritional status could, also, be measured and compared.)

5. Assuming the results were positive, the findings from this project could be disseminated widely. And efforts could be made to incorporate a technology dimension into nutrition and health behavior change interventions through a variety of approaches, including the encouragement of larger scale AID Mission projects.

5.4 Recommendation

The third option, the integrated approach, is recommended as preferred for several reasons:

1. It would most directly accomplish the goal of using

technology to alleviate women's burdens as a means of enabling improved nutrition practices.

2. It would break new ground by showing that this approach could make a substantial contribution to improving the effectiveness of nutrition/health behavior change interventions.

3. This approach would be new and, therefore, for a given level of effort, the Office of Nutrition's contribution would be maximized. This seems particulary important in the appropriate technology field where there are already a large number of actors.

4. There is always the possibility that alleviation of women's burdens through technology, as important as this is as a development objective, would only have marginal impact on nutrition and health care practices, if such technology were introduced in isolation. But, if laborsaving technology were introduced in conjunction with nutrition education, there is the possibility that there might be a strong synergistic effect. Offering the technology might make the woman more open to the education, and providing the education might encourage optimal use of the time freed up.

Appendix F--Implementation of Recommended Trial--provides a brief discussion of the steps, duration, and cost which might be required to implement the trial proposed.

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LABOR-SAVING TECHNOLOGY CRITERIA

The purpose of this form is to help identify home and village level technologies which substantially reduce the time that women spend on food processing and preparation in the developing world and which can be replicated across cultural settings.

TECHNOLOGY

Name of Device:____________________

Summary Description:____________________

____

____

SOURCE

Name of Organization:____________________

Address:____________________

Telephone:__________ Telex:__________

Contact Person(s):____________________

IMPLEMENTATION

___Not introduced--->potential areas:____________________

___Pilot introduction--->where:____________________

___Large-scale introduction--->where:____________________

CRITERIA

(CODE: 1=fair 2=good 3=very good X=don't know)

Impact

- Saves significant time 1 2 3 X

  Comments (specify quantity if known):____________________

  ____

- Saves significant effort 1 2 3 X

  Comments (specify if known):____________________

  ____

- Meets need of large area or region 1 2 3 X

  Comments:____________________

  ____

CRITERIA (continued)

(CODE: 1=fair 2=good 3=very good X=don't know)

- Maintains nutritional integrity of food YES NO DON'T KNOW

  Comments:____

- Maintains taste, texture, color of food YES NO DON'T KNOW

  Comments:____

<u>Viability</u>

(Demand)

- Affordable at the home or village level 1 2 3 X

  Comments (specify cost if known):____________________________

- Culturally acceptable to users YES NO DON'T KNOW

  Comments:____

- Meets needs as perceived by users 1 2 3 X

  Comments:____

(Supply)

- Profitable to potential manufacturers and other similar relevant factors YES NO DON'T KNOW

  Comments:____

(Other)

- Durability 1 2 3 X

  Comments:____

CRITERIA (continued)

- Ease of maintenance 1 2 3 X

  Comments:____

  ____

(CODE: 1=high level 2=intermediate level 3=basic level)

<u>Ease of Introduction</u>

- User training required 1 2 3

  Comments:____

  ____

- Level of infrastructure required for training 1 2 3

  Comments:____

  ____

- Level of infrastructure required for manufacture and distribution 1 2 3

  Comments:____

  ____

- Level of community organization required 1 2 3

  Comments:____

  ____

For those areas where this technology has been introduced, are there any other factors--other than those covered above--relevant to its successful introduction?

____

____

____

____

____

____

ADDITIONAL INFORMATION

- Are there other areas of the world where this technology might be appropriate and could successfully be introduced?

- How might this technology best be introduced in new areas?

