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FULL-FAT SOY FLOUR BY A SIMPLE PROCESS FOR VILLAGERS

By

G. C. Mustakas, W. J. Albrecht, G. N. Bookwalter,
and E. L. Griffin, Jr.^{1/}

INTRODUCTION

Food shortages among the developing nations have led to efforts to develop low-cost protein foods based on crops that can be grown in these countries. The Northern Research Division has taken part in a research program, supported by AID,^{2/} to improve the processing of soybeans for foods.

One part of this research was to find a simple hand process for villages where skilled labor, electric power, and steam cannot be had. A process that uses only simple equipment was developed. With this equipment six men can make 136 kg. (300 lb.) of soy flour in an 8-hr. day. Operation can be changed from hand to mechanical by wind, water, animal, or other available power source. A production of 136 kg. (300 lb.) per day will supply half the daily need for protein of more than 1,600 adults.

EQUIPMENT

Table 1 lists the things needed for each process step, capacities, approximate cost, and source. Capacities shown in the table are based on the use of hand power. Mechanical power can increase these capacities. For example, a 1/4-hp. motor could double the capacity of the hand grinder.

PROCESS

The basic steps in processing whole soybeans are outlined in figure 1, and details for producing 136 kg. (300 lb.) of soy flour per day in figure 2.

^{1/} Engineering and Development Laboratory, Northern Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture, Peoria, Ill. 61604.

^{2/} Agency for International Development, U.S. Department of State, Washington, D. C. 20250.

TABLE 1.--Equipment and cost information on making soy flour by hand process
 [Capacity 136 kg. (300 lb.) soy flour per 8-hr. day]

Process step	Equipment needed	Capacity of equipment basis: soybeans		Approximate cost	Source ^{1/}
		Kilograms	Per time		
				<u>Dollars</u>	
1. Soaking the beans --	Four 208-liter (55 gal.) galvanized drums, plus 24 heavy porous cotton bags (about 46 by 115 cm.)	172	Day	60 (estimated)	Generally available
2. Immersion cooking --	Heavy gage galvanized steel tank, 200-liter capacity	90	Hour	50 (estimated)	
3. Air drying -----	Cloth, paper, or flat trays	--	--	---	
4. Hand cracking -----	Corn crusher, type S	--	Hour	35 f.o.b. Japan	CeCoCo Chuo Boeki Kaisha Central Commercial Co., Osaka-Fu, Japan
5. Winnowing (dehulling)-----	Hand grain winnower, type A-1	45	Hour	35 f.o.b. Japan	
6. Hand grinding -----	Flour grind mill, type D (2 mills)	9	Hour per mill	100 (at \$50 per mill, with 2 mills required))	
Total estimated cost -----				280	

^{1/} The mention of firm names or trade products does not imply that they are recommended by the U.S. Department of Agriculture over other firms or similar products not mentioned.

