Mechanization Strategies and Economic Sustainability of Akpu and Fufu Production Technologies in Cross River State, Nigeria

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Abstract

Mechanization Strategies and Economic Sustainability of akpu and fufu Production Technologies in Cross River State, Nigeria was studied. Akpu and fufu recipes are consumed by majority of the population in the state and environs. Most farmers are engaged in producing akpu and fufu mainly for consumption and economic gains. In spite of the afore mentioned, level of mechanization remains very low with poor quality, output and high drudgery. 50 akpu and fufu production communities were randomly selected in each of the three geo-political zones of the state, making a total of 150 communities for studies. Collection of data was carried out including interview, use of structured questionnaires, physical observation, participation and sensory analysis. Analysis of data revealed that, akpu and fufu pastes are the major sources of food and economic sustainability in the state and environs. Majority of the farmers affirmed that processing of cassava into akpu and fufu are the major agricultural activity carried out for food provision and economic well-being. Thus, 67% of the akpu and fufu processors affirmed that their products are accessible, affordable and acceptable among the people. According to the study 48% respondents process akpu and fufu pastes mainly for consumption, while 52% process the products mainly for sales, but lacks funds and machineries to increase production. Hence, provision of funds (loans and grants) to farmers should be encourage to enhance production. More research should be carried out towards equipment development for mechanising akpu and fufu production to enhance economic sustainability of farmers.

Keywords: *Mechanization, Strategies, Akpu, Fufu, Production, Technologies*

1. Introduction

Nigeria is the leading producer of cassava (Manihot esculenta Crantz) globally, **accounting for about one-fifth (21%) of total production worldwide** with an annual production of about 60 million tonnes **[14].** Cassava has been put to use in various ways and each component of cassava plant, from leave to roots can be utilized in one way or another [5]. Some communities in Nigeria and beyond consume cassava leaves as vegetable in soup preparation or dried and fed to livestock as protein feed supplement. It is known globally as a cheap source of calorie in human diet and animal feeds especially in Africa where it accounts for 60% of root crops consumption. Cassava is primarily a source of carbohydrate and contains very little protein or fat. The approximate composition of the cassava tuber is starch, 20-30%; protein, 2-3%; water, 75-80%; fat, 0.1%; fibre, 1.0%; ash, 1-1.5% [4]; [7] and [16].

1.1 Mechanization of Cassava Processing Technologies

Cassava is consumed in all the 6 geopolitical zones of the country. It is the second most consumed staple food after maize and has become a food security crop due to its increased significance in the country [2], [9] and [1]. Owing to the large production, the crop is processed into many food items such as Gari, Akpu, Fufu, Lafun, Cassava chips, Abacha, Starch, Cassava Baking Flour and others [11] and [12]. [8] reported that Several efforts have been made to develop suitable indigenous machines for cassava processing; this attempt was made to make the cassava mash process more energy-efficient and to meet the Millennium Development Goals (MDGs), aimed at poverty reduction over a stipulated period of time. [10] recorded that constraints to cassava processing include the absence of efficient equipment; appropriate processing technologies, machines, and tools. These are not easily affordable and sometimes unavailable at the farm level. The currently available ones were merely fabricated without adequate engineering research. Furthermore, equipment available are the grater, dryer, dewatering machines in the processing of gari and cassava milling machine into flour.

1.2 Akpu and Fufu Technologies

Akpu and Fufu are the products of soaked fermented cassava roots, widely consumed in Nigeria. According to [12] the quality of fufu has been known to vary from one location to another. The processing technique may be responsible for this variation in quality. Hence it is therefore imperative to develop appropriate technologies affordable by the small-scale processors of cassava into akpu and fufu.

Fermented cassava mashing/loosening and sieving is commonly and manually done using perforated plastic, metal and locally made, calabash sieves to remove unfermented casava and other chaff. Loosening and sieving is done manually by placing in batches, fermented cassava in the sieve and continuously rubbing it against the sieve till the paste is sieved into a basin of clean water, leaving the unfermented cassava and other chaff in the sieve. [13] reiterated that fermented cassava mashing by hand was the only method identified. [12] further reported that Cassava mashing by hand was observed to be the dominant method of mashing in Abeokuta agricultural zone.