ADDITIONAL COMMENTS:

APPENDIX B

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Texas A&M University
College Station, TX 77843

Kirk Smith
East-West Center
1777 East West Road
Honolulu, Hawaii

Technoserve
148 East Avenue
Norwalk, CN 06851-5721

Peter Reiling

Irene Tinker
EPOC
8120 Woodmont Avenue
Bethesda, MD 20814

UNICEF
3 United Nations Plaza
New York, NY 10017

UNIFEM (United Nations Development Fund for Women)
304 East 45th Street
New York, NY 10017

Rose Delageot

U.S. Agency for International Development
Washington, DC 20523

Melody Batcha, Office of Rural Development, Science and Technology Bureau

Frank Mertons, Office of Agriculture, Science and Technology Bureau

Norge Jerome, Office of Nutrition, Science and Technology Bureau

Tulane Pulley, Office of Women in Development, Program and Policy Coordination Bureau

Penny Van Esterik
Director of Thai Studies
Department of Anthropology
York University
4700 Keele Street
N. York, Ontario 9M3B8

Volunteers in Technical Assistance
1815 North Lynne Street
Arlington, VA 22209

Margaret Crouch
Steve Hirch
Carl Lindblad

World Bank
1818 H Street, NW
Washington, DC 20006

William Flor, Household Energy Division

Judith McGuire, Population, Health; Nutrition Division

Lynn Bennett, Population, Human Resources; Women in Development Division

APPENDIX C
ADDITIONAL ORGANIZATIONS SURVEYED

agromiga
AGROMISA
Posthus 41
Wageningen
NETHERLANDS
phone: +31.8370.122 17

ahrtag
Appropriate Health Resources and Technologies Action Group
AHRTAG
1 London Bridge Street
London SE1 9SG
UNITED KINGDOM
phone: +44.1.378 14 03
telex: 933524 geonet g
email: geo2:ahrtag

ait-lrdc
Library and Regional Documentation Centres (LERC), Asian Institute of Technology (AIT)
LRDC
AIT
PO Box 2754
Bangkok 10501
THAILAND
phone: +66.2.529 01 00
telex: 84276 ait th
fax: +66.2.529 03 74

apica
Association por la Promotion des Initiatives Communautaires Africaines
APICA
BP 5946
Douala - Akwa
CAMEROON
phone: +237.42 12 28
telex: (0970) 5456 kn

approtec
Asian Alliance of Appropriate Technology Practitioners
APPROTECH ASIA
c/o Philippines Social Development Center
Magallanes cor. Real Streets
Intramuros Manila 1002
PHILIPPINES
phone: +63.2.49 82 23/49 82 42
telex: (ITT) 40404 tx box 1324

aprodech
APRODECH
BP 180
Mbanza-Njunju
Bas Zaire
Zaire

atda
Appropriate Technology Development Association (ATDA)
ATDA
PO Box 311, Gandhi Bhawan
Lucknow- 226 001
INDIA
phone: +91.552.33 506
Cable: APTECH

atol
Study and Documentation Centre on Appropriate Technology in Developing Countries
ATOL
Blijde Inkomststraat 9
B-3000 Leuven
BELGIUM
phone: +32.16.22 45 17
telex: 25715 kulbib (for atol)

ayuda en accion
Ayuda en Accion Ecuador
Ayuda en Accion
Casilla A - 769
Quito
ECUADOR
phone: +593.2.547 682/529 934

base
Programa TA, Investigaciones Sociales Educacion Communicaciones
BASE
Casilla de Correo 1814
Asuncion
PARAGUAY
phone: +595.21.44 78 34

btc
Botswana Technical Information Servic (BTIS), Botswana Technology Centre
Private Bag 0082
Gaborone
BOTSWANA
phone: +267.31.41 61/28 29

Centre for Agricultural
Mechanisation and Rural Technology
The Director General
CAMARTEC
PO Box 764
Arusha, TANZANIA
phone: +255.57.35 94
telex: 42115 (for camartec)

Comision de Coordinacion de
Tecnologia Andina
CCTA
Av. Javier Prado Oeste 595
Lima 17, PERU
phone: +51.14.61 72 53
email: geo2:desco (para ccta)

Centro de Estudios Mesoamericanos
sobre Tecnologias Apropiadas
CEMAT
Apartado Postal 1160
Guatemala Ciudad, GUATEMALA
phone: +502.2.718380/ 762355/ 762018
email: geo2:cemat

Centro Salvadoreno de Technolgia
Apropiada
CESTA
Apdo Postal 3065
San Salvador, EL SALVADOR
phone: +503. .25 67 46

