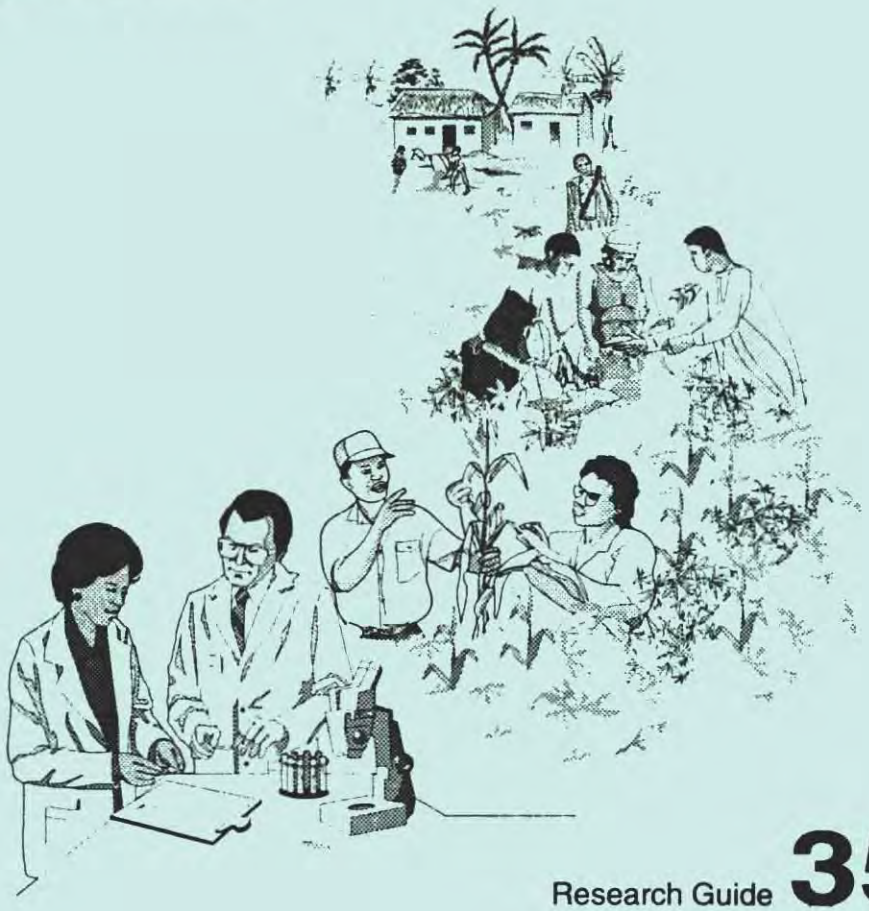
International Institute of Tropical Agriculture (IITA)

Utilization and processing of maize

Augustine E. Okoruwa



Research Guide 35

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Utilization and processing of maize

Objectives. This guide is intended to enable you to:

- discuss the importance of maize utilization and processing
- discuss the utilization of maize as animal feed
- describe industrial utilization of maize
- describe the uses of maize in human diets
- list traditional processed maize products in Africa

Study materials

- Samples of different maize types.
- Samples of end products.
- Photographs (slides) of processes and equipment.
- African maize dishes.

Practicals

- Demonstrate utilization and processing methods.
- Prepare African maize dishes.

Questions

1 What is the importance of maize worldwide?
2 What is the importance of maize in your country?
3 How is maize used in your country?
4 What are the quality factors that influence suitability of varieties for various uses?
5 What are the three primary uses of maize?
6 How is the bulk of maize used in developing versus industrialized countries?
7 Why is maize a good animal feed?
8 In what form(s) is maize used as feed?
9 Why is per capita utilization of maize high in industrialized countries?
10 How is the industrial use of maize categorized?
11 What is the basic function of processing?
12 What are the principal food products from the wet milling industry?
13 What is corn starch primarily used for?
14 What is high fructose corn syrup used for?
15 What is corn dextrose used for?
16 What is corn oil used for?
17 What are the primary products derived from dry milling?
18 In what food products is maize flour particularly useful?
19 How can green maize be used for human food?
20 What are the most common food products made from maize in Africa?

Utilization and processing of maize

Abstract. Maize is of high importance among the world's cereal crops. Maize can be used for human consumption, animal feed, and industrial purposes. Many traditional and industrial maize processing methods exist. Industrial processing includes wet and dry milling to produce a wide variety of products. Many maize dishes are prepared in Africa and elsewhere as human food.

1 Importance of maize utilization and processing

Maize (*Zea mays* L.), or corn as it is called in USA, has a multitude of uses and ranks second to wheat among the world's cereal crops in terms of total production. Also, because of its worldwide distribution and lower prices relative to other cereals, maize has a wider range of uses than any other cereal. Within the developing world, there are a number of countries where maize is a major staple food and the per capita human consumption reaches high levels.

Maize can be processed into different products for various end uses at the traditional level and on an industrial scale. While a large proportion of products utilized in developing countries is obtained via traditional processing, industrial processing meets the bulk of the demand in developed countries.

However, significant changes are occurring throughout the developing countries in the processing of maize for major uses. The tendency is towards the adoption of simple processing machines for dehulling, dry and wet-milling operations.

Moreover, in some developing countries like Nigeria, a few commercial maize processing mills are in operation producing brewers grits, maize flour and maize meal. Nonetheless, just over 40% of total world utilization of maize occurs in the developing world which also accounts for the bulk of direct human consumption.

A vast array of maize varieties — including local and improved varieties — are grown by commercial and subsistence farmers. Consumers use certain maize types to produce the major food products in a given area.

Traditional or commercial products are based on certain endosperm properties and quality parameters. Quality factors that influence the choice and suitability of maize varieties for various uses include chemical, physical, biochemical, physico-chemical, organoleptic and rheological properties. Fortunately, a number of these properties can be influenced and altered favorably through breeding and other agronomic practices.

Maize is used primarily as:

- a staple food for human consumption
- animal feed
- raw material for industrial use

It is also used as seed. In industrialized countries, a larger proportion of maize is used for livestock feeding and as industrial raw material for food and non-food uses. On the other hand, the bulk of maize produced in developing countries is used as human food although its use as animal feed is increasing. Grain types utilized are flint, dent, floury or of intermediate endosperm texture. White and yellow colored varieties are used.

An understanding of trends in maize processing/utilization is of timely interest and importance to IITA and to those interested in the role of maize production in agricultural development in a sustainable economy.

2 Utilization of maize as animal feed

Maize is the number-one feed grain of the world, including the developing countries. It is used extensively as the main source of calories in animal feeding and feed formulation.

Maize givies the highest conversion of dry substance to meat, milk and eggs compared to other cereal grains. Maize is a valuable feed grain, because it is among the highest in net energy content and lowest in protein and fibre content. Animals like and eat it readily.

Maize is either fed directly or is dried, milled and compounded with other ingredients and thoroughly mixed. The mixture is then fed or converted into forms most desired by specific animals. By-products of industrial wet-and dry-milling are also used as feed.

