IDRC-114e

Cassava Harvesting and Processing

PROCEEDINGS OF A WORKSHOP HELD AT
CIAT, CALI, COLOMBIA
[illegible]-2[illegible] APRIL 1978

EDITORS: EDWARD J. WEBER
JAMES H. COCK
AMY CHOUINARD

CASSAVA HARVESTING AND PROCESSING IDRC-114e

The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in five sectors: agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; and communications. IDRC is financed solely by the Government of Canada; its policies, however, are set by an international Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.

Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa

Weber, E. J.
Cock, J. H.
Chouinard, A.
IDRC
Centro Internacional de Agricultura Tropical (CIAT) IDRC-114e
Cassava harvesting and processing: proceedings of a workshop held at CIAT, Cali, Colombia, 24–28 April 1978. Ottawa, IDRC, 1978. 84 p.

/IDRC publication/. Report of a workshop on /cassava/ /harvesting/ and /food processing/ – discusses /feed production/, /drying/ /food technology/, effects of chip size and shape; /starch/ extraction, use of cassava /flour/ in /food preparation/, cassava /fermentation/ for /fuel/ /alcohol/ production. /List of participants/.

UDC: 633.68 ISBN: 0-88936-188-6

Microfiche edition available

IDRC-114e

Cassava Harvesting and Processing

Proceedings of a workshop held at CIAT, Cali, Colombia, 24–28 April 1978

Editors: Edward J. Weber,[1] James H. Cock,[2] and Amy Chouinard[3]

Cosponsored by the
International Development Research Centre
and the
Centro Internacional de Agricultura Tropical, CIAT

[1]Senior Program Officer, Agriculture, Food and Nutrition Sciences Division, Latin American Regional Office, International Development Research Centre, Bogota, Colombia.
[2]Leader, cassava program, CIAT, Cali, Colombia.
[3]Editor, Communications Division, International Development Research Centre, Ottawa, Canada.

Contents

Cassava Processing in Southeast Asia

Robert H. Booth[1] and Douglas W. Wholey
Tropical Products Institute, London, England, and Malaysian Agricultural Research and Development Institute, Serdang, Selangor, West Malaysia

Abstract. The different utilization patterns of cassava in Indonesia, Thailand, West Malaysia, and the Philippines are briefly discussed. Country differences in methods used in the production of chips and pellets are described. The need for further information on all aspects of chip and pellet quality and quality assessment methods that may be used to influence pricing structures is stressed. The methods used for the extraction of starch and the preparation of cassava pearl and flake are briefly described.

One of cassava's major advantages over other carbohydrate/starch-producing crops is that the roots can be put to many uses. In Southeast Asia alone, there are many different utilization patterns that are influenced by and in turn influence both production and processing patterns. At present, some information is available on cassava exports, but little data exist on the quantities of different products used within the countries. This is particularly true for the amounts used directly as human food, frequently coming from small backyard crops, but it is also true for cassava starch and other products that are locally manufactured and marketed (Table 1).

In Thailand, cassava is almost entirely utilized as cassava pellets and starch for export. Thailand is the largest single supplier of cassava products on the world market and is different from other major producing countries, such as Brazil, Indonesia, Zaire, and Nigeria, which all consume internally more than 90% of their production. In Thailand, cassava does not form an important part of the staple diet of the people. During 1976, Thailand exported approximately 3.5 million t of cassava products valued at approximately U.S. $350 million, making cassava the number two export earner (just behind rice and superseding both sugar and maize). Of the total volume exported, starch constituted about 7%, and meal, chips, and pellets 93%, 98% of which was in the form of pellets. In terms of value, starch constituted about 11% of the total earnings. The chips and pellets were largely exported to the EEC, and starch was divided among Japan (35%), Indonesia (29%), the USA (15%), and other countries.

In Indonesia, the patterns of utilization differ throughout the country. In Java, a high percentage of the crop is used as a staple food for human consumption in the form of *gaplek* (sun-dried, peeled root pieces), fresh roots, and traditionally prepared confections. Both starch and animal feed are also produced. In South Sumatra, the situation is similar to that in Thailand in that cassava is primarily exported, although it is also consumed by the settlers. An estimated 180 000 and 140 000 t of pellets were exported to the EEC from Lampung in 1975 and 1976 respectively.