Centro de Estudios en Tecnologia
Apropiada para America Latina
CETAL
Casilla 197 -V
Valparaiso, CHILE
phone: +56.32.68 41 49
telex: 330506 pbrck (para cetal)

CHANGE
PO Box 824
London SE24 9JX
UNITED KINGDOM
phone: +44.1.274 4043

Centre for International
Cooperation and Appropriate
Technology
CICAT
Delft University of Technology
PO Box 5048
2600 GA Delft
NETHERLANDS
phone: +31.15.78 36 12
telex: 38151 butud nl

Centro Internacional de
Mejoramiento de Maiz Y Trigo
International Maize and Wheat
Improvement Center
CIMMYT
Lisboa 27
Apdo. Postal 6-641
06600 Mexico DF, MEXICO
phone: +52.5.761 33 11
telex: 177 20 23 cimme
cable: CENCIMMYT MEXICO

Centro de Ingenieria para
Tecnologia Adecuadas
CITA-EC
Casilla 1024
Cuenca, ECUADOR
phone: +593.4.80 00 85
telex: 8589 kadecu (para cita)

Consortium on Rural Technology
CORT
PO Box 9236
New Delhi - 110 092
INDIA
phone: +91.11.2244545
telex: 3161167 fair in (for Cort)

Collectif d'Echanges pour la
Technologie Appropriee
COTA
18 rue de la Sablonniere
1000 Bruxelles, BELGIUM
phone: +32.2.218 18 96

Centre Regional d'Energie Solaire
CRES
BP 1872
Bamako, MALI
phhone: +..226 791/ 224 676
telex 2532

Centre of Science for the Village
CSV
Magan Sangrahalaya
Wardha 442 001, Maharashtra
INDIA
phone: +91. .2412
cable:GRAMVIGYAN Wardha

Development Alternatives
B-32 Institutional Area
New Mehrauli Road Hauz Khas
New Delhi 110 016, INDIA
phone: +91.11.66 53 70/ 60 58 35
telex: 31 61 735 vc in
emial: geo2:tara

Dian Desa
Jl. Kaliurang Km 7
PO Box 19, Bulaksumur
Yogyakarta, INDONESIA
phone +62.274.86 24 7/ 4022
telex: 25370 txbooth (for dian desa
cable:DIAN DESA

Development Technologies Unit
Faculty of Engineering
University of Melbourne
Parkville, Victoria 3052
AUSTRALIA
phone: +61.3.344 4000
telex: aa35185 unimel
cable: UNIMELB
fax: +61.3.347 1343

Centro de Desarrollo y Promocion
de Tecnologias Apropiadas
ECOTEXTURA
Apartado A-300
Managua, NICARAGUA
phone; +505.2.24 134

enda
Environment. Development et
Action dans le Tiers Monde
ENDA-TM
BP 3370
Dakar, SENEGAL
phone: +221.22 42 29/21 60 27
telex: 456 enda tm sg
Cable:ENDA DAKAR

ENDA America Latina
ENDA-AL
c/o NaCIONES Unidas
AP 091369
Bogota, COLOMBIA
phone: +57.249 78 44/249 46 20
telex: 43316 undevpro

ENDA CARIBE
Apartado 21000, Huacal
Santo Domingo
DOMINICAN REP.
phone: +1.809.566 83 21
telex: 6101 Agemir/0115 unation

ENDA INDIA
c/o Tata Inst. of Social Sciences
PO Box 8313, Deonar
Bombay 400 88 INDIA
phone: + 91.22.52 37 05