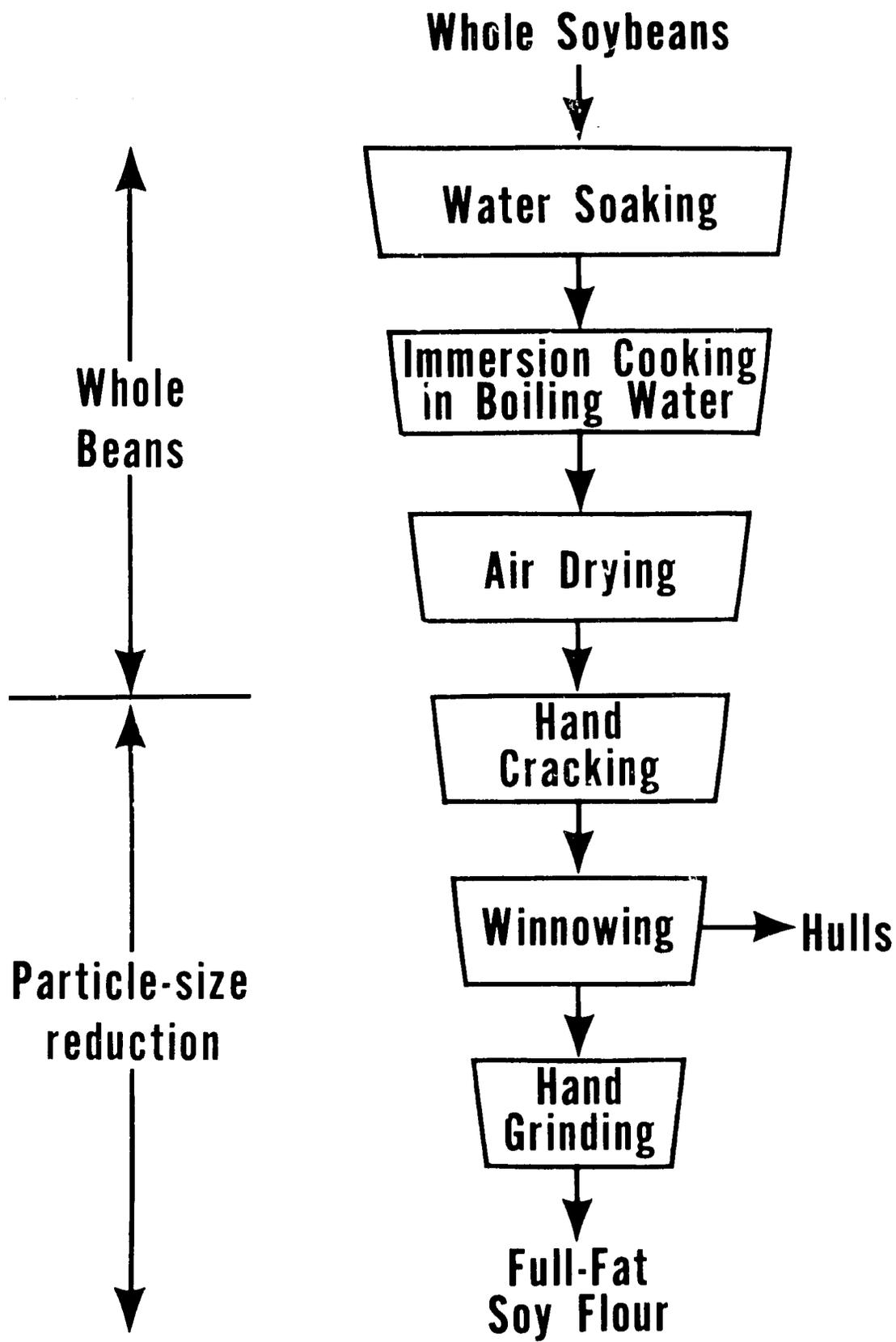


Figure 1.--Flow sheet of a simple method for preparing a full-fat soybean flour.