In the Philippines, cassava is predominantly used for food and starch production. It has been estimated that 67% is used for human food, 27% for industrial purposes, predominantly starch production, and 6% for animal feed. Furthermore, it is reported that of the total cassava starch, 60% is used for food and 40% for industrial purposes, such as textiles and laundering and as a binder in the plywood and carton industries. Starch is used in the food industry to produce native foods, noodles, sago, ice cream wafers, various bakery products, and also glucose and monosodium glutamate. Starch production in the Philippines is

[1]Present address: Centro Internacional de la Papa, Lima, Peru.

not enough to meet requirements, and cassava starch was imported at approximately 2000 t annually from 1968 to 1972.

In Malaysia, two distinct utilization patterns exist. Virtually all the commercially produced cassava is used for industrial purposes in the production of starch and animal feed, whereas the majority of the backyard crop is used for human food. No reliable statistics are available on the amount produced or consumed. Much of Malaysia's cassava is utilized internally, although considerable quantities of starch and starch-like products, such as pearl and flake, are exported, primarily to Singapore. In 1976–77, it was estimated that about 6000 t of cassava starch were produced each month and 30% was exported. In 1967, it was estimated that the total production of 12 000 t of cassava chips was utilized internally as animal feed and was complemented by locally produced and imported cassava waste from the extraction of starch. Since then, estimates of chip production have varied considerably, ranging as high as 28 000 t for feed millers alone in 1970. No figures are available for the quantities of chips sold directly to consumers for feed. Essentially, no cassava pellets are produced in Malaysia; no chips are exported; and in fact, small quantities of pellets are occasionally imported from Thailand. The large feed millers who use cassava products complain about the lack of consistent supplies of acceptable quality and quantity.

Cassava leaves are also utilized in the region. In Indonesia, the Philippines, and Malaysia, young leaves are consumed as a spinach-type green vegetable after boiling. In Thailand, a Japanese factory mechanically dries leaves and green stems collected from plants at harvest time, pelleting the product and exporting it to Japan as a protein source for use in animal feeds.

Commercial Processing

The methods and equipment used in the production of chips and pellets vary in the different countries of the region; for instance, only in parts of Indonesia where chips are still produced as traditional *gaplek* are the roots individually hand peeled before further processing. In other areas of Indonesia, as in Thailand and Malaysia, whole unwashed roots are fed directly into chipping machines. The amount of soil that passes into the final product is largely determined by soil type and weather conditions during harvesting, wet clay soils tending to adhere to roots.

The chipping machines used and, hence, the size and geometry of the chips produced differ greatly within the region. In Indonesia, following hand peeling, the roots are traditionally cut or split longitudinally by hand, frequently into two or four large pieces only. In some of the large Sumatran enterprises, various chipping machines commonly produce flat transverse or oblique slices about 10 mm thick.

The chipping machines used in Malaysia consist of a heavy rotating circular steel plate about 12 mm thick and 1 m in diameter to which usually six, but sometimes four or eight, cutting blades are attached. The mild steel blades measure about 40 cm × 10 cm × 16 swg (standard wire gauge). One edge is hammered and sharpened into a corrugated cutting edge. Blades of three corrugation sizes are made, but commonly the medium-size ones producing a uniform chip about 6 mm wide and 3–6 mm thick are used. The length of the chips depends on the angle at which roots contact the blades but is frequently around 50–100 mm. The blades are removed and sharpened regularly and are replaced at frequent intervals. The chipping wheels are commonly mounted into wooden frames incorporating feed hoppers and are driven by petrol, diesel, kerosine, or electric motors. There is thus no such thing as a standard Malaysian chipper; the heavy rotating wheel and mounted blades are, however, common to all machines.