ENDA - Maghreb
5 Zenkat Jabir Ibn Hayane
Rabat, MOROCCO

ENDA - Ocean Indien
c/o UNDP
PO Box 253
Port-Louis, MAURITIUS

enda-zimba
ENDA - Zimbabwe
Box MP 83
Mt. Pleasant, Harare
ZIMBABWE
phone: +263.0.70 85 69

ews
Development Workshop,
Entwicklungswerkstatt Salzburg
5411 EWS Oberalm 4431
Salzburg, AUSTRIA
phone: +43.6245.57 38

fakt
Working Group for Contextual
Technology (FAKT)
FAKT
Gansheidestrasse 43
7000 Stuttgart 1
FEDERAL REP. OF GERMANY
phone: +49.711.23 50 30/24 40 62
telex: 721499 (for FAKT)

fase-pta
Programa Tecnologia Apropiada
(PTA), FASE
FASE-PTA
rua Bento Lisboa 58, Catete
22221-Rio de Janeiro-RJ
BRAZIL
phone: +55.21.286 67 97/286 96 41
telex: 3834201 foas

panos
The Panos Institute
8 Alfred Place
London WC1E 7EB
UNITED KINGDOM
phone: +44.631 1590
telex: 9419293 panos g
fax: +44.1.436 8293
email: dialcom 87:cqq267

pcatt
Philippine Center for Appropriate
Technology and Training
PCATT
224 Diego Silang Street
Batangas City 4201
PHILIPPINES
phone: + 63.43.724 16 09
telex: 40003 booth pm

recast
Research Centre for the
Application of Science and
Technology
RECAST
Tribhuvan University
Box 1030 - 138
Kiratipur, Kathmandu
NEPAL
phone: +977.2.14303

semta
Servicos Multiples para
Tecnologias Apropiadas
SEMTA
Casilla 20410
La Paz, BOLIVIA
phone: + . .36 00 42/35 56 74

sibat
Sibol ng Agham at Teknolohiya
(SIBAT) / Spring of Science and
Technology
SIBAT
PO Box 375
Manila, PHILIPPINES
phone: +63.1.40 11 20
cable: sibat manila
email: geo2:access (for sibat)

skat
Swiss Centre for Appropriate
Technology
SKAT
Varnbuelstrasse 14
CH-9000 St Gallen
SWITZERLAND
phone: +41.71.30 25 90
fax: +41.71.228355 (skat)
email: geo2:skat

spatf
South Pacific Appropriate
Technology Foundation
SPATF
PO Box 6937
Boroko
PAPUNA NEW GUINEA
phone: +675. 212498
telex: 44212 ne

tdau
Technology Development and
Advisory Unit
TDAU
University of Zambia
PO Box 32379
Lusaka, ZAMBIA
phone: +260.1.213221x469
cable:UNZA - Lusaka

tool
Technical Development with
Developing Countries
TOOL
Entrepotdok 68a/69a
1018 AD Amsterdam
NETHERLANDS
phone: +31.20.26 44 09
telex: 15080 kit nl (for tool)

verc
Village Education Resource Centre
GPO Box 2281
Dhaka, BANGLADESH
phone: +880.2.310 934
telex: VERC DHAKA

APPENDIX D
SOURCES OF INFORMATION ON RECOMMENDED TECHNOLOGIES

Under each technology, there is listed: first, an organization which is active in introducing the technology and which can serve as a general source of information; second, where applicable, the organization, or organizations, which manufacture or supply the technology and may be able to provide more detailed or technical information.

PRL Dehuller

International Development Research Center
PO 8500
Ottowa
Canada K1G 3H9
TEL: 613/236-6163

ENSIAAC (cole National Superiure des Industries Agro-Alimentaire du Cameroun
BP 544
Ngaounder; Cameroun
Tel: 25-10-21; TELEX: 7645 KN
M. Gerard Fumey, Directeur

Anguh Maize Mill

Appropriate Technology International
1331 H Street NW
Washington, D.C. 20005
202/879-2900

B.A. Anguh Agricultural Tools Mfg.
PO Box 5075
Bamenda-Nkwen
Cameroon
M. B.A. Anguh, Principal.

APICA (Association pour la Promotion des Initiatives Communautaires Africain)
BP 5946
Douala-Akwa
Cameroon
Tel: 42-12-28; TELEX AGRICHIM 5632KN
M. Alain Laffitte, General Secretary.

TDAU (Technology Development and Advisory Unit)
University of Zambia
Lusaka
Zambia
Tel: 22.77.12/13; TELEX: 3282 SG
Prof. J.J.A. Banda.