Mashing with hand was possible due to the softening of the tubers after soaking. The use of mortar and pestle and hammer mill for mashing is prominent in Ilaro agricultural zone, although mashing with the legs was also identified.

Akpu and Fufu are the major food forms of cassava fermentation. Both recipes are consumed in all the geopolitical zones of the country. After harvesting of cassava, it is washed, peeled and washed again and cut into average sizes, before soaking with water in containers such as plastic, pots and tanks for 3-5 days to ferment. After fermentation, sieving is done manually using perforated plastic, metal or locally made calabash sieves to get the marshy paste. The chaff is dried or used directly to feed ruminants. Water is drained from the sieved products to get a semi-solid paste before further processing into akpu or fufu as desired. Akpu and Fufu contains 6.50, 1.68, 1.32, 1.84, 1.42 and 87.24% moisture, protein, fat, ash, crude fibre and carbohydrate, respectively.

Preparation of akpu from the drained paste is done by kneading with the hands to mix the particles well and then mould into about 0.4-1.0 kg lumps or balls and put in a pot of boiling water and allow to simmer for about 3-5 minutes. Making sure that the pot is lined with banana leaves or plastic bags to avoid the akpu sticking to the pot during boiling. This is removed from the pot and pound very well with pestle and mortar to make it plastic. Should in case any lumps are noticed in it, a little salt is added to the pot on fire to dissolve the lumps when it's finally done. It is then moulded again into smaller lumps or moulds after pounding, make a hole(s) in the moulds and put in the pot with little quantity of water on fire and allow to cook for about 10 to 15mins. At times, each mould is wrapped in a thin plastic film or white cellophane bag.

The product is then brought down and pound batch by batch with pestle and mortar till it becomes very smooth and plastic. The akpu is ready for eating with any type of soup. Note that akpu is cooked twice because at the half-done stage, the lumps are easier to crush.

If you try to cook it straight till done, it will be impossible to crush the lumps and the fufu will not be smooth but too soft. A well-done akpu has an off-white colour. If it is almost grey, it means it's overcooked. Thus, the pounded akpu is wrapped in thin cellophane bags. The product can be stored for up to 5 - 7 days. In some areas, low cyanide cassava roots can be boiled or steamed and pounded into akpu.

Fufu is prepared from the drained past by kneading with the hands to mix the particles well in a quantity of water until a reasonable viscosity is achieved. The viscous mixture is put in a pot and place on fire and stir continuously using a stirring stick until the mixture coagulates and becomes plastic (sticky) and smooth.

During stirring the side of the pot is continuously cleaned and incorporated into the content until a uniform mixture is attained. At the point where it becomes harder to stir, it is an indication that the fufu is getting ready. Some water (preferably hot water) is added and heated for 15-20 minutes to cook with the pot covered. The pot is opened and the translucent substance is stirred, adding water and stirring until a desired texture is got. The fire is put off. Thus, the fufu is ready. The final product (Fufu) is then wrapped in thin cellophane bags. The product can be stored for up to 5 - 7 days.

According to [12], fufu can also be processed by drying the drained paste and storing in bags or milling the dry product into flour before bagging and storage. Milling is done using a hammer mill machine, and the size of final fine flour can be customized according to customers' requirements, the standard one is 80-100mesh. Preparation of the flour into fufu recipe is done by (a) putting a quantity of water in a pot to boil, placing quantity of the fufu flour into the boiling water and continue to stir until it dissolves. This is stirred to avoid lumps until it starts getting sticky. Stirring is intensified until a thick consistency is got. The fufu is almost ready when it turns off white colour. Little quantity of water is added and allowed to steam for a while. Stirring continuous until a desired texture is achieved. (b) secondly a calculated quantity of fufu flour is measured in a container of water and stirred to get uniform mixture. The mixture is poured into a pot of boiling water and stirred continuously until it starts getting sticky to avoid getting lumps. Stirring is done as in stage (a) above until a desired texture is attained.