Industrialized countries show a high per capita utilization of maize because of high consumption of livestock products and the importance of maize in livestock feeding. For instance, over 80% of the maize grown in USA is used for animal feed. Rapid increases in poultry consumption in Africa and other developing countries is a major factor contributing to the increased use of maize for livestock feed.

3 Industrial utilization of maize

Industrial use of maize is categorized into two processes:

- wet milling
- dry milling

Processing basically separates the fractions of the grain into germ, hull and endosperm to produce a wide range of products for various food and non-food uses. Extensive reviews of food uses of whole corn and specialized products made by fractionating corn by dry or wet milling are in the literature.

Wet milling. The principal food products from the wet milling industry are corn starch, corn syrup, high fructose syrup, dextrose and corn oil. By-products are used for livestock feed and other applications. Corn starch is used primarily to thicken and stabilize other ingredients.

Various modifications of corn starch can be made to obtain the desired results in foods. Baking powder, prepared mixes, candies, baking goods, and puddings require starch products. Paper and textile industries utilize starch. The greatest use of corn syrup is in confections, followed by bakery and dairy products.

High fructose corn syrup (HFCS) is utilized in a wide variety of food systems such as confections, baked foods, table syrup, fountain syrups, sweet beverages, catsup, pickles and other condiments.

The largest single food use for dextrose is in baked goods where it serves as a yeast nutrient, provides some sweetness and causes crust browning. Other major uses for dextrose are in confectionery manufacturing,

canning and frozen packs, catsup, jams, jellies, soft drinks, wines and malt liquors.

Corn oil is consumed as salad or cooking oil and in margarine. Corn oil is also used as a carrier for vitamins and medicine.

Dry milling. Primary products derived from dry milling of maize are maize meal, flour and maize grits. Other products are oil and by-products for animal feed. The endosperm fractions are characterized by their particulate dimensions and sizes which affect composition and utilization.

- Grit fractions (1.2–0.6 mm). Grit fractions are used for many foods domestically and commercially. Examples are boiled hominy grits (USA), imitation rice (Senegal, Nigeria), and corn flakes worldwide. Brewers grits are used in beer production.

- Maize meal (0.6–0.2 mm). Maize meal is used for meal mixes, maize bread, maize muffins and some extruded maize snack products.

- Maize flour (< 0.2 mm). Maize flour is particularly valuable as an ingredient of pancake mixes, baby foods, cookies, biscuits, ice cream cones, ready-to-eat cereals, batter breading mixes, and binders for loaf-type sandwich meats. Maize flour can be pregelatinized and used in compounding high nutrient mixes like corn-soy-milk (CSM) and corn-soy-blend (CSB).

4 Maize as human food

Maize is widely used directly for human food in Asia, Africa, Latin America and parts of the Soviet Union.

In the green state, maize can be parched, baked, roasted, boiled or steamed on the cob (Figure 1). Figure 2 shows traditional dry milling of maize for flour production. An overview of the utilization of dry maize grain by traditional wet and dry milling is presented in Figure 3. Food products from industrial wet and dry milling have been mentioned earlier. Emphasis is hereafter laid on uses of maize in tropical Africa.

African food products most widely made from ground maize grain are a cooked paste or mush, eaten while still warm, and a thick beer of low alcoholic content. Chunks of the paste or mush are broken off and dipped into stews or sauces of meat, fish or vegetables before eating. In some areas, maize mush is fried or baked, but not in the traditional Central and Latin American forms of maize bread or tortillas.

Other major dishes of tropical Africa are maize fritters, whole maize cooked with beans, fermented and flavored maize starch, parched or popped maize, dehydrated immature maize boiled just before eating, thin maize mush, maize gruel, flavored weak maize beer, and distilled maize drinks.

Each country has one or more maize dishes that are unique to its culture. Examples are *Ogi* (Nigeria), *Kenkey* (Ghana), *Koga* (Cameroon), *Tô* (Mali), *Injera* (Ethiopia), *Ugali* (Kenya). Most of these products are still traditionally processed.

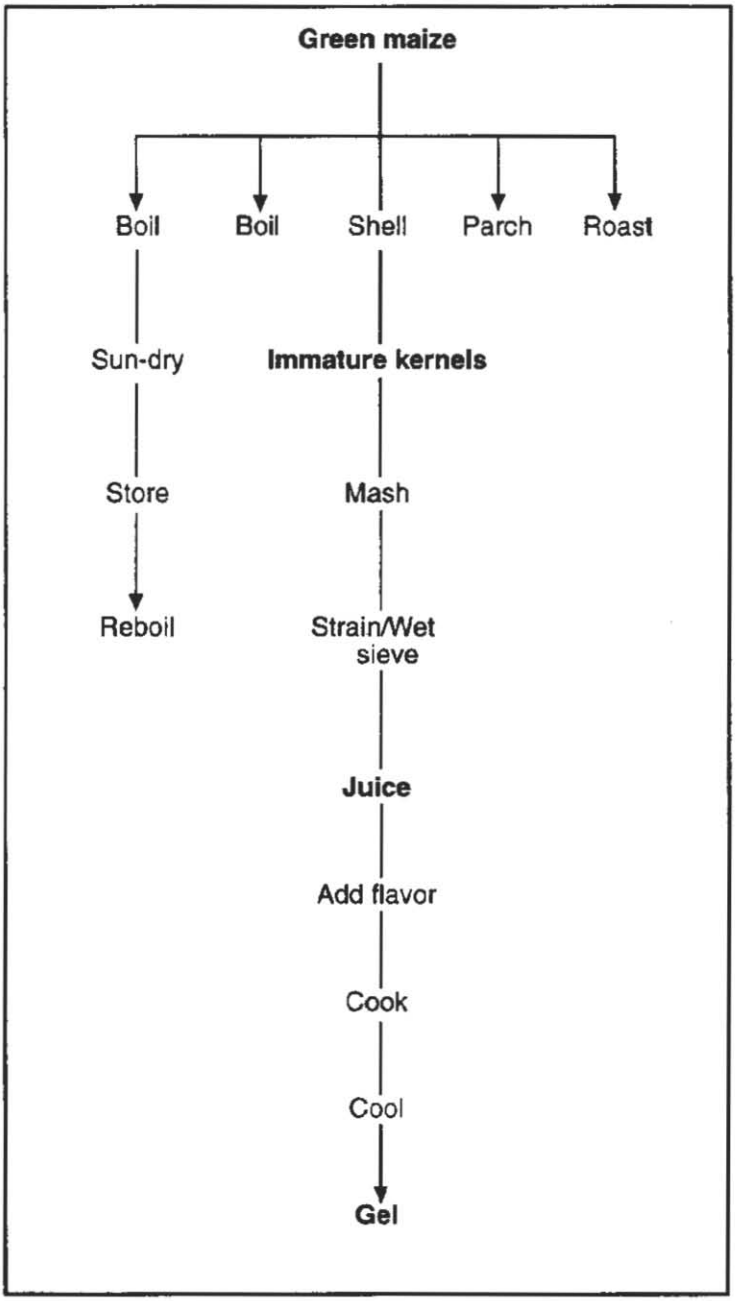

Figure 1. Utilization of green maize.