In contrast, the Thai chippers use a thin circular plate that is usually made from the ends of 200-litre (44-gal) oil drums and into which cutting edges are chiseled. These crude cutting plates are usually mounted on a fairly standard machine, frequently equipped with small metal wheels for mobility, and a short elevator that deposits the chipped roots into hand carts. The chips produced are very irregular, lumpy, and often greater than 30 mm thick.

The advantages of the Malaysian chipping machines over the Thai machines are that they produce a more uniform product of better geometry and they partially separate the thin brown root skin, which falls to the base of the machines, from the chips.

In Indonesia, the hand-cut roots are sun dried by hanging the pieces on fences or spreading them out on woven mats or racks on bare earth or on roofs. In the chipping factories in Thailand, Malaysia, and Indonesia, the common practice is to produce the chips in the early morning and then distribute them over concrete drying yards. Some chippers delay spreading until midmorning by which time the drying floors have absorbed some heat from the sun.

In Malaysia, the chips are first distributed around the drying yards using small old tractors or cars fitted with wooden boards in bulldozer fashion. The chips are then spread out into a thin layer manually with shovels. In Thailand, the chips are distributed in small hand carts and then spread out manually as in Malaysia. To speed up drying, the chips are usually disturbed every 1–2 hours using simple hand-pushed wooden rakes. At the end of the day or during rainy weather, the chips are heaped into mounds and covered with portable corrugated iron roofs or sheets of tarpauline or polythene. In one drying yard observed in South Sumatra, the concrete was cambered to assist rapid water runoff.

Because sun drying is largely dependent on the weather, the duration of drying and thus the quality of the chips varies considerably. Chip size and geometry together with depth and density of chips, i.e., loading rate, also influence drying time. In Malaysia, the loading rate is usually around 377 kg/10 m^2 of drying yard (15 tons/acre), whereas in Thailand it can be regularly as high as 628 kg/10 m^2 (25 t/a). The lighter loads together with the better geometry of the smaller, more regular chips usually mean the chips are dried to a 15% moisture content within 1½ days during sunny weather.

In Thailand, drying to this moisture level regularly takes 3–4 days, but chips are frequently sold after only 1–2 days drying when they still have a high moisture content, commonly in excess of 20%. Similarly, in Indonesia, the traditionally produced *gaplek* has a moisture content of more than 20% even after sun drying for 1 week. A major factor influencing the final quality of the chips is the quality of the roots being chipped. To produce high quality chips, the roots need to be processed rapidly after harvesting. However, it is common in all countries in Southeast Asia, particularly during rainy periods, to see very large amounts of already deteriorated roots waiting to be chipped and dried; such roots will never produce high quality chips.

The obvious advantage of mechanical drying over sun drying is that it provides a system of continuous processing that is independent of weather conditions. Scattered throughout the region, several mechanized chipping, drying, and pelleting plants have been installed. The majority use oil-fired rotary drum driers. Although a high quality product is frequently produced, the economics of the various systems available need very careful examination.

Pelleting is only practiced in parts of Indonesia and Thailand where the product is primarily for export. It is designed to facilitate bulk handling and to reduce the shipping costs. Two types of pelleting units are in use: highly automated units imported usually from Germany, Switzerland, or USA and native plants that are produced in Thailand. The diameter of the pellets produced is 8–10 mm. In Indonesia, the dried chips and *gaplek* are first hammer milled, whereas in Thailand they are smaller and commonly fed directly into the presses. The native pellet plants do not usually incorporate material preconditioners; thus the chips are fed directly into the pelleting dies or are sometimes simply sprayed with a little water. The recommended moisture content in pelleted cassava is 16–18%; frequently, however, chips with a much higher moisture content are used. Native plants commonly do not have or do not operate either a pellet cooler or a pellet screen and simply bag all the material directly from the presses. This contributes to the generally poor quality of native pellets, although brand pellets are frequently equally poor because conditioners, coolers, and screens are often

Table 1. Production and utilization of cassava in Southeast Asia.

