



Original scientific paper

DOI: 10.17508/CJFST.2020.12.1.04

Upscaling cassava processing machines and products in Liberia

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ARTICLE INFO

Article history:

Received: November 1, 2018

Accepted: November 26, 2019

Keywords:

Liberia

cassava products

processing machines

livelihood

vulnerable group

ABSTRACT

Cassava is produced by more than 80% of farming households and is an important contributor to gross domestic product (GDP) in Liberia. It is therefore important to assess the status of cassava processing into food and other products. A total of one hundred and sixty (160) well-structured questionnaires were used for the collection of information from eight counties, with twenty respondents from each county. It was found out that all the counties lack adequate modern cassava processing machines, with almost all cassava processing operations being done with rudimentary equipment. Gari and wet fufu are common products in Liberian markets, with no high-quality cassava flour (HQCF) or derivatives. Consequently, user and gender friendly processing machines were installed in six established modern cassava processing centres, and new cassava products, such as fufu powder, tapioca, and HQCF with its value-added products (10% bread and pastries), were introduced. This upscaling will enhance the cassava value chain in Liberia with improvement in livelihoods, especially for vulnerable women and unemployed youth.

Introduction

Cassava is produced by over 80% of farming households and is an important contributor to the GDP in Liberia, with about 53, 4810 tons produced in 2014 (Coulibaly et al., 2014). Fresh cassava root has a high moisture content (75-80 %) Thus, it undergoes rapid spoilage within 2 to 3 days if not immediately processed (Oyewole and Asagbra, 2003; Oluwole et al., 2004; Ashaye et al., 2005). Processing cassava root makes it palatable, decreases toxicity, and prolongs shelf-life (Sanni, 1991). Almost all cassava root harvested in Liberia is processed into various forms for human consumption. This includes gari, depah, fufu, attieke, starch, and dumbo (Awoyale et al., 2018). Besides the root, the leaves are consumed extensively as a vegetable, and as the source of proteins.

Cassava roots are mainly processed using traditional methods and processing is usually done by women in Liberia. Traditional cassava processing does not require sophisticated equipment. For instance, the traditional cassava grater for gari processing in Liberia is made of flattened kerosene tin or iron sheet perforated with nails and fastened to a wooden board with handles. The grating operation is done by rubbing the peeled roots against the rough perforated surface of the iron sheet that crushes the peeled cassava root into mash (Coulibaly et al., 2014), and at times cuts the hand of the processor, resulting in a mixture of human blood with the cassava mash, which has health and safety implications for consumers of *gari*. However, various attempts have been made by different programs and projects to improve graters in Liberia. Big stones are used to press water out from the grated mash, and tied wooden frames are used in

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places where big stones are not available. The roasting of the fermented cassava mash is done using pans made from iron or earthen pots, using fuelwood as a source of energy. However, fuelwood may not be easily or cheaply obtained in the future because of rapid deforestation. Drying of the dewatered cassava mash for *depah* production is done on flat rocks, tarred roads, and even on the bare floor, with or without the use of polyethylene sheets, exposing the product to environmental contamination. The milling operation of the dried cassava mash is done using the local pestle and mortar and sieved into powder with a locally made sieve. Most of these processing operations take place under a locally constructed building with little or no professional contribution. Consequently, slight changes in the cassava processing equipment housed in a professionally constructed building can help to save fuel and lessen the discomfort, health hazard, and drudgery for the women who carry out these operations.

As the urban population expands, the demand for more convenience and shelf-stable foods increases. Some cassava foods, such as different types of value-added and branded gari from different processors are highly valued by urban population, and these have managed to retain their markets in Liberia. Imported food products are important urban foods but there is still a high demand for traditional foods, although they are often considered less acceptable because of the concerns of quality and safety (Sanni et al., 2007, Awoyale et al., 2018). Consequently, to increase food security, improve the livelihoods of vulnerable women, and adequately develop the postharvest and marketing systems for cassava in Liberia, the SAPEC project through the Ministry of Agriculture in collaboration with the International Institute of Tropical Agriculture (IITA) deemed it fit to upscale the cassava processing machines and products in Liberia.