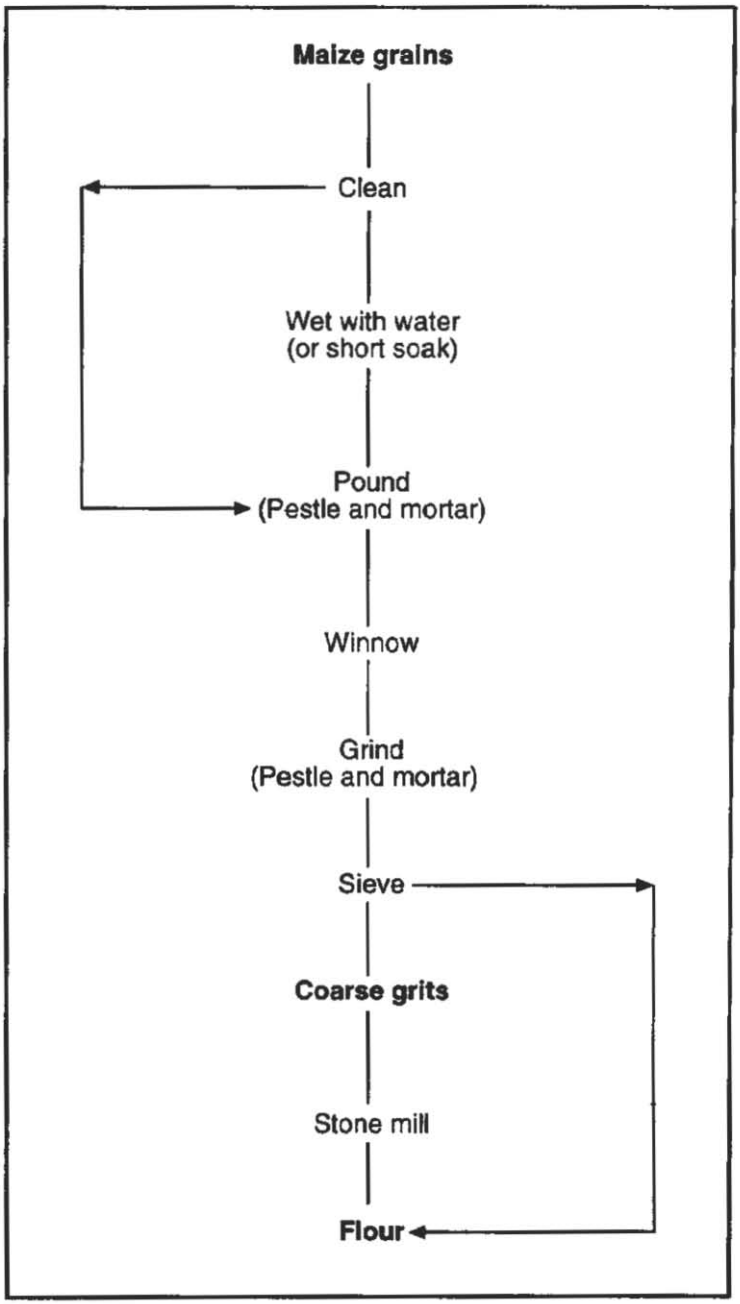

Figure 2. Traditional dry milling of maize.

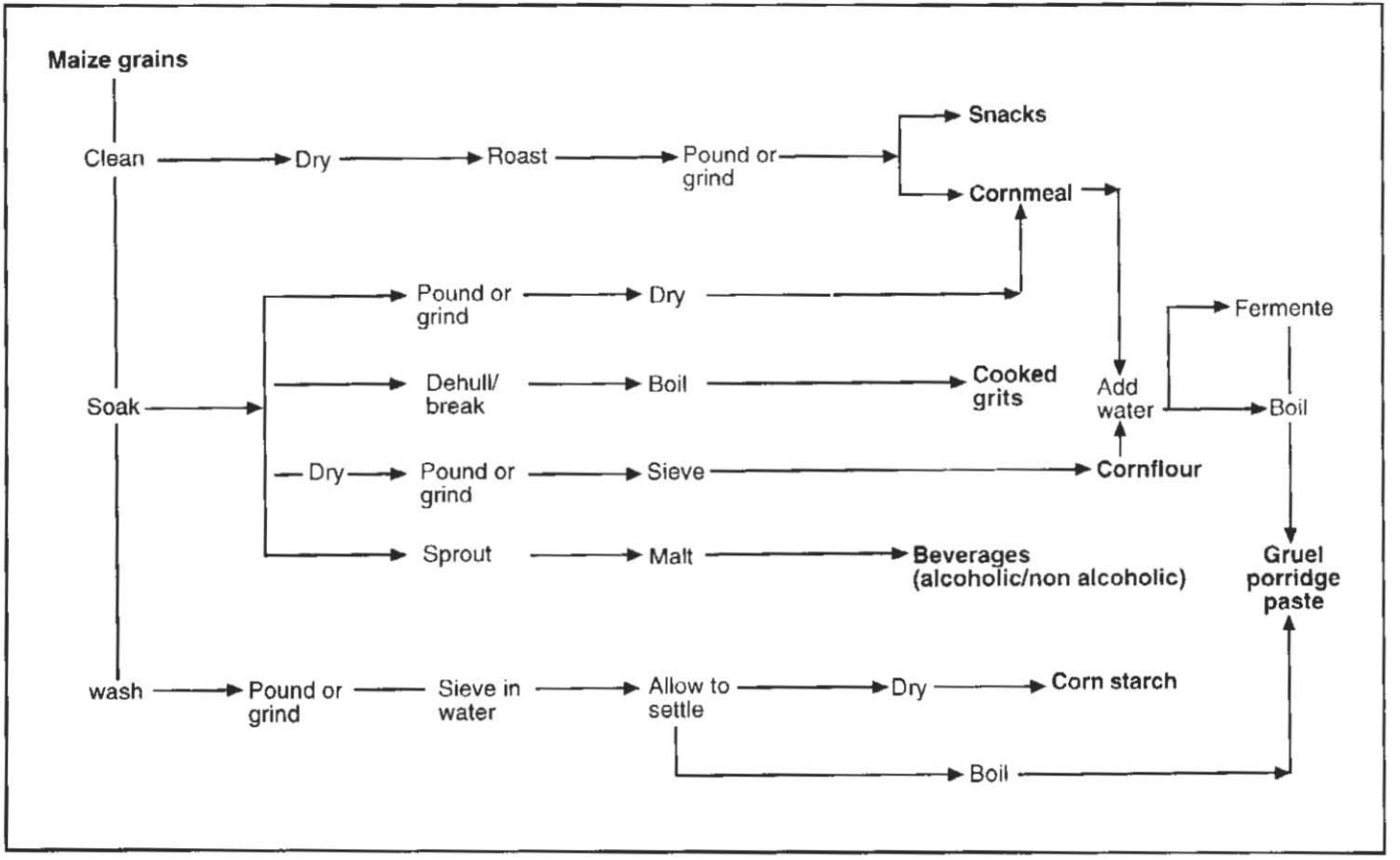

Figure 3. Utilization of dry maize grains.