	Indonesia	Thailand	W. Malaysia	Philippines
Production[a]				
Area (millions of ha)	1.50	0.43	0.01	0.09
Yield (t/ha)	8.61	14.82	21.63	5.39
Production (millions of t)	12.92	6.36	0.26	0.48
Utilization[b]				
Human food	*	–	*	*
Starch (internal and export)	*	*	*	*
Animal feed:				
internal	–	–	*	–
export	*	*	–	–

[a]Source: FAO Yearbook 1975.
[b]Key: * positive, – negative or only small amounts.

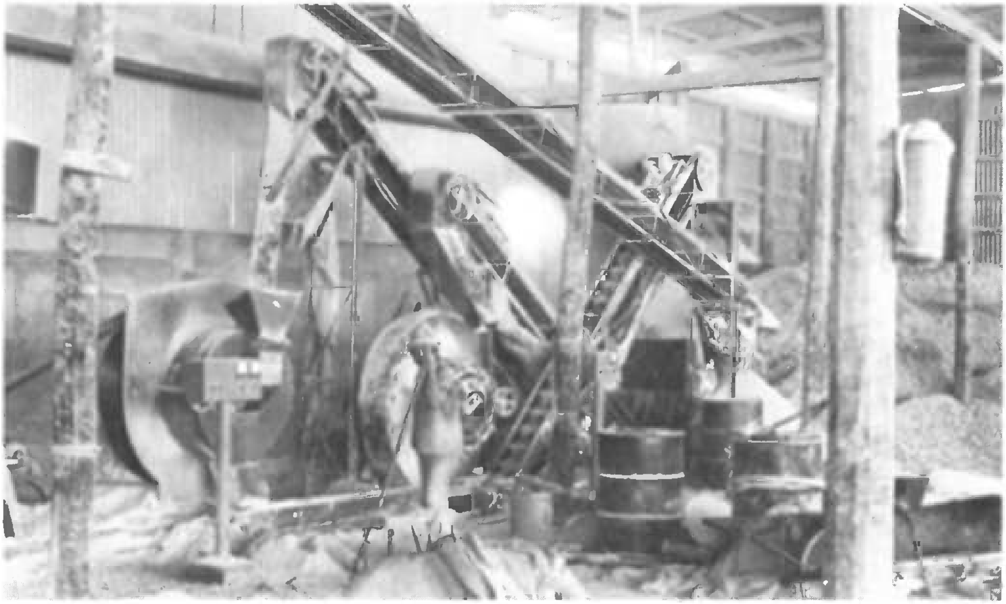

Fig. 1. In Thailand, the bulk of cassava for export is pelleted in local mills. The pellets produced often are adulterated and have a high moisture content.

by-passed to effect economies. In Thailand, in particular, it is common to find extraneous materials, such as sand, corncobs, and cassava waste, being introduced into the presses. This adversely affects the quality of the pellets and reduces the life of the machinery. Thus, in general, very poor quality pellets of friable consistency are produced. Although official standards exist, they are frequently not met, and complaints concerning quality and physical condition of exported pellets are common (Fig. 1).

Although many of the technical factors affecting pellet quality are well known and understood by the industry, there remains little or no incentive to improve product quality. As long as pellet producers and chippers are paid poorly regardless of quality, they will generally produce a poor product to gain in weight and throughput and thus reduce production costs.

Large differences exist in the organization of the industries in the region. In Indonesia, a high proportion of the dried material for pelleting is produced in the form of *gaplek* by small farmers and is in the farmers' house until it is collected by buying agents who quickly send it to the pelleting *godowns*. The *godowns* are large steel and brick buildings where, owing to the seasonality of cassava production in parts of Indonesia, the *gaplek* may be stored for many months before processing. The long storage together with the high moisture content of the *gaplek* encourages mould attack and insect infestation, both of which are common. In Malaysia and Thailand, the dried chips are bagged in jute sacks containing about 70–80 kg and then stored in sheds. Malaysian chips are rarely kept long before despatch whereas Thailand's chips are sent to the pellet producers where they are stored, frequently for long periods, either in sacks or in bulk. During storage, mould growth and insect infestation are common. Most pellets are bagged and transported to the harbour where they are kept in large *godowns* or are stored in special bulk silos to await shipment. In Thailand, therefore, the industry is fairly fragmented and intermediaries are involved at various stages. In Malaysia, the industry tends to be more integrated, and an increasing number of factories have both chip- and starch-processing facilities, enabling them to switch production depending on market prices and weather conditions.