Hydro-powered Hammer Mill

Appropriate Technology International
1331 H Street NW
Washington, D.C. 20005
202/879-2900

TPI Maize Sheller

Tropical Product Development and Research Institute
Industrial Development Department
Abingdon
Oxfordshire OX14 3DA
United Kingdom

General information on maize shellers:

Intermediate Technology Development Group
Myson House Railway Terrace;
Rugby, CV21 3HT, UK
Tel: 011 44 788 60631.

Overseas Development Natural Resources Institute
56-62 Gray's Inn Road
London WC1X 8LU, UK
Tel: 01 937-8191.

Cassava SIS Grater and Screw Pr

Ross G. Kreamer
Foreign Agriculture Service
U.S. Department of Agriculture
Washington, D.C. 20250

AGRICO
Accra
Ghana

UMN Rice Huller

United Mission to Nepal
Khatmandu
Nepal

General information on rice hulling which may include UMN Huller:

IRRI (International Rice Research Institute)
PO Box 933
Manila
Philippines

WARDA (West African Rice Development Association)
PO Box 1C19
Monrovia, Liberia.

Quinoa Thresher, Cleaner and Polisher

The Pillsbury Company
Research and Development Laboratories
311 Second Street Southeast
Minneapolis, Minn. 55414
Jerry Rabe, Research Manager
Tel:612/330-8262

CeCoCo Chuo Boeki Goshi Kaisha
PO Box 8; Ibaraki
OSAKA
Japan
(0726) 2202441; FAX (0726) 27-9580.

Seedboro Equipment Company
1022 W. Jackson Blvd.
Chicago
IL 60607-2990
312/738-3700.

Bielenberg Oil Press

CARE INC.
660 First Avenue
New York, N.Y. 10016
Micro-enterprise Division
TEL: 212/686-3110

CAMARTECH
PO Box 764
Arusha
Tanzania
Mr. L.L. Kiriama, Director.

Mr. Carl Bielenberg
RFD #1
Marshfield, VT 05658

Groundnut Sheller

Department of Agricultural Engineering
Kansas State University
147 Seaton Hall
Manhattan, KS. 66506-2906
TEL: 913/532-5580

Senafrica
Kano
Nigeria.

Caltech Expeller

Appropriate Technology International
1331 H Street NW
Washington, D.C. 20005
202/879-2900

APICA (Association pour la Promotion des Initiatives Communautaires Africain)
BP 5946
Douala-Akwa
Cameroon
Tel: 42-12-28; TELEX AGRICHIM 5632KN
M. Alain Laffitte, General Secretary.

Shea Butter Extraction Unit

Appropriate Technology International
1331 H Street NW
Washington, D.C. 20005
202/879-2900

CEPAZE (CENTRE D'Eschanges et Promotion des Artisans en Zones a Equiper)
18 Rue de Varenne
75007 Paris
France

M. Bernard Clamagirand, General Delegate
Tel: 544-68-75.

DMA (Division du Mechinisme Agricole)
BP 155; Bamako
Mali
M. Dramane Zerbo, Director; Tel: 22-25-59.

USDA/VPI SMOKEHOUSE

Cooperative Extension Service
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061
Eldridge R. Collins, Jr.

Stoves

Improved Three Stone Hearth

Barry Wheeler
c/o Togo Desk
Peace Corps
1990 K Street, N.W.
Washington, D.C. 20526

Togo Desk
Peace Corps
1990 K Street, N.W.
Washington, D.C. 20526

Jiko Stove

CARE INC.
660 First Avenue
New York, N.Y. 10016
Micro-enterprise Division
TEL: 212/686-3110

Energy Development International (EDI)
PO Box 62360
Nairobi, Kenya
Mr. Maxwell Kinyanjui

KENGO
PO Box 48197
Nairobi
Kenya

CARE/Kenya
PO Box 43864
Nairobi
Kenya
Mr. Hugh Allen

<u>Leso Stove</u>

VITA
1815 Lynn Street
Arlington, VA 22209
Ms. Margaret Crouch

<u>Solar Box Cooker</u>

Solar Box Cookers International
1823 Eleventh Street
Sacramento, CA 95814

<u>Technique to Overcome Hard to Cook Phenomena of Beans</u>

Northern Regional Research Center
Agricultural Research Service
U.S. Department of Agriculture
Peoria, Illinois