Materials and methods

A survey of cassava processing machines and products in Liberia using Rivercess, Grand Bassa, Bomi, Margibi, Sinoe, Gbarpolu, Montserrado, and Grand Capemount counties, was conducted, as a case study, by means of a well-structured questionnaire, administered through a participatory learning technique. A total of 160 questionnaires were administered in markets and available processing centres in eight counties, with twenty respondents from each county. Some of the major questions directed to the respondents included/considered the demographic information of cassava actors, the available cassava processing machines and value

added products in Liberia, prior to the project implementation. The data generated was subjected to quantitative statistical analyses using SPSS version 21.0. The outcome of this survey was used for the training of cassava processors on different value-added products, procurement of modernized processing machines/equipment, and the construction of a modern cassava processing hubs, which were initiated, implemented, and supervised by IITA.

Results and discussions

The result of the demographic information of the cassava actors in Liberia (Table 1) showed that over 50% are involved in cassava production in all the counties except for Montserrado and Grand Capemount, where more people are involved in marketing (50%) and consumption (30%). This was contrary to the observation of Coulibaly et al. (2014) that Montserrado County is one of the main areas of cassava production regardless of their total output and the number of farming families involved. This implied that 70% of the respondents in Grand Capemount County may be consuming more of the major staple (rice) than cassava products. Most of the cassava actors are married with a primary school certificate and are between 41 and 50 years old except for Montserrado and Grand Capemount where the age ranged from 31 to 40 years. This implied that younger people are not interested in cassava production in counties such as Montserrado and Grand Capemount. This may be attributed to the fact that most young people are engaged in activities where they can make money fast, instead of planting cassava and waiting for eleven or twelve months before harvesting. More than 60% of the people do not belong to any cooperative society, which may be the result of mismanagement of funds or self-centeredness on the part of the leaders of the cooperatives. However/ on the contrary, Coulibaly et al. (2014) reported that 60% of cassava processors belong to an organization where they have access to credits, inputs, and information. Men were the main actors in counties such as Rivercess (70%), Bomi (70%), and Margibi (67%), while women dominate in Grand Bassa (59%), Sinoe (78%), and Montserrado (80%). Gbarpolu and Grand Capemount counties have equal participation of both sexes. The survey carried out by Coulibaly et al. (2014) revealed that most of the cassava enterprises are directed by women within an average age of 48.

Table 1. Demographic information of cassava actors in Liberia

| County | Rivercess | | Grand Bassa | | Bomi | | Margibi | | Sinoe | | Gbarpolu | | Montserrado | | Grand Capemount | |
|----------------------------|-----------|------|-------------|------|-------|----|---------|----|-------|----|----------|-----|-------------|-----|-----------------|----|
| | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % |
| Sex | | | | | | | | | | | | | | | | |
| Male | 12 | 71 | 9 | 41 | 14 | 70 | 14 | 67 | 4 | 22 | 10 | 50 | 4 | 20 | 10 | 50 |
| Female | 5 | 29 | 13 | 59 | 6 | 30 | 7 | 33 | 14 | 78 | 10 | 50 | 16 | 80 | 10 | 50 |
| Age (yrs) | | | | | | | | | | | | | | | | |
| Not available | 4 | 24 | 3 | 14 | 0 | 0 | 2 | 10 | 8 | 44 | 2 | 10 | 4 | 20 | 3 | 15 |
| 20–30 | 3 | 18 | 3 | 14 | 1 | 5 | 4 | 19 | 0 | 0 | 2 | 10 | 3 | 15 | 2 | 10 |
| 31–40 | 3 | 18 | 3 | 14 | 8 | 40 | 6 | 29 | 3 | 17 | 6 | 30 | 9 | 45 | 7 | 35 |
| 41–50 | 6 | 35 | 5 | 23 | 9 | 45 | 8 | 38 | 4 | 22 | 7 | 35 | 4 | 20 | 5 | 25 |
| 51–60 | 1 | 6 | 6 | 9 | 2 | 10 | 1 | 5 | 3 | 17 | 3 | 15 | 0 | 0 | 3 | 15 |
| Education | | | | | | | | | | | | | | | | |
| Degree | 2 | 12 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Primary | 8 | 47 | 7 | 32 | 19 | 95 | 10 | 48 | 14 | 78 | 7 | 35 | 6 | 30 | 5 | 25 |
| SSCE | 5 | 29 | 3 | 14 | 1 | 5 | 2 | 10 | 2 | 11 | 1 | 5 | 3 | 15 | 0 | 0 |
| Diploma | 1 | 6 | 1 | 5 | 0 | 0 | 3 | 14 | 0 | 0 | 3 | 15 | 1 | 5 | 0 | 0 |
| Others | 1 | 6 | 10 | 46 | 0 | 0 | 6 | 29 | 2 | 11 | 9 | 45 | 10 | 50 | 15 | 75 |
| Marital status | | | | | | | | | | | | | | | | |
| Married | 13 | 77 | 20 | 91 | 19 | 95 | 20 | 95 | 17 | 94 | 20 | 100 | 11 | 55 | 19 | 95 |
| Single | 4 | 23 | 2 | 9 | 1 | 5 | 1 | 5 | 1 | 6 | 0 | 0 | 9 | 45 | 1 | 5 |
| Cassava involvement | | | | | | | | | | | | | | | | |
| Producers | 15 | 88 | 13 | 59 | 17 | 85 | 11 | 52 | 13 | 72 | 18 | 90 | 3 | 15 | 4 | 20 |
| Processors | 2 | 12 | 3 | 14 | 3 | 15 | 5 | 24 | 4 | 22 | 0 | 0 | 5 | 25 | 4 | 20 |
| Marketers | 0 | 0 | 3 | 14 | 0 | 0 | 1 | 5 | 0 | 0 | 2 | 10 | 10 | 50 | 4 | 20 |
| Consumers | 0 | 0 | 1 | 5 | 0 | 0 | 2 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 30 |
| Fabricator | 0 | 0 | 2 | 9 | 0 | 0 | 2 | 10 | 1 | 6 | 0 | 0 | 2 | 10 | 2 | 10 |
| Cooperative | | | | | | | | | | | | | | | | |
| No | 13 | 76.5 | 18 | 81.8 | 12 | 60 | 16 | 76 | 15 | 83 | 15 | 75 | 20 | 100 | 16 | 80 |
| Yes | 4 | 23.5 | 4 | 18.2 | 8 | 40 | 5 | 24 | 3 | 17 | 5 | 25 | 0 | 0 | 4 | 20 |