5 Traditionally processed maize products

Based on rheological properties, maize food products are classified into four main groups. These are beverages, porridges, dumplings, and baked or fried products. In addition, one may consider traditional maize snacks and rice-like products as another group.

Beverages. Beverages are low viscosity liquids with water content of about 94% or more. These beverages may be sweet, sour, alcoholic or non-alcoholic. Examples are maize beer, *Tella*, iced *Kenkey*, *Mahewu*, (Bantu — South Africa), *Aliha* (Ghana), and *Chakpalo* (Benin Republic).

Porridges. The moisture content of porridges is about 90%. An example is *Ogi* which is eaten all over Nigeria and in parts of Ghana. *Ogi* and *Koko* porridge preparation is shown in Figure 4.

Dumplings. The moisture content of dumplings is about 65–80%. These preparations are different from porridges as dumplings can be formed into balls which do not flow under gravity. Examples are *Kenkey, Eko, Banku*, and *Tô*. Figures 5, 6 and 7 show the traditional preparation of *Eko*, *Kenkey* and *Tô* respectively.

Baked or fried products. Examples are *Injera*, a fermented leavened bread locally consumed by Ethiopians, home-made maize bread, and fried maize mush.

Maize snacks. Snacks include *Guguru, Aadun, Dakuwa* (Figure 8), *Kokoro* (Figure 9) (Nigeria), and *Lakiri* (Ghana).

Rice-like products. Rice-like products are *Egbo* (Nigeria, Figure 10), and *Chenga* (Kenya).

The following flow charts summarize some of the various preparations of African traditional maize foods. In addition, *tortilla* and other products from alkaline cooked maize *masa*, which are not African traditional products are shown in Figures 11 and 12.

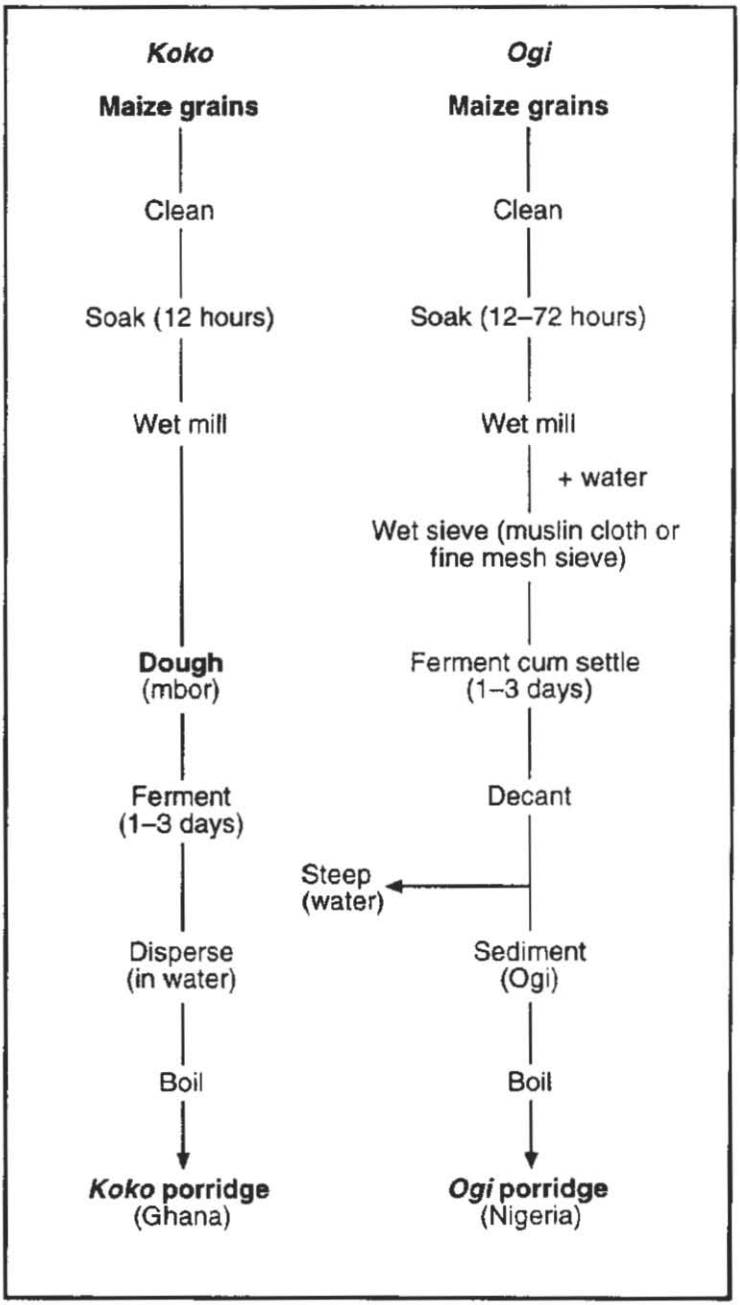

Figure 4. Preparation of *Ogi* and *Koko* porridges.