Research and development programs exist in several countries, and much technical information on improved chipping, drying, and pelleting methods is becoming available. One interesting development is the cutting of roots into cubes rather than chips. Cubes, once dried, can be readily bulk handled and so the process of pelleting is avoided and thus the scope for product adulteration is reduced. However, the likelihood of much technology being applied in the industry as a whole is slight under the present marketing and pricing structures. More research data on the importance of all aspects of product quality and quality assessment are required so that appropriate price structures incorporating quality incentives may be soundly drawn up.

Starch Production

In all countries in the region, starch is commercially produced from cassava roots. In many parts, the extracted starch is commonly referred to as "flour"; however, it is considered desirable that the term "flour" be restricted to ground or milled dried products and that the term "starch" be used for the extracted product.

The basic process of starch extraction involves root washing; root crushing/rasping/disintegrating; starch extraction; starch washing/refining; starch dewatering; and starch drying (for more detailed discussions, see Salazar de Buckle p. 26 and Dahlberg p. 33). Generally speaking, two processing methods together with various combinations of these are used throughout the region. One method employs the traditional sedimentation technique and the other uses more modern machinery, such as centrifugal separators, refiners, and flash driers. In the region, the starch extraction industry has been changing rapidly over recent years and many factories are now using modern equipment and methods. Using conventional methods, a total processing time of about 5 days is required, much of this time being absorbed in the repeated washing and resettling of the starch. Using modern equipment, the total processing time is reduced to 1 day or even less. The mechanization of starch production results in not only shorter processing time and a higher throughput but also a higher quality product. Due to the reduced processing time, there is a much lower degree of fermentation and the starch, which is centrifugally extracted, has a higher viscosity, an important consideration for the textile market. Also, substantially higher extraction rates are obtained in modern plants.

For starch extraction plants to run successfully, very careful management is required. Continuous availability of freshly harvested roots is, of course, a major prerequisite, and for the production of top quality starch, the roots should be processed within 24 hours of harvesting. Delays, beyond this, result in the lowering of product quality, and roots older than 3 days produce a very inferior product. Unfortunately, it is only too common to see already deteriorated cassava roots being utilized in a modern extraction plant capable of producing top quality starch.

A further requirement in starch production is a continuous and reliable water supply. It is estimated that the total quantity of water required to process a ton of roots is 14 000–18 000 litres using conventional methods and about 8000 litres using modern equipment. For certain phases of the process, especially the purification of the starch, highly purified water is required. Dissolved impurities contaminate the product and those high in iron content discolour the starch. Treatment of water with sulfur dioxide, a sterilizing and bleaching agent, is practiced in many of the modern plants. It has been observed that general sanitation conditions in many of the factories, particularly those using sedimentation techniques, are unsatisfactory.

In factories using traditional sedimentation techniques, flake and pearl are sometimes produced by additional processing of the moist starch. Pearl is made by placing partially dried, or a mixture of wet and dry starch, into open, slightly inclined cylindrical rotating drums. During rotation, the starch grains adhere to form small beads, the sizes of which are influenced by the speed and duration of rotation. The raw pearl is then size graded, placed in iron pans, set in fire bricks, and heated from below by a wood fire. The pans are slightly greased and are rotated. The baking takes about 3–5 minutes at a temperature of about 65–75 °C, which causes the starch to gel. The baked product is again size screened into different grades of pearl (sago) and finally dried for 12–24 hours on wood-fired, starch-drying yards. Flakes are irregular lumps of semigelled starch prepared in a similar manner to pearl except that the moist starch is not formed into beads.

The waste material from starch plants is used in various ways. In Malaysia, it is sold to local farmers either in the wet state or following sun drying. In Thailand, the refuse is commonly sun dried and then sold to cassava-pelleting factories where it is incorporated into cassava pellets for export.