Freq. = Frequency

Table 2. Available cassava processing machines in Liberia

| Machine | Rivercess | | Grand Bassa | | Bomi | | Margibi | | Sinoe | | Gbarpolu | | Montserrado | | Grand Capemount | |
|---------------------------|-----------|-----|-------------|-----|-------|-----|---------|-----|-------|-----|----------|-----|-------------|-----|-----------------|-----|
| | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % |
| Peeling | | | | | | | | | | | | | | | | |
| No | 17 | 100 | 22 | 100 | 20 | 100 | 21 | 100 | 15 | 100 | 20 | 100 | 18 | 90 | 20 | 100 |
| Yes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |
| Grating | | | | | | | | | | | | | | | | |
| No | 12 | 71 | 19 | 86 | 19 | 95 | 19 | 57 | 13 | 72 | 16 | 80 | 19 | 95 | 13 | 65 |
| Yes | 5 | 29 | 3 | 14 | 1 | 5 | 9 | 43 | 5 | 28 | 4 | 20 | 1 | 5 | 7 | 35 |
| Pressing | | | | | | | | | | | | | | | | |
| No | 13 | 77 | 19 | 86 | 19 | 95 | 18 | 86 | 16 | 89 | 20 | 100 | 19 | 95 | 19 | 95 |
| Yes | 4 | 23 | 3 | 14 | 1 | 5 | 3 | 14 | 2 | 11 | 0 | 0 | 1 | 5 | 1 | 5 |
| Sieving | | | | | | | | | | | | | | | | |
| No | 15 | 88 | 19 | 86 | 19 | 95 | 20 | 95 | 18 | 100 | 20 | 100 | 18 | 90 | 20 | 100 |
| Yes | 2 | 12 | 3 | 14 | 1 | 5 | 1 | 5 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |
| Drying | | | | | | | | | | | | | | | | |
| No | 17 | 100 | 19 | 100 | 20 | 100 | 20 | 95 | 18 | 100 | 20 | 100 | 18 | 90 | 20 | 100 |
| Yes | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |
| Chipping | | | | | | | | | | | | | | | | |
| No | 15 | 88 | 22 | 100 | 20 | 100 | 21 | 100 | 18 | 100 | 20 | 100 | 18 | 90 | 20 | 100 |
| Yes | 2 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |
| Mechanical Roaster | | | | | | | | | | | | | | | | |
| No | 15 | 100 | 22 | 100 | 20 | 100 | 21 | 100 | 18 | 100 | 20 | 100 | 18 | 90 | 20 | 100 |
| Yes | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |
| Roasting Pan | | | | | | | | | | | | | | | | |
| No | 12 | 29 | 5 | 23 | 6 | 30 | 8 | 38 | 0 | 0 | 9 | 45 | 20 | 0 | 0 | 0 |
| Yes | 5 | 71 | 17 | 77 | 14 | 70 | 13 | 62 | 18 | 100 | 11 | 55 | 0 | 100 | 20 | 100 |
| Packaging | | | | | | | | | | | | | | | | |
| No | 15 | 88 | 22 | 100 | 18 | 90 | 20 | 95 | 18 | 100 | 20 | 100 | 18 | 90 | 20 | 100 |
| Yes | 2 | 12 | 0 | 0 | 2 | 10 | 1 | 5 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |