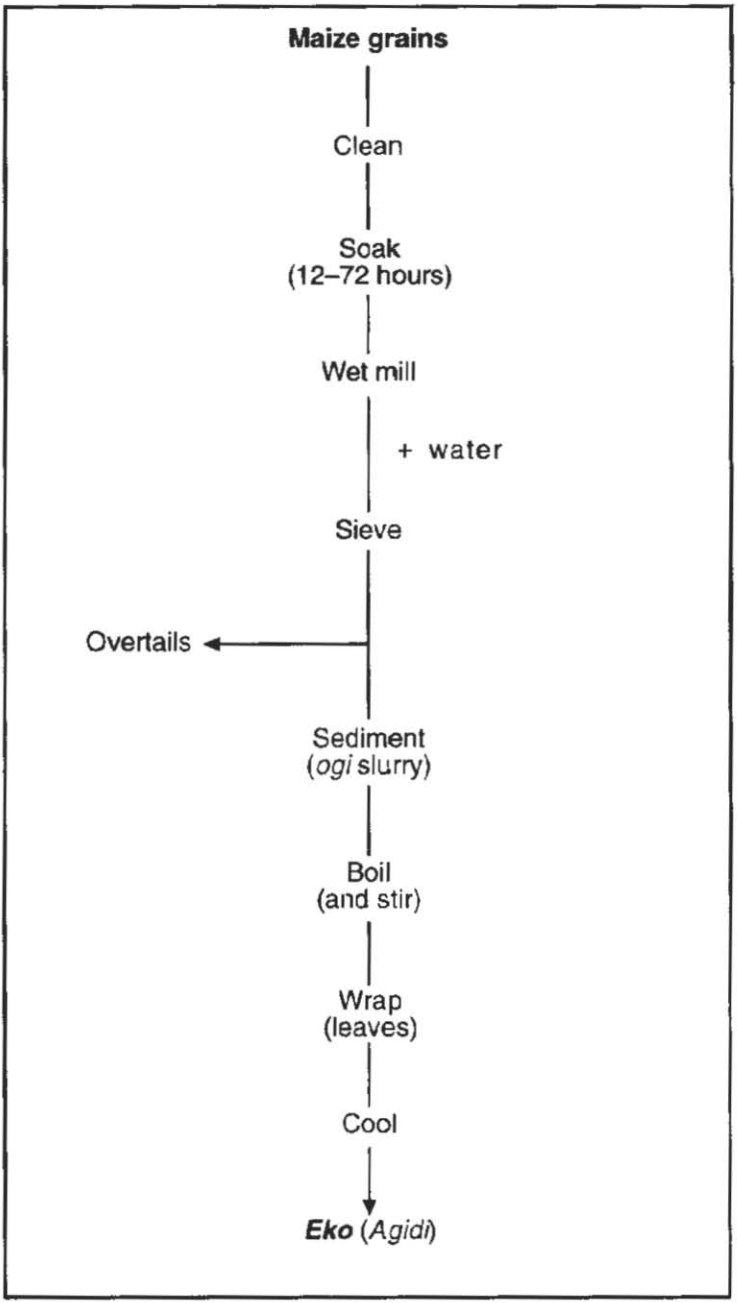

Figure 5. Preparation of *Eko* (Nigeria).

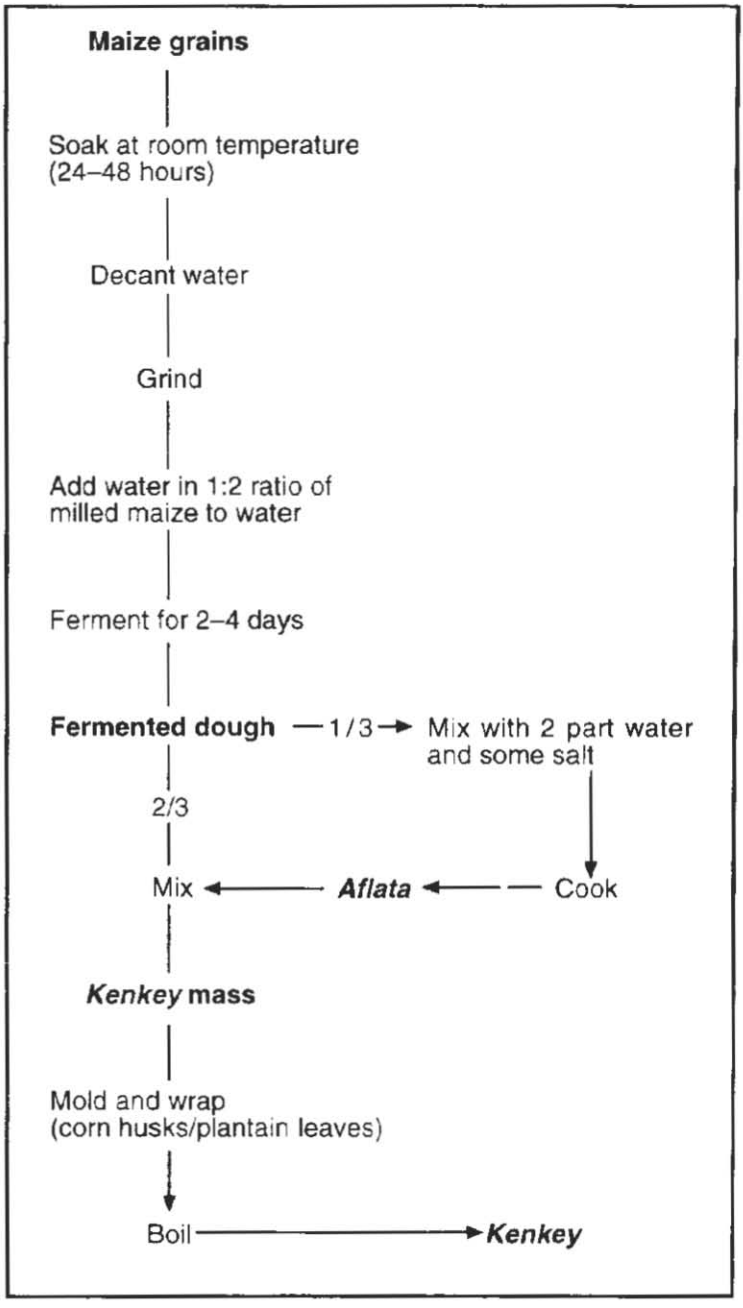

Figure 6. Production of *Kenkey* (Ghana).