1.3 Motion and Time Study

Motion and Time study is the important aspect in business to determine the production rate. The motion study aspect consists of a wide variety of procedures for the description, systematic analysis, and improvement of work methods considering the raw materials, the design of the outputs, the process or order work, the tolls, workplace and equipment for each step in the process and the human activity used to perform each step. Simplification is most effective method to reduce cost, that saving would be smaller compare to elimination or combining but still can be simplified [3]. Aspects of time study contains a wide diversity of procedures to determine the amount of time required, under an excellent measurement of the state, for work associated with the human, machine, or a combination of both. It was introduced by Frederick W. Taylor since the year 1881, but is still widely used as a method of time study. Generally, time study is used to measure work. The decision results than the time study is the period in which a person in accordance with a job or task and fully trained to use specific method, will perform this task if the worker in the normal or expert. This is called the ti standard for operation [3].

System study a detailed study to determine whether, and how automatic processing equipment should be. It usual includes the development of system specification which provi a basis for equipment selection. Time study is a direct an continuous observation of a task, using a time keeping device (e. decimal minute stopwatch, computer-assisted electronic sto watch, and video camera) to record the time taken to accomplish task by an employee or a worker. According to [15], it is ofte used when there are repetitive work cycles of short to long duration or when a wide variety of dissimilar work is performed or when process control elements constitute a part of the cycle [6]. Time and motion study is a method for establishing employee productivity standards in which: a complex task is broken into small, simple steps, the sequence of movement taken by the employee in performing those steps is carefully observed to detect and eliminate redundant or wasteful motion; and precise time taken for each correct movement is measured. Hence, measurement production, delivery times and prices can be determined.

1.4 Objective of the study

The objective of this study is to carry out system study of the different processing technologies adopted for production of Akpu and Fufu from cassava value chain, at different processing centres in Cross River State, in order to suggest and recommend strategies towards mechanization of the value chain.

2. Materials and Methods

2.1 Study Area, Study Techniques and Study Population

The study area, Cross River State was selected because of the predominant Akpu and Fufu processing activities ongoing in the state. With a population of about 4.5 million and 20,156 km^2, Cross River is an agrarian state and known for the production of cash crops such as cocoa, rubber, timber and palm products. The major staple food crops produced in the state are cassava, yam rice and others. The state comprises of three geo-political zones, Cross river North, Cross River Central and Cross River South. Cross River North comprises of the following Local Government Areas (LGAs) - Yala, Ogoja, Bekwara, Obudu, Obanleku and Boki. While Cross River Central comprises of the following LGAs - Etung, Ikom, Obubra, Abi, Biase and Yakkurr. Whereas the Southern Cross River is made up of Akamkpa, Odukani, Calabar Municipal, Calabar South, Akpabuyo and Bakasi LGAs. The entire LGAs are noted for their technology in Akpu and Fufu production. 50 Akpu and Fufu processing communities were randomly selected in each of the three geo-political zones, making a total of 150 communities for studies and data collected.

2.2 Data collection and analysis

Collection of data was carried out in each specified location including interview, using structured questionnaires, physical observation, participation and sensory analysis. Market prices of processed Akpu and Fufu, colour, odour, texture and taste were gathered in each of the 3 geo-political zones. Each of the questionnaires used was divided into three major parts - (1) Akpu and Fufu Processing Personnel Data, (2) Akpu and Fufu processing methods and (3) Operator's views of Akpu and Fufu Industry.

Fifty (50) processing centers including households, individuals and groups were selected from each geopolitical zones for studies, making a total of 150 processing centers. 100 questionnaires were distributed to each senatorial district, making a total of 300. System study of akpu and fufu processing was carried out here. Among the data generated were time of completion of each operation in the production process, output in kg,

Majority of the respondents stated that between 350 kg to 400 kg /day of 8 hour/person is required during processing. The process is slow and labour intensive which invariably leads to low productivity

3.1.1 Mashing and Sieving

100% of the respondents stated that mashing and sieving process of fermented cassava is still manually done. Thus, the process involves making use of calabash, plastic or metal sieves to manually mash the products and sieve into a basin of clean water. According to respondents, this process is one of the most difficult and slowest stages.

