Innovative equipment for cassava dewatering

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This document describes a piece of innovative equipment developed to mechanically dewater cassava mash. The press uses chain-hoist, overcoming the main issues of the equipment currently available for cassava dewatering in sub-Saharan African countries, namely elevated work drudgery and low throughput. The document also describes the results from a preliminary assessment and outline follow-up activities. The activity was funded by the CGIAR Research Program on Roots, Tubers and Bananas (RTB) and executed by the Natural Resources Institute (NRI) of the University of Greenwich, UK, in partnership with the Food Research Institute (FRI) of the Council for Scientific and Industrial Research (CSIR), Ghana.

Background

In most cassava processing centres in sub-Saharan Africa, the cassava roots are hand-peeled, washed and grated into a mash. The mash is mechanically dewatered with a press and the resulting press-cake is pulverized with another grater. The obtained cassava grits are introduced into a dryer, that reduces the moisture content of the product down to 12% on a wet basis (wb). Finally, the dried cassava grits are milled with a hammer mill. Figure 1 shows the main units of operation and the moisture content reduction of the material.

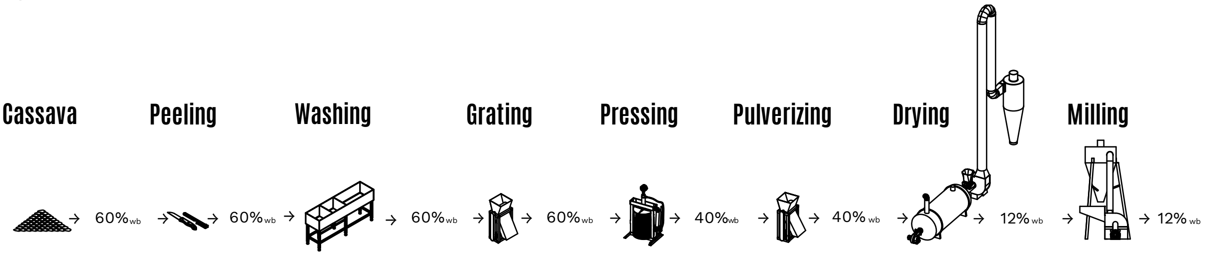

Figure 1 *Overview of the cassava processing main units of operation.*

Dewatering is a solid-liquid separation process. Reducing moisture content by dewatering is significantly less expensive than drying. This is because the energy required to remove water by mechanical means is less than the energy needed for drying. Therefore, by mechanically reducing the material moisture content the energy needed for the subsequent drying is minimized. However, while the object is to remove as much water as possible, doing it consistently is equally important to achieve a final product of uniform quality.

In sub-Sahara Africa, cassava dewatering is mostly done with presses. Dewatering with presses is based on the application of pressure to disrupt the root cells and release the contained water. It is basically a squeezing process, where, under pressure, the cells rupture and the water from it flows out. Dewatering with presses depends largely on the amount of mechanical force applied. In most of the presses being used in sub-Sahara Africa, this force is generated by a screw or hydraulic mechanism.

Screw operated presses consist of a ram which is driven upwards and downwards with the help of a screw and a shaft. The top and bottom platforms are attached by a double (Figure 2a) or single (Figure 2b) screw that can make the two platforms come closer or further apart. By placing the wet cassava mash in between the two platforms, and moving the platforms towards each other, a compression force is exerted which squeeze the water out of the wet cassava mash.

Figure 2 *Double screw operated (a), and single screw operated press (b), both being used to dewater cassava mash.*

Hydraulic operated presses use a hydraulic mechanism to generate the force. It can be hand-powered using a hydraulic jack (Figure 3a), or a motor-powered using a hydraulic pump (Figure 3b).

Figure 3 *Hand-powered (a) and motor-powered (b) hydraulic press used for cassava mash dewatering.*

Presses that uses the screw mechanism is common due to their simplicity and durability. However, the amount of force that can be generated with screw operated presses is inferior to what can be applied with a hydraulic operated one. Still, the hand-powered hydraulic press is particularly labour intensive and the motor-powered operated one has much higher capital and running costs, requiring electricity to operate and regular maintenance. The objective of this work was to develop a piece of innovative dewatering equipment that reduces work drudgery, has high capacity and low capital and running costs. A press that uses a set of chain-hoist was designed and, after manufacturing it, tested in a cassava processing centre in Ghana.

Innovative dewatering equipment

The designed innovative press has a frame with a plunge, a reinforced basket and 4 chain-hoists of 20 tonnes of capacity each (Figure 4). The frame supports the chain-hoists and the plunge. The basket is for placing the material and the chain-hoists for lifting the basket, pressing the mash against the plunge, consequently squeezing the water out of it (Figure 5).

Figure 4 *The innovative press uses a chain-hoist to lift a basket containing the material, pressing it against a plunge.*