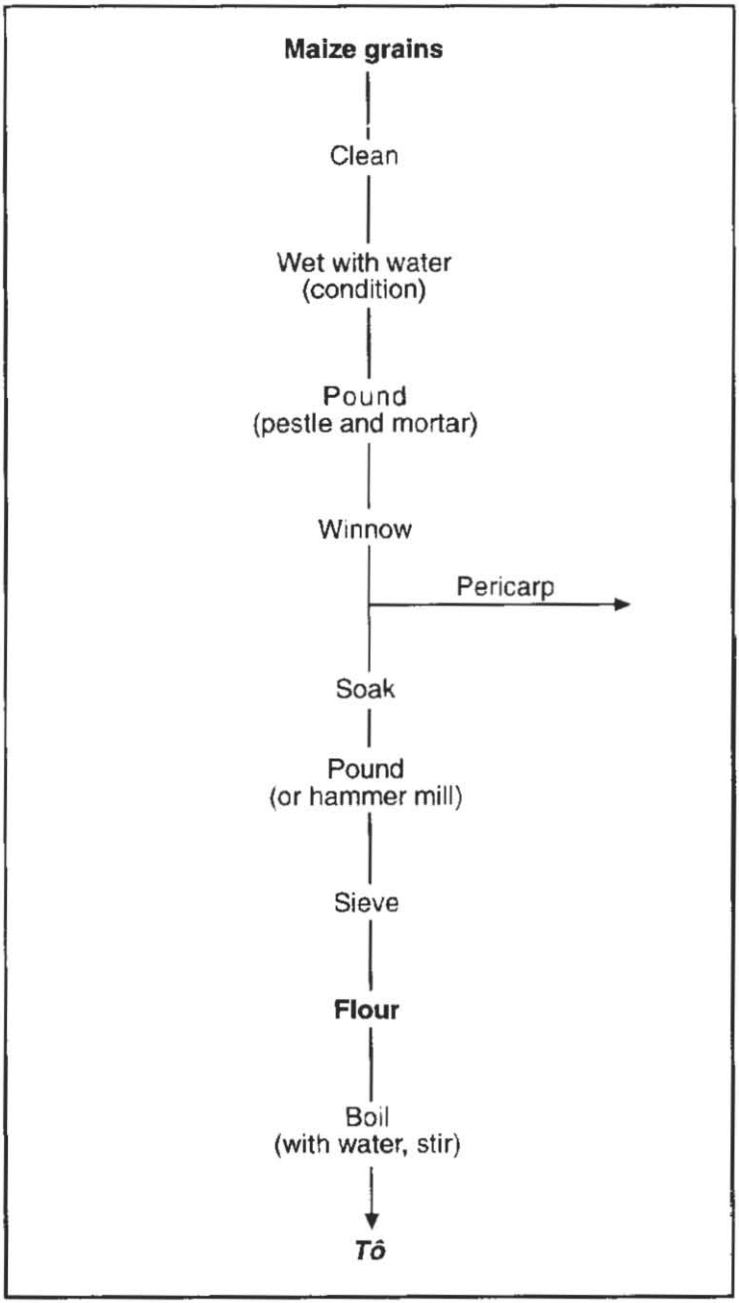

Figure 7. Preparation of *Tô* (Mali).

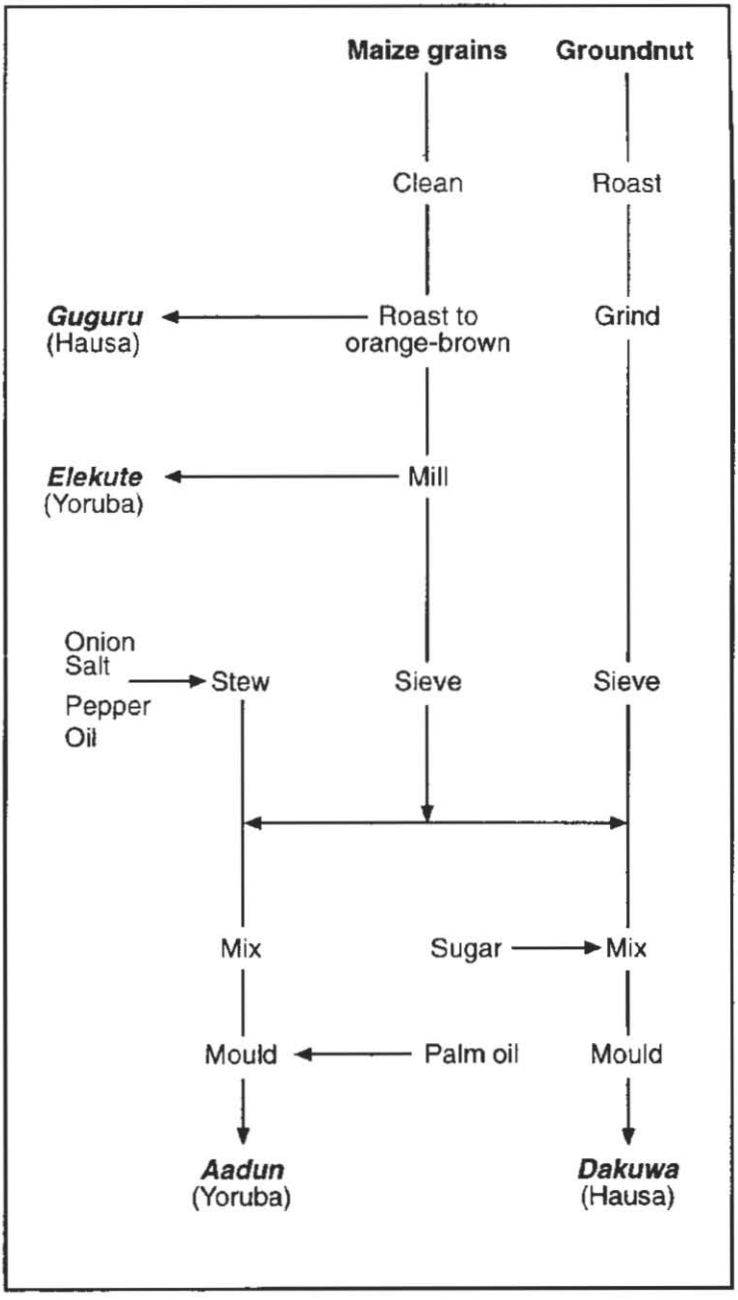

Figure 8. Some Nigerian maize snacks.

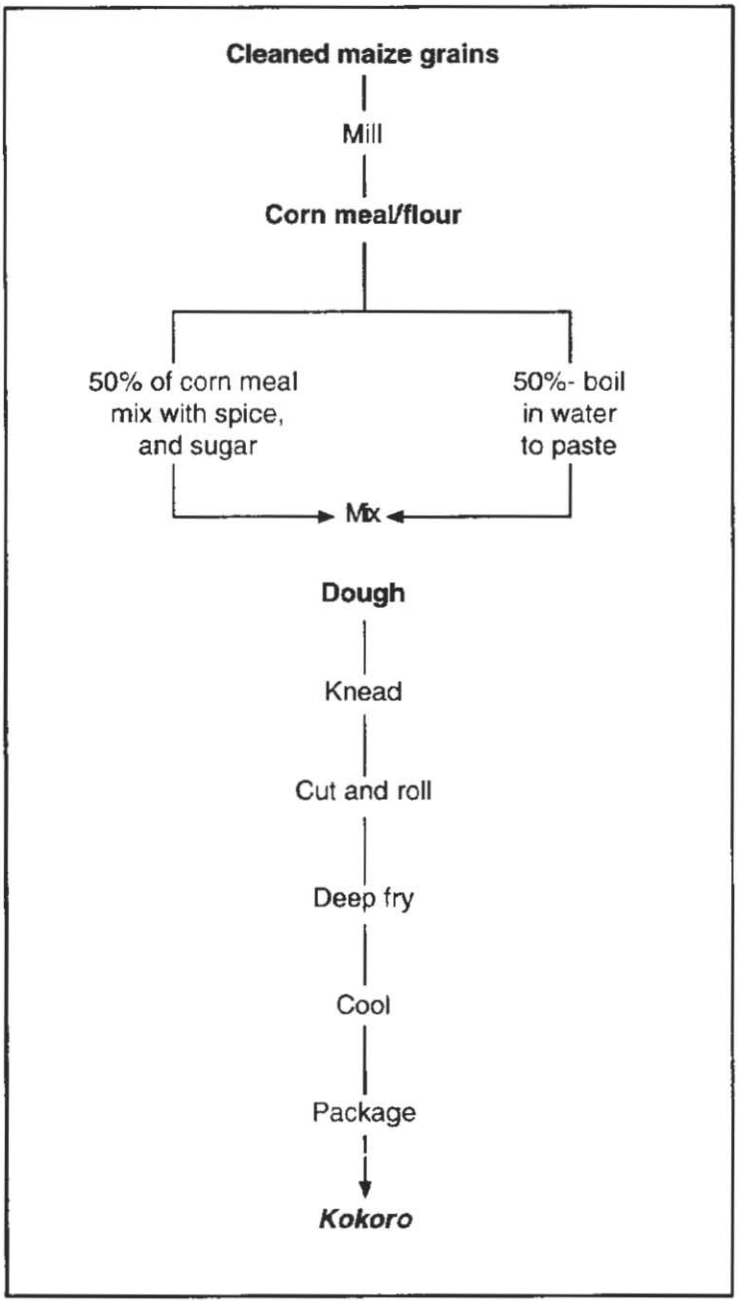

Figure 9. Production of *Kokoro* (Nigeria).