Freq. = Frequency

The increase in the participation of men in the cassava enterprises in counties such as Rivercess, Bomi, and Margibi, in contrary to the findings of Coulibaly et al. (2014), may be linked to the possibilities of getting

money to take care of their families from any aspect of the cassava value chain, since cassava root is normally left in the soil until it is required for sale.

Traditional cassava processing does not require sophisticated equipment. Thus, there is an absence of modern cassava processing equipment in Liberia (Table 2). The survey depicts that most of the cassava processing operations are done locally. The most common equipment found in all counties was the roasting pan. The peeling machine combined with a chipper, which is not currently being used is available only in Montserrado (10%). Less than 45% of the cassava processors in Liberia have a grating machine, with Margibi having the highest percentage (43%) while Bomi and Montserrado had the lowest (5%). However, local graters made from zinc sheets are available in all the counties. The highest percentage of

pressers was found in Rivercess County (24%) and Gbarpolu County processors have no press apart from the local pressing method that uses tied wooden frames, and which was common in all the counties. These findings agreed with the outcome of the survey done by Coulibaly et al. (2014). The cabinet dryer is available only in Montserrado County (10%). The mechanical roaster (10%) is available in Montserrado County but is not working. To this end, the SAPEC project through IITA initiated and supervised the construction of six modern cassava processing centres in Montserrado (1), Grand Bassa (1), Sinoe (1), and Bomi (2) counties, as well as in CARI based in Bong County.

Table 3. Modern cassava processing equipment now available in each centre

| S/No | Equipment | Capacity | Quantity/center |
|------|---|-------------|-----------------|
| 1 | Cake breaker/pulverizer (5 Hp 3 phase) | 4 tons/h | 1 |
| 2 | Wet hammer mill (15 Hp 3 phase) | 3 tons/h | 1 |
| 3 | Dry hammer mill (15 Hp 3 phase coupled with blower) | 1 ton/h | 1 |
| 4 | Six cyclone flash dryers (10 Hp 3 phase) | 300 kg/h | 1 |
| 5 | Hydraulic press | 32tons | 2 |
| 6 | 1000 kg Avery weighing scale | | 1 |
| 7 | 500 kg Avery weighing scale | | 1 |
| 8 | 200 kg hanging scale | | 1 |
| 9 | Stitching machine | 220 V/50 Hz | 1 |
| 10 | Generator | 80 KVA | 1 |