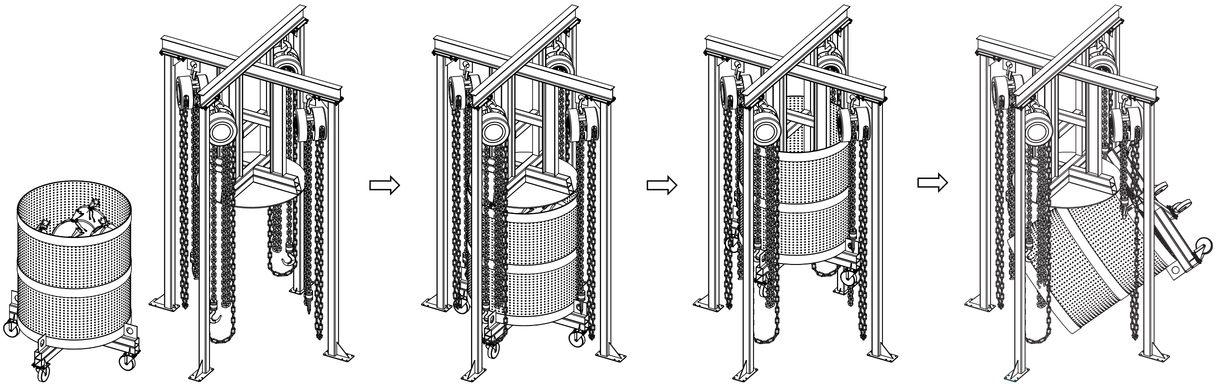

Figure 5 *The material is placed in a basket and the basket is lifted against a plunge, squeezing the mash.*

Preliminary equipment evaluation

The innovative press was manufactured locally (Figure 6) and installed in a processing centre in Accra. This processing centre uses a screw operated press for dewatering (Figure 7).

Figure 6 *Innovative press that uses chain-hoists, locally manufactured and installed in a cassava processing centre.*

Figure 7 *Screw operated press used for mechanical dewatering of cassava mash.*

During the press preliminary evaluation, data on the amount of material loaded to the press, and the amount of material removed from the equipment after pressing, was recorded using a digital weighing scale. The time needed for dewatering was also recorded. The chronometer was started when the operator initiated the pressing procedure and stopped when the pressure was released. In the end, samples of the pressed material were collected and submitted to moisture content analysis. Data was collected in triplicates for each press: screw operated press and chain-hoist operated press. Table 1 shows the obtained results from the preliminary evaluation.

Table 1 *Results from the preliminary evaluation of the innovative press, compared to screw operated one.*

Press type	Mash input rate (kg/h)	Press cake output rate (kg/h)	Water removal rate (kg/h)	Cake moisture content ($\%_{wb}$)
Screw operated	269.5^{a}	189.1^{a}	80.4^{a}	44.6^{a}
Chain-hoist	$1,260.3^{b}$	$1,000.1^{b}$	260.2^{b}	44.9^{a}

Means followed by a common letter are not significantly different by LSD-test at 5% level of significance.

The innovative press was able to reduce the moisture to the same level that the screw operated press achieved, but with much higher throughput and less work drudgery. However, the target moisture content of $40\%_{wb}$ was not reached. It might be possible to reach it by increasing the pressing time, but this still needs to be tested.

Follow-up activities

While the innovative press proved to be effective and easy to operate. Its throughput and manufacturing cost are only suitable for processing centre drying more than 4 tonnes of roots per day. For smaller operations, the press needs to be of reduced size and less expensive. The main component aggregating cost to this press is the chain-hoists. Therefore, a piece of new equipment will be designed, using the same principle, but with a throughput suitable for processing centres drying less than 4 tonnes of root per day, and substituting the costly chain-hoists with a pulley system driven by hand winches, as shown in Figure 8.

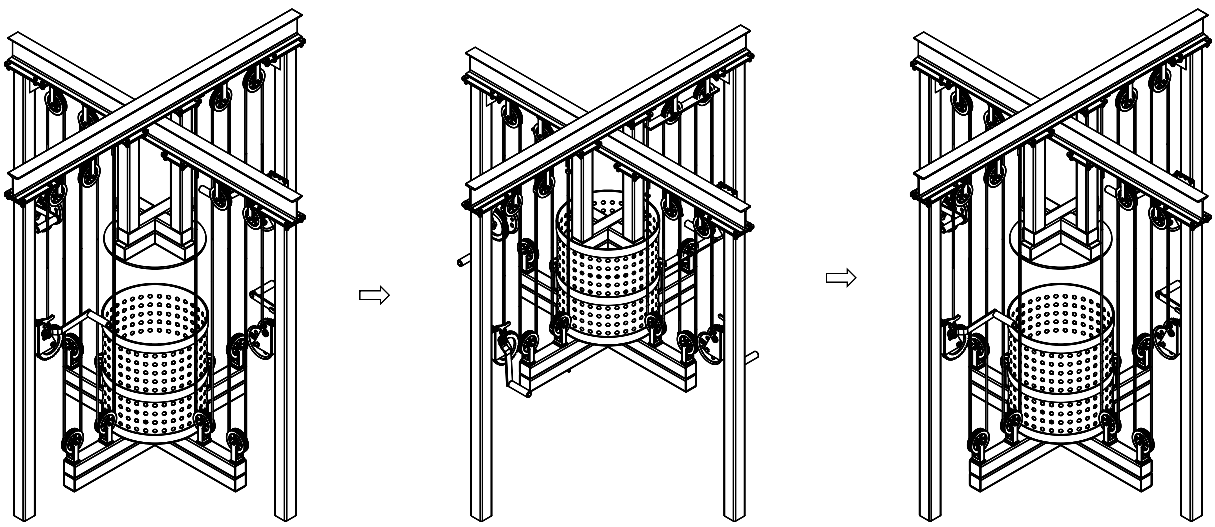

Figure 8 *Winch operated press that uses a pulley system to amplify the mechanical force (not to scale).*

After the construction of this smaller press, a comprehensive and thorough assessment will be performed. This assessment will compare the performance between hydraulic, screw, chain-hoist and winch operated presses. Table 2 shows the follow-up activities schedule.

Table 2 *Follow-up activities related to cassava mechanical dewatering.*

Activities	2020				2021			
Construction of hand-winch operated press for cassava dewatering			■					
Performance assessment of mechanical dewatering equipment							■	