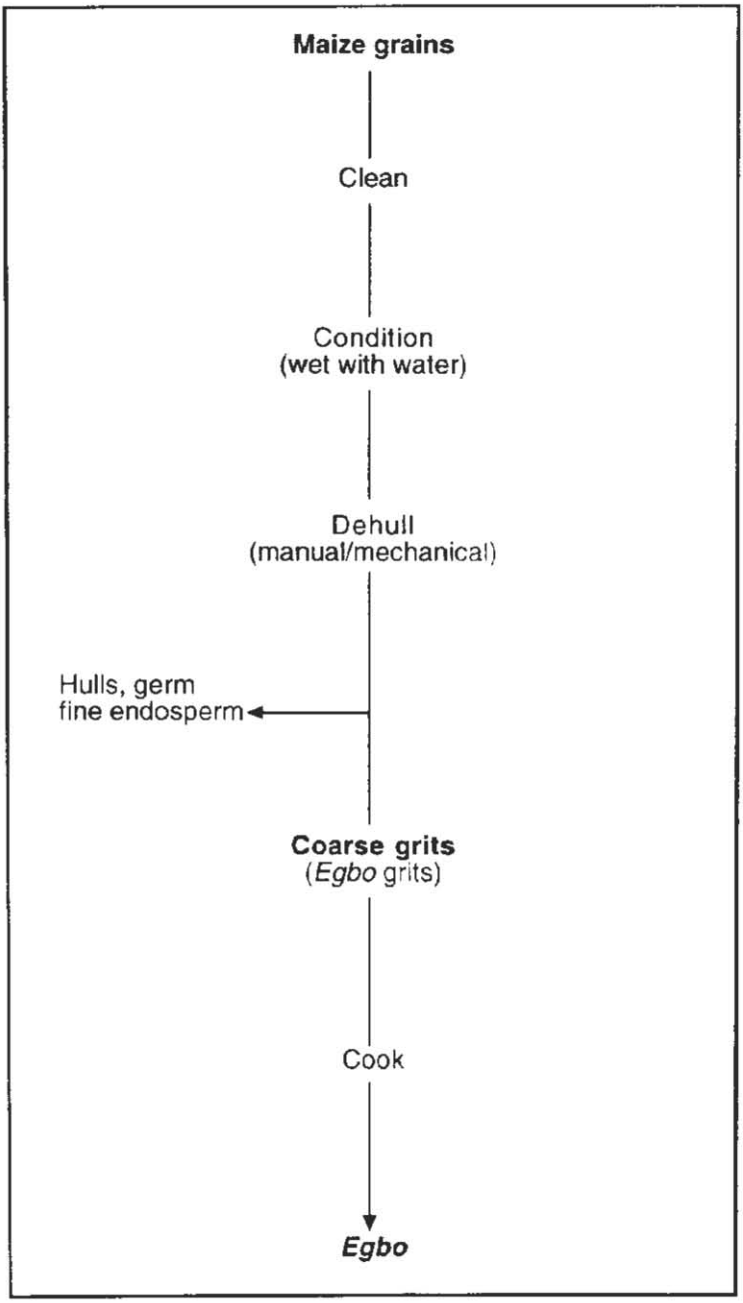

Figure 10. Production of *Egbo* (imitation rice, Nigeria).

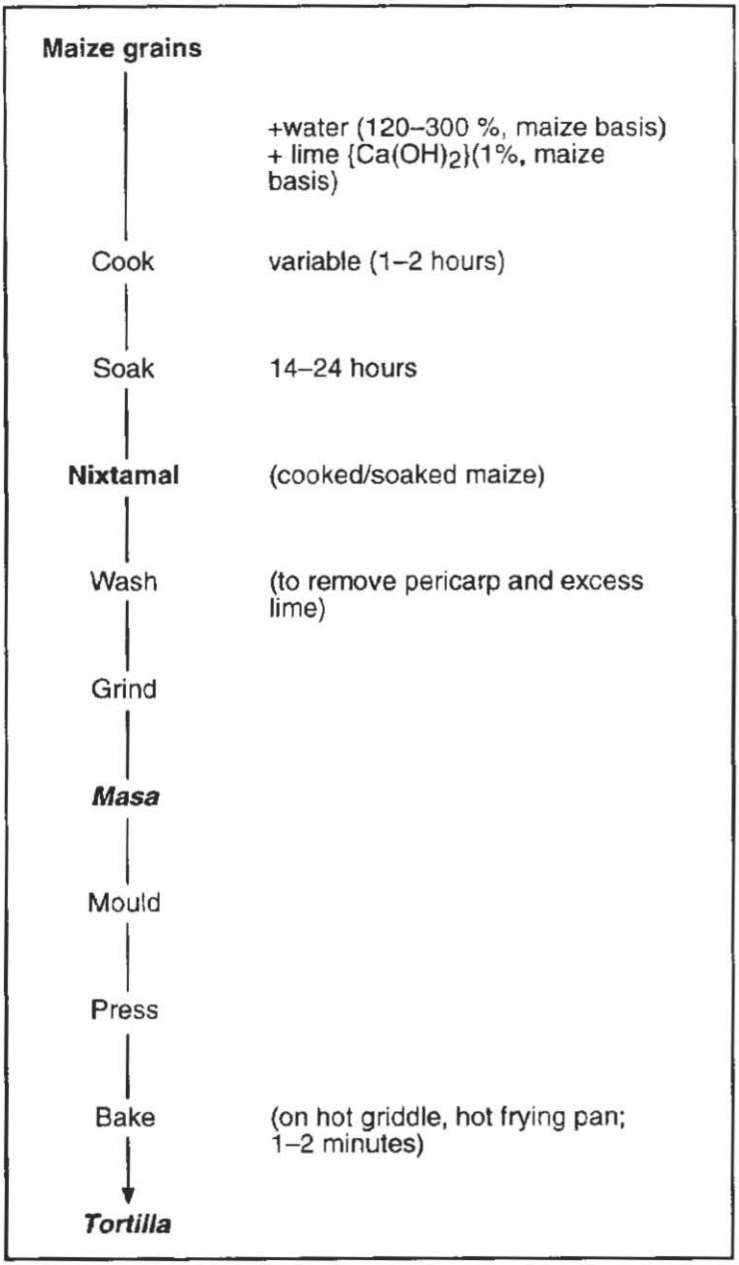

Figure 11. Production of *Masa* and *Tortillas* (Mexico, Latin America).