3.1.2 Dewatering/Pressing Process

A total of 75% respondents stated that dewatering/pressing process of the mashed and sieved fermented cassava into akpu and fufu pastes is done manually, while 25% revealed that mechanical press is adopted in dewatering the products while inside the jute/Chinese bag.

3.1.3 Wet Preparation (Akpu and Fufu)

The dewatering process results in the paste which is either processed into akpu or fufu. 85% of the respondents revealed that the wet paste is further processed into akpu. While 15% respondents stated that the wet paste is further processed into fufu (the finished product).

3.1.4 Drying, Milling and Packaging (Fufu)

Only 5% of the total respondents stated that the fermented cassava is further dried, milled and packaged. Whereas 95% of the respondents confirmed that they are solely involved in the wet preparation of fermented cassava. This submission is different from the work of [12], where majority of the respondents were engaged drying, milling and packaging of fufu products in Ogun state. number of workers (skilled and unskilled), tools/equipment used, manual or mechanical process involve in each activity, and level of mechanization of each of the stages.

Personnel data centered on name, age, marital status, number of household or dependance, level of education, village/town, Local Government Area (LGA), initial sources of income, member of cooperative society. The section on processing method focused on collecting comprehensive information on the processing centre. The information gathered include, the ownership status of the centre, number of employees, educational level of operators, age of the enterprise, predominant sex, and source of water supply, power supply, equipment or machine used, weekly or monthly input and output. The unit operations involved were investigated to determine the method and equipment in use. The unit operations investigated include; peeling, washing, soaking, water replacement, decanting of effluence/wastewater, mashing/loosening, dewatering the paste, drying of dewatered paste or cooking of wet paste, packaging and sales. Data were also gathered on waste generated and uses and disposal, estimate of fufu processing waste/by product and general cleanliness of processing centre.

The section on operator's perception of Akpu and Fufu industry was used in gathering information on the problems confronting fufu processing centres and suggested solution. Participation and physical observation were carried out noting the general outlook of the processing sites, activities of the processors and witnessing the drudgery involved. Data collected were analysed using descriptive and inferential statistics, and other relevant statistical tools using IBM SPSS Statistics 20 and Microsoft Excel, 2017.

3. Results and Discussion

3.1 Akpu and Fufu Processing Centres

The ownership of Akpu and Fufu processing centers across the selected villages in the three Senatorial Zones was considered. 94.5% of these processing centers were owned by households and individual farmers. While 5.5% were owned by cooperatives and other groups. Out of all the selected centers 78% specialized mainly in Akpu processing and are scattered within the Northern and Central Senatorial Regions, while 22% specialized in Fufu production were mainly located in the Southern and partly in the Central regions. Anova analysis of the data showed significant difference in the proportions of households, individuals and cooperatives or group ownership. Thus, cassava processing into akpu and fufu is dominated by households and individuals. The result agrees with that of [12] who observed that cassava processing centres in the rural communities of Ahiazu, Ikeduru, Mbaitoli, Owerri and Ohaji Egbema in Imo State, Nigeria were completely owned by households and individuals; and that fufu processing enterprises in Ogun state Agricultural Zones were dominated by individuals.

3.2 Level of Education of Processors

Analysis of the questionnaires received revealed that 56.8% of the respondents agreed that they were illiterate and did not attend primary school, while 42% stated that they attended primary or secondary school. Whereas the remaining 1.2% of the respondents confirmed that they attended higher institution. Among the 56.8% of the illiterate Akpu and Fufu processors, 6.8% were females while 50% were males. Whereas out of the 42% literate cassava processors into akpu and fufu, 37% were females while 5% were males. In another development, all the 1.2% akpu and fufu value chain who attended higher institutions were females. This implies that females dominate fufu processing centres in Cross River State. This revelation is inline with the dominance of women in cassava processing value chain as recorded by [12].