APPENDIX E

REQUESTS RECEIVED BY UNIFEM FOR FOOD PROCESSING TECHNOLOGIES

Technology	H.L.[1]	V.L.[2]	Man.[3]	Mot.[4]	H.C.[5]	H.C.-S.[6]	In.[7]	Country	Subarea	Source of Information[8]
					Purpose of Use					
*Fish Smoking (Mostly chorkor fish-smoker required)		X	X				X	Botswana	Nothern Botswana	UNIFEM Mission Report, also request for information from Botswana Food Labaratory
"		X	X			X		Cameroon		Project Proposal from the Ministry of Women's Affairs
"		X	X					Ethiopia	Tetletsadik Getalhew	Personal Request for Information
"		X	X			X		Gabon		UNIFEM On-going Project
"		X	X			X		Ivory Coast	Etukossa Village	UNIFEM Mission Report
"		X	X			X		Liberia	Rural Areas in general	Project Proposal by the Home Economics Division, Ministry of Agriculture
"		X	X				X	Mozambique	From Tiete Province to Niassa Province	UNIFEM Mission Report
"		X	X			X		Sao Tome		UNIFEM On-going Project

1.H.L.-Home Level 2.V.L.-Village Level 3.Man.-Manual 4.Mot.-Motorized 5.H.C.-Home Consumption 6.H.C.-S.-Home Consumption and Sale 7.In.-Primarily for Income 8.The information extracted from UNIFEM records on technologies needed throughout Africa comes from a variety of sources: UNIFEM Mission Reports;UNIFEM.Pipeline Projects,i.e. projects which have not been started yet;UNIFEM on-going projects(they have been included since there is still a need in most of these project sites for further expansion of the identified technology);and actual project proposals or requests for information received from organizations, governmental agencies, or individuals in Africa.

Technology	H.L.[1]	V.L.[2]	Man.[3]	Mot.[4]	Purpose of Use H.C.[5]	H.C.-S.[6]	In.[7]	Country	Subarea	Source of Information[8]
Fish Smoking		X	X			X		Zaire		UNIFEM Mission Report
		X	X					Sierra Leone		Request for informati from Plan Internationa
* Oil Extraction (Palm Oil Presses)								Burundi		Personal Request for Information
Vegetable Oil Processing - Electric Oil Presser		X		X			X	Mozambique	Inhambana Province	UNIFEM Pipeline Project
Oil Extraction		X		X			X	Senegal	Bargny and Kolda	UNIFEM Pipeline Project
* Cereal Processing (Cassava Processing)		X		X		X		Gabon		UNIFEM Mission Report
Diesel powered Grain Mills		X		X	X			Mali	Kayes, Sikasso, Segou	UNIFEM Pipeline Project
Maize Mills		X		X				Mozambique	Chokwe	UNIFEM On-going Project

1.H.L.-Home Level 2.V.L.-Village Level 3.Man.-Manual 4.Mot.-Motorized 5.H.C.-Home Consumption 6.H.C.-S.-Home Consumption and Sale 7.In.-Primarily for Income 8.The information extracted from UNIFEM records on technologies needed throughout Africa comes from a variety of sources: UNIFEM Mission Reports;UNIFEM Pipeline Projects,i.e. projects which have not been started yet;UNIFEM on-going projects(they have been included since there is still a need in most of these project sites for further expansion of the identifi technology);and actual project proposals or requests for information received from organizations, governmental agencies, or individuals in Africa.

Technology	H.L.[1]	V.L.[2]	Man.[3]	Purpose of Use Mot.[4]	H.C.[5]	H.C.-S.[6]	In.[7]	Country	Subarea	Source of Information[8]
Cereal Processing										
Diesel operated Grain Mills		X		X		X		Niger	Deoule, Guidan, Bado, Kogoubtche	UNIFEM Pipeline Project
Grain Mills		X		X		X		Senegal	Djiourbel	UNDP-UNIFEM Pipeline Project
Maize Mills		X		X		X		Tanzania		UNIFEM On-going Project
* Cooking-Stoves										
Baking techniques and bakeries		X				X		Botswana		UNIFEM Mission Report
Bakeries for improved maize and cassava baking Wood-burning stoves		X			X			Mozambique	Inhambane District	UNIFEM Pipeline Project
Bio-gas Digestor for cooking		X			X				The Green Zone of Maputo	UNIFEM Mission Report
* Vegetable Processing		X				X		Senegal	Thies	UNDP-UNIFEM Pipeline Projects