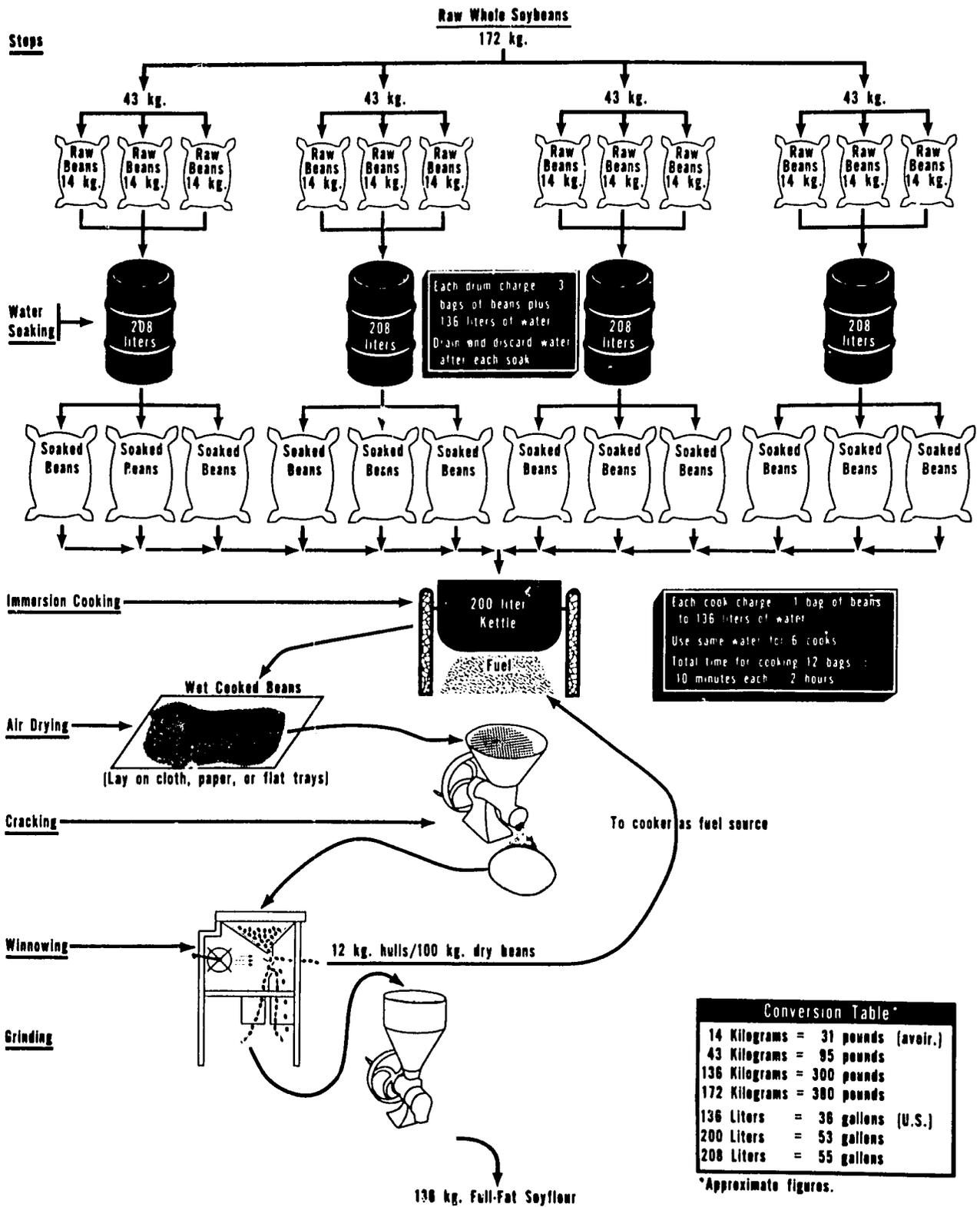


Figure 2.--Flow sheet showing amounts for producing 136 kg. (300 lb.) of soybean flour per day.

Whole soybeans are soaked in water of drinking quality for several hours, drained, cooked in boiling water to cover, drained, air-dried, cracked, dehulled, and finally ground to flour. Of the original bean solids 7 to 9 percent is lost in soaking and cooking.

The six steps are discussed below and illustrated in figure 3, A to F.

Step 1.--Soaking the Beans

If possible, start soaking the beans before sunrise. This allows as much daylight time as possible for the drying step. Fill a cloth bag, or a perforated basket one-quarter to one-third full with soybeans and lower it into fresh water in a container, such as a 208-liter (55-gal.) drum. The water temperature should be 75° F., or less, to minimize growth of microorganisms.

To improve the flavor of the beans slightly, add 1 kg. of sodium bicarbonate (baking soda) to 100 kg. of soak water. Baking soda, however, does not have to be added.

After 4 to 6 hr. of soaking, the beans will have swollen to about twice their size and will contain more than 40 percent water. This soaking is needed for uniform cooking. Lift the beans out of the soak water, drain briefly, and put them into the cooking pot (fig. 3, A).

Step 2.--Immersion Cooking

Cook the beans, still in the bag, in water at full boil for 10 min. Cooking can be done in an open pot over an open fire. In high altitudes, up to 10,000 feet, the cooking period at full boil should be about 15 min. This cooking is necessary to make the beans safe for eating, but does not remove or destroy protein.

Lift the bag of beans out of the boiling water and allow to drain for a few minutes.

Cooking water can be reused about six times. The soybean hulls removed later in the process can be used as fuel.

Step 3.--Air Drying

After the beans are cooked, spread them out to dry in the air (fig. 3, B). The area required for drying soybeans in a single layer is about 0.5 square meter per kilogram of dry soybeans, or a total area of 86 square meters (103 sq. yd.) for 1 day's production.

Drying conditions required for preventing mold or bacteria growth are discussed under Sanitation Requirements (see p. 9).

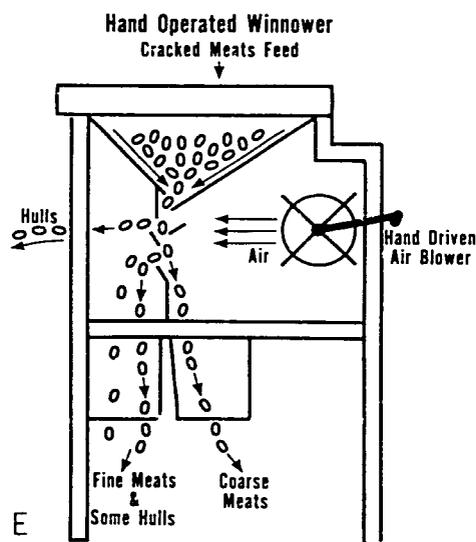
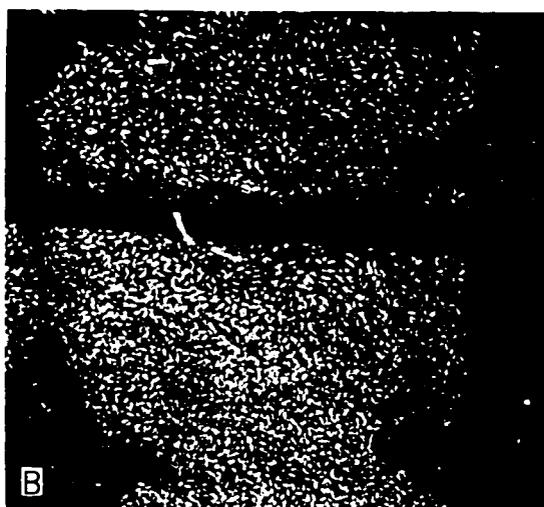


Figure 3.--Processing whole soybeans: A, Cooking; B, air-drying; C, cracking cooked, dried beans; D, winnowing to separate hulls; E, diagram of winnower construction and operation; and F, hand grinding meats to flour.