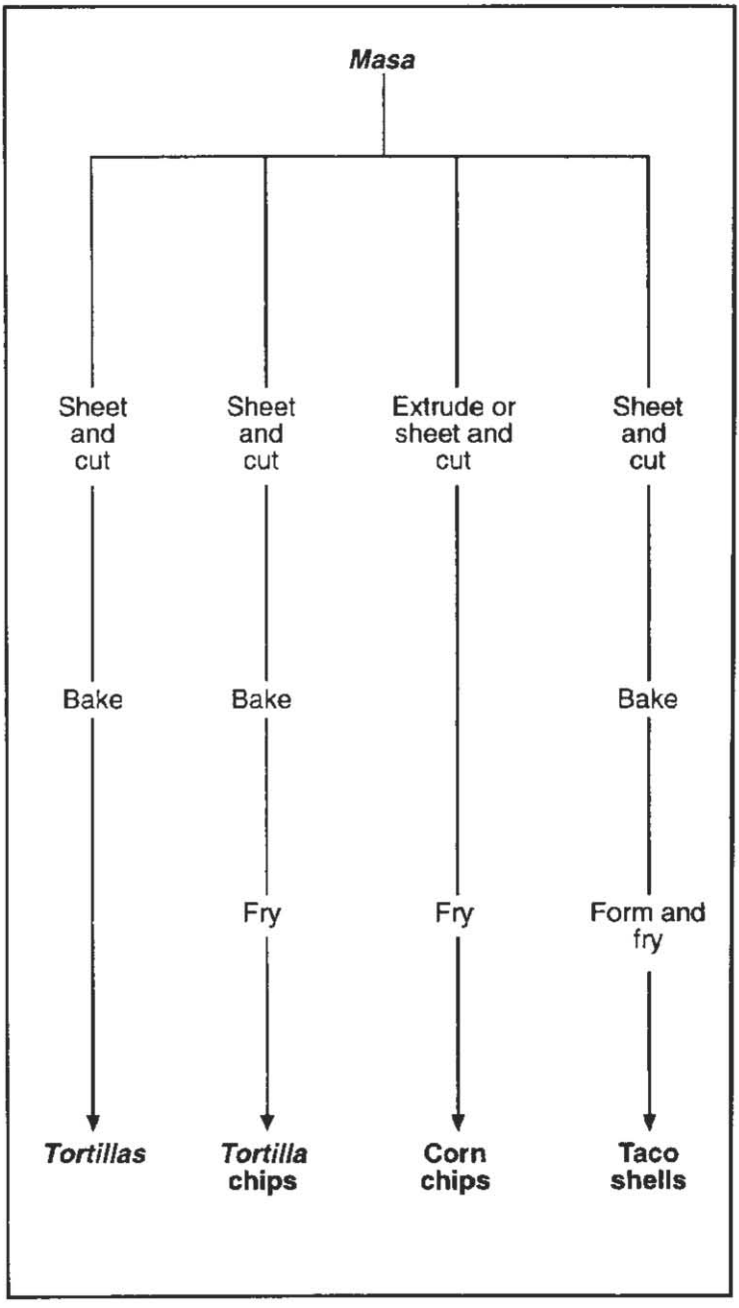

Figure 12. Products from alkaline-cooked maize *Masa*.

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7 Suggestions for trainers

If you use this Research Guide in training:

Generally:

- Distribute handouts (including this Research Guide) to trainees one or several days before your presentation, or distribute them at the end of the presentation.

- Do not distribute handouts at the beginning of a presentation, otherwise trainees will read instead of listening to you.

- Ask trainees not to take notes, but to pay full attention to the training activity. Assure them that your handouts (and this Research Guide) contain all relevant information.

- Keep your training activities practical. Reduce theory to the minimum that is necessary to understand the practical exercises.

- Use the questions on page 4 (or a selection of questions) for examinations (quizzes, periodical tests, and so on). Allow consultation of handouts and books during examinations.

- Promote interaction of trainees. Allow questions, but do not deviate from the subject.

- Respect the time allotted.

Specifically:

- Discuss with trainees about the importance of maize and maize products at trainees locations. Ask

trainees about their experiences and perceptions with regard to the content of this Research Guide as listed on page 5 (10 minutes).

- Present, discuss and demonstrate the content of this Research Guide, considering the study materials listed on page 3 (45 minutes).

  You may photocopy the diagrams and tables of the Research Guide on transparencies for projection with an overhead projector.

  Have real samples of maize, maize products, tools and equipment available so that each trainee can see, feel and taste. Show color slides of material and equipment that you cannot have available.

- Conduct demonstrations/practicals on the different processing methods in groups of 3–4 trainees per group (2 hours). Make sure that each trainee has the opportunity to practice. Have resource persons available for each group and practical. Keep trainees busy.

- Organize a lunch or dinner offering different maize dishes.

- Conduct an informal survey with farmers, at markets, processing plants etc. to determine opportunities and constraints in maize processing (½ day). You may assign different locations to different groups. Have resource persons available for each group. Ask groups to prepare, present, and discuss their findings.

International Institute of Tropical Agriculture (IITA)
Institut international d'agriculture tropicale (IITA)
Instituto Internacional de Agricultura Tropical (IITA)

The International Institute of Tropical Agriculture (IITA) is an international agricultural research center in the Consultative Group on International Agricultural Research (CGIAR), which is an association of about 50 countries, international and regional organizations, and private foundations. IITA seeks to increase agricultural production in a sustainable way, in order to improve the nutritional status and well-being of people in tropical sub-Saharan Africa. To achieve this goal, IITA conducts research and training, provides information, collects and exchanges germplasm, and encourages transfer of technology, in partnership with African national agricultural research and development programs.

L'Institut international d'agriculture tropicale (IITA) est un centre international de recherche agricole, membre du Groupe consultatif pour la recherche agricole internationale (GCRAI), une association regroupant quelque 50 pays, organisations internationales et régionales et fondations privées. L'IITA a pour objectif d'accroître durablement la production agricole, afin d'améliorer l'alimentation et le bien-être des populations de l'Afrique tropicale subsaharienne. Pour atteindre cet objectif, l'IITA mène des activités de recherche et de formation, divulgue des informations, réunit et échange du matériel génétique et encourage le transfert de technologies en collaboration avec les programmes nationaux africains de recherche et développement.

O Instituto Internacional de Agricultura Tropical (IITA) é um centro internacional de investigação agrícola pertencendo ao Grupo Consultivo para Investigação Agrícola Internacional (GCIAI), uma associação de cerca de 50 países, organizações internacionais e regionais e fundações privadas. O IITA procura aumentar duravelmente a produção agrícola para melhorar a alimentação e o bem-estar das populações da Africa tropical ao sul do Sahara. Para alcançar esse objetivo, o IITA conduz actividades de investigação e treinamento, fornece informações, reúne e troca material genético e favorece a transferência de tecnologias en colaboração com os programas nacionais africanos de investigação e desenvolvimiento.

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