Table 4. Cassava root products available in Liberia

| Cassava products | Rivercess | | Grand Bassa | | Bomi | | Margibi | | Sinoe | | Gbarpolu | | Montserrado | | Grand Capemount | |
|--------------------|-----------|-----|-------------|-----|-------|-----|---------|-----|-------|-----|----------|-----|-------------|-----|-----------------|-----|
| | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % | Freq. | % |
| Starch | | | | | | | | | | | | | | | | |
| No | 15 | 88 | 22 | 100 | 18 | 90 | 15 | 71 | 17 | 94 | 16 | 80 | 19 | 95 | 15 | 75 |
| Yes | 2 | 12 | 0 | 0 | 2 | 10 | 6 | 29 | 1 | 6 | 4 | 20 | 1 | 5 | 5 | 25 |
| Wet fufu | | | | | | | | | | | | | | | | |
| No | 2 | 12 | 9 | 41 | 1 | 5 | 7 | 33 | 0 | 0 | 2 | 10 | 15 | 75 | 14 | 70 |
| Yes | 15 | 88 | 13 | 59 | 19 | 95 | 14 | 67 | 18 | 100 | 18 | 90 | 5 | 25 | 6 | 30 |
| Dumbo | | | | | | | | | | | | | | | | |
| No | 3 | 18 | 12 | 55 | 12 | 60 | 16 | 76 | 15 | 83 | 4 | 20 | 20 | 100 | 17 | 85 |
| Yes | 14 | 82 | 10 | 45 | 8 | 40 | 5 | 24 | 3 | 17 | 16 | 80 | 0 | 0 | 3 | 15 |
| Gari | | | | | | | | | | | | | | | | |
| No | 3 | 18 | 9 | 41 | 6 | 30 | 6 | 29 | 0 | 0 | 6 | 20 | 16 | 80 | 12 | 60 |
| Yes | 14 | 82 | 13 | 59 | 14 | 70 | 15 | 71 | 18 | 100 | 14 | 80 | 4 | 20 | 8 | 40 |
| GB | | | | | | | | | | | | | | | | |
| No | 15 | 88 | 19 | 86 | 15 | 75 | 19 | 91 | 17 | 94 | 4 | 20 | 18 | 90 | 18 | 90 |
| Yes | 2 | 12 | 3 | 14 | 5 | 25 | 2 | 9 | 1 | 6 | 16 | 80 | 2 | 10 | 2 | 10 |
| Fried chips | | | | | | | | | | | | | | | | |
| No | 16 | 94 | 22 | 100 | 20 | 100 | 20 | 95 | 18 | 100 | 20 | 100 | 20 | 100 | 20 | 100 |
| Yes | 1 | 6 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depah | | | | | | | | | | | | | | | | |
| No | 11 | 65 | 21 | 95 | 13 | 65 | 8 | 38 | 12 | 67 | 4 | 20 | 17 | 85 | 14 | 70 |
| Yes | 6 | 35 | 1 | 5 | 7 | 35 | 13 | 62 | 6 | 33 | 16 | 80 | 3 | 15 | 6 | 30 |
| HQCF | | | | | | | | | | | | | | | | |
| No | 17 | 100 | 22 | 100 | 20 | 100 | 21 | 100 | 18 | 100 | 20 | 100 | 20 | 100 | 20 | 100 |
| Yes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Freq.=Frequency

These processing centres were fully equipped with modern cassava processing machines such as a mechanical peeler, wet and dry hammer mill, pressers, weighing machines, and flash dryer (Table 3). The mechanical peeler is to replace the use of manual peeling with a knife, the wet hammer mill for crushing cassava into mash in place of the locally made manual graters, the dry hammer mill for milling

to replace the use of the pestle and mortar, and weighing machines for weighing fresh roots during procurement and final products during packaging, which were not done prior to the project intervention. The flash dryer will replace the use of flat rocks, tarred roads, and bare floors with or without the use of polyethylene sheets for drying cassava products (Fig. 1).