1.H.L.-Home Level 2.V.L.-Village Level 3.Man.-Manual 4.Mot.-Motorized 5.H.C.-Home Consumption 6.H.C.-S.-Home Consumption and Sale 7.In.-Primarily for Income 8.The information extracted from UNIFEM records on technologies needed throughout Africa comes from a variety of sources: UNIFEM Mission Reports;UNIFEM Pipeline Projects,i.e. projects which have not been started yet;UNIFEM on-going projects(they have been included since there is still a need in most of these project sites for further expansion of the identified technology);and actual project proposals or requests for information received from organizations, governmental agencies, or individuals in Africa.

Technology	H.L.[1]	V.L.[2]	Man.[3]	Mot.[4]	Purpose of Use H.C.[5]	H.C.-S.[6]	In.[7]	Country	Subarea	Source of Information[8]
*Salt-extraction		X	X				X	Senegal	Bargny and Kolda	UNIFEM Pipeline Project
Solar salt extraction		X	X				X	Niger	Tegeduine	UNIFEM Pipeline Project
		X	X				X	Guinea		UNIFEM-UNIDO Pipeline Project

1.H.L.-Home Level 2.V.L.-Village Level 3.Man.-Manual 4.Mot.-Motorized 5.H.C.-Home Consumption 6.H.C.-S.-Home Consumption and Sale 7.In.-Primarily for Income 8.The information extracted from UNIFEM records on technologies needed throughout Africa comes from a variety of sources: UNIFEM Mission Reports;UNIFEM Pipeline Projects,i.e. projects which have not been started yet;UNIFEM on-going projects(they have been included since there is still a need in most of these project sites for further expansion of the identified technology);and actual project proposals or requests i information received from organizations, governmental agencies, or individuals in Africa.

APPENDIX F

IMPLEMENTATION OF RECOMMENDED TRIAL

The following offers a few notes on implementation of a suggested trial (which was discussed in Section 5.0, Next Steps) to test and demonstrate the impact of laborsaving technology on improvement of nutrition practices.

The trial might, ideally, be designed so as to draw and build on existing activities. Nutrition education which was already designed and in place in one area of a country could, if possible, simply be extended to the new trial area for use with the experimental and control group. Similarly, it might be possible to identify a local appropriate technology organization which already had experience with a high impact technology suitable to the test area.

The trial might have a duration of about two-and-a-half years. In the first nine to twelve months, a baseline would be established which would include analysis to identify or confirm a constraint on women's time and energy which might be alleviated by technology. A technology would be selected, and if necessary pre-tested. Adaptations in the nutrition education plan, already in place elsewhere in the country, would be made. And field workers would be trained both to deliver the nutrition education and to provide whatever promotion, or other action, was needed to introduce and demonstrate the technology.

In the second year, the trial with the two groups would be implemented. And in the concluding six months of the activity, the intervention would be evaluated and the results analyzed and written up.

The cost of the trial is estimated to be in the range of $250,000 to $300,000, recognizing that this could vary, considerably, depending on the extent to which it would be possible to take advantage of activities already partly in place.

To our knowledge, there is no activity similar to the trial proposed. However, in developing plans for such a trial, a project which is being carried out by The Center to Prevent Childhood Malnutrition should be reviewed for possible experience which could be relevant. In that project, a cassava processing activity is being carried out in a community in Ghana. In addition, weight charts have been introduced to aid the mother in caring for her child. The project was not designed to measure the impact of laborsaving technology on a nutrition intervention, which would require a control group and probably greater emphasis on the nutrition intervention component. However, there may well be some useful insights which could be gained from review of this activity which might contribute to the design of the proposed trial. (The Director of the Center is Sandra Huffman; the address: 7200 Wisconsin Ave., Bethesda, MD, 20814.)