The water content at the end of drying should be low enough to permit good separation of hulls in the cracking step (about 9 percent or less). A simple impact test may be used as a guide to determine when the beans are dry enough for cracking. In this test place a few beans on a flat hard surface and hit sharply with a small mallet or a flat stone. The beans should break easily with clean separation of the hull.

Ideally, soy flour should be produced during the driest season. If poor drying conditions exist because of wet weather, high humidity, and lack of sun, make changes in the drying step by drying with heated air.

Step 4.--Hand Cracking

Crack the air-dried whole beans by using hand-operated equipment (fig. 3, C). Cracking frees the hulls (seedcoat) from the seed. Now, we can remove the hulls.

Step 5.--Winnowing

Place soybeans in the winnowing (dehulling) machine and hand crank the blower (fig. 3, D and E). The moving air lifts the light hulls and carries them to one side. The heavier meats (free of hulls) fall directly below. Put the rest through the machine again.

Step 6.--Hand Grinding

Hand grind the dehulled soybean meats (fig. 3, E) to make the flour.

SANITATION REQUIREMENTS

In all food processing operations sanitary conditions are necessary to ensure wholesome food products. Contamination of food can be prevented by strict observance of the following conditions.

Village Laborers

All workers must understand the need for maintaining clean, sanitary conditions. They must be in good health and keep their hands clean at all times.

Soaking

Use clean, pure water for soaking the beans. If the water is contaminated, boil before using. Do not reuse water to soak a second batch of beans. Examine the beans for insect or rodent contamination and wash the beans before soaking. Clean all equipment before using. Cover the soak pots during soaking. Wash all bags, soak pots, ropes, and utensils thoroughly with clean water after each use. Turn the bags inside out and expose to the sun to dry.

Cooking

Clean all cooking pots, utensils, and other equipment before using.

Drying

After cooking, spread the beans out in thin layers on clean paper, cloth, or trays in an area with good air circulation. Complete drying within 30 to 36 hr., with as much exposure to direct sunlight as possible. If air-drying cannot be finished within 36 hr., use heated air. If drying conditions are bad, the flour you make from the beans will not be good. For example, with slow drying, high bacteria counts and putrefaction can develop in 2 days, and flour from such beans might be contaminated with molds that could produce toxic products. If mold can be seen, throw the beans away. Keep the drying area as free as possible from dust or any kind of dirt. Protect the drying beans from rain and dew.

Milling

Clean the winnow, cracking mill, and flour mill at the beginning and end of each day.

Flour Storage

Store the flour in clean containers off the ground. Protect the containers and storage area against moisture, rodent, insect, and other possible contamination.

QUALITY OF PRODUCT

Analytical data for typical full-fat soy flour produced by this process are shown in table 2. Protein efficiency ratios^{3/} of 2.0 and available lysine values in the range of 6 to 6.5 indicate good nutritional value.

The flour has been tested in many basic food formulas and food combinations in cooperation with USDA's Human Nutrition Research Division, Agricultural Research Center, Beltsville, Md. It has good flavor acceptability and stability. Types of food that were prepared include breads (with wheat and corn flour), cooked vegetable and stew dishes, cereal products (noodles, porridge), cooked desserts, and beverages for babies and young children. In beverage use for infants, a flour-water dispersion of improved smoothness will be obtained if the flour is finer ground or if the mixture is homogenized.

^{3/} Determined by A. N. Booth, Western Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture, Albany, Calif. 94706.

TABLE 2.--Analysis of full-fat soy flour

Constituent	Range
Protein -----pct.--	41 to 42
Crude fat -----pct.--	20 to 23
Ash -----pct.--	5 to 7
Moisture-----pct.--	6 to 8
Crude fiber -----pct.--	2.5 to 3.0
Urease activity, pH change -----	0.0 to 0.1
Nitrogen solubility index -----	15 to 20
Available lysine ---pct. of protein--	6.0 to 6.5
Protein efficiency ratio average -----	2.0 (Casein - 2.5)

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AGRICULTURAL RESEARCH SERVICE
NORTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION
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