Fig 1. Upscaled cassava processing equipment in Liberia

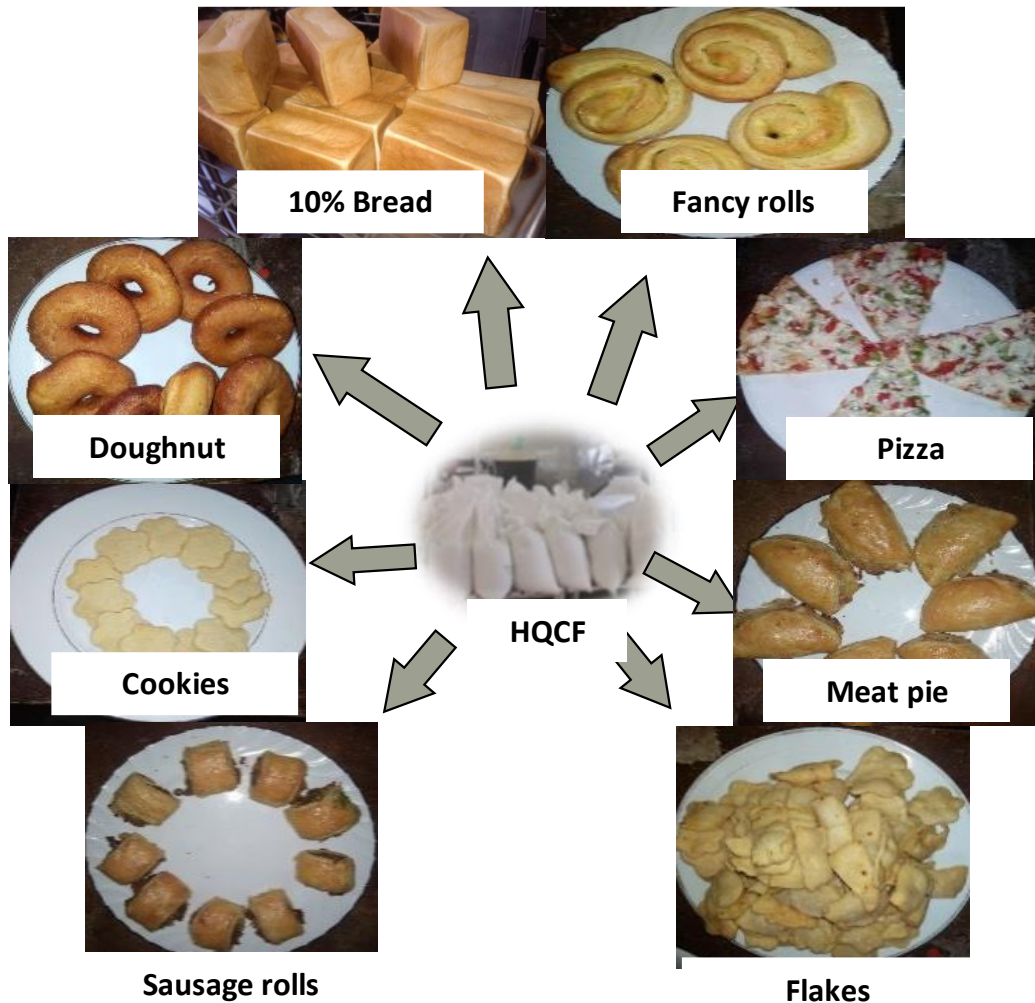


Fig 2. High quality cassava flour value-added products

One of the fully equipped processing centres based in Montserrado County was recently commissioned by the President of Liberia, Mrs Ellen Johnson Sirleaf (Wiakanty, 2017). A sister project (Liberia Agricultural Development Activity) is planning to replace the roasting pan with a mechanical roaster in some of the modern processing centres. In addition to the technology transfer from IITA to Liberia, was the construction of a septic tank (2 m × 2 m × 2 m) and a soakaway (4 m × 4 m × 5 m) for the proper disposal of liquid effluent from the processing centers. Furthermore, this intervention was complemented by many trainings for cassava farmers on cassava production through improved varieties, demonstration farms, and the introduction of good agricultural practices. These interventions may contribute to the growth of the Liberian economy if properly managed and sustained by the beneficiaries, thus, a need for the impact assessment study at the end of the project.

In Liberia, cassava is normally left in the soil until it is required for sale, consumed by the farmer, or processed into a more palatable product. Table 4 shows the available cassava products in Liberia. Gari and wet fufu are the common cassava products, with Sinoe County having the highest (100%) and Montserrado the lowest (20% and 25%, respectively). This does not support the result of Coulibaly et al. (2014), who reported that Grand Bassa County was among the highest producers of gari in Liberia. Less than 6% of fried chips and 30% of starch are available in Liberia. “GB” is another cassava product common in Gbarpolu (80%), with less than 30% availability in other counties. The HQCF (0%) is not available in Liberia, while depah is available, with Gbarpolu (80%) and Margibi (62%) having the highest percentage. Thus, the availability of each of the cassava products in Liberia depends on their level of consumption in each county. Due to the low level of cassava value addition in Liberia, IITA trained a total

of 500 cassava processors (351 women and 149 men) on the production of fufu powder, powdered starch, tapioca, and HQCF. The HQCF produced was used for the training on production of 10% cassava bread, cake, doughnut, meat and fish pies, puff-puff and chin-chin among others (Fig. 2). This is because prior to the introduction of HQCF to Liberians, depah was used for baking, which gives the baked products a sour taste. Most of these value-added products are presently being sold in an open and in supermarkets in Liberia, thus creating jobs and contributing to the country's GDP. Additionally, standard operating procedures for consistency in product quality wereshared with the processors. (Awoyale, 2018).

Conclusion

The introduction of the modernized cassava processing machines such as the peeling machine, wet and dry hammer mill, pressers, the pulverizer, and the flash dryer, as well as the training on the production of fufu powder, starch/tapioca grits, and high quality cassava flour with its value-added products (10% cassava bread and pastries) will increase food security, create jobs, improve the livelihoods of vulnerable women, and increase cassava's popularity and its use as a cash crop to boost the country's GDP. The participation of more educated youth and women, with proper backstopping from the Liberia government, in all the areas of the cassava value chain will contribute to the sustainability of the project output.

Funding

This research was funded by the Global Agriculture and Food Security Program (GAFSP) of the World Bank, and the African Development Bank (AfDB) under the Smallholder Agricultural Productivity Enhancement and Commercialization (SAPEC) project.

Acknowledgments

The laboratory analyses of the *gari* samples were done at the Food and Nutrition Sciences laboratory of IITA, Nigeria.

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