3.3 Membership of Cooperative Society and Sources of Income

Out of the 150 questionnaires distributed across the three geopolitical zones of the state 4.5% confirmed that they belong to cooperative societies, while 95.5% of the respondents revealed that they belong to no such society. On the sources of income for operators 21.5% of the respondent asserted that got their income through borrowing from local cooperative groups such as OSUSU, Age Grade, OHOTU and so on. On the other hand, 78.5% revealed that they got their initial income from personal savings.

3.1 Sources of Power Supply

Among the 300 respondents, 87% revealed that they used manual operations during cassava processing into akpu and fufu. While 23% stated that they used technical devices in some of the processing aspects, especially during the dewatering (pressing) of the mashed fermented cassava.

This confirms that manual energy use is higher than technical energy use in most cassava processing centres as opined by [12]. This confirmed the extremely low level of mechanization in the processing of cassava into akpu and fufu recipes in Cross River State.

3.2 Akpu and Fufu Production Employees

Data obtained from respondents revealed more than 80% of them stated that 2-5 employees were used in their processing units. This confirms the fact that cassava processing into akpu and fufu value chain comprises mainly of households and families. This is similar to the report of [12] that the households are mainly involved in cassava processing in south-west Nigeria.

3.3 Procurement of Raw Materials

Data received from the respondents in this study showed that 86.5% of the cassava tubers used in processing akpu and fufu was

cultivated by the processors, while 17.5% of the respondents got their supplies of cassava from the market. Hence, a good number of the processing centres cultivated their cassava. This is in contrast with the conclusion of [12] who stated that a good number of the processing centres buy their cassava from the market or directly from the farm, and later convey to the processing centres by a motor cyclist. It is also contrast to the report of [1] who observed that most of the cassava tubers used in cassava processing is purchased off farm in Enugu state, Nigeria.

3.4 Views of Akpu and Fufu Producers as their livelihood

Majority (66.4%) of the respondents in the Northern and Central Senatorial Districts of Cross River state averred that the business is lucrative and forms a major part of their livelihood, as the venture provides enough food on their tables and more for sale in the market for economic gain. While 23% of the respondents viewed akpu and fufu production as their main source of food, as they rely mainly on other crops like yam, sweet potatoes and vegetables for their income generation. Whereas the remaining percentage of the respondents neither depend solely on akpu and fufu for generation of income or as food on their tables. In the southern Senatorial zone where majority of the respondents, process cassava mainly for fufu recipes averred that they view it as a commercial venture for financial gain and provision of food on their tables.

3.1 Level of Mechanization in Unit Operation

3.1.1 Peeling, Washing, Soaking and Fermentation

Cassava peeling, washing, soaking and fermentation processes are still largely done manually in the study area as women and teenage girls are normally involved in this level of production. Thus, 98% of the respondents revealed that this level of production process is mainly carried out manually, while 2% respondents stated that some machines are utilized.

3.1.5 Sales of Finished Products

The study revealed that 48% respondents process akpu and fufu pastes mainly for consumption while 52% process the products mainly for sales. 76% of this assertion came mainly from respondents from the Northern Senatorial District of the state, while most of the respondents in Central and Southern Senatorial Districts revealed that their major sources of income flows from sales of other agricultural produce such as cocoa, timber and vegetables production. The study showed that 85 kg bag of akpu/fufu paste is sold between N4,500.00 - N5,500.00

3.1.1 Usage of Bye-Products and Waste Disposal Method

On the usage of bye-products from fermented cassava processing to akpu and fufu pastes, 83% of respondents stated that chaff and unfermented cassava from the processing activity are disposed freely and allowed to be consumed by ruminants. While 17% of the total respondents confirmed that these bye-products are dried and stored for future processing into powdered fufu (alibo). 99.8% of respondents affirmed that waste liquids from the processing activities are allowed to flow freely into drainage channels. On the other hand, 98% of respondents affirmed that cassava peels and other wastes are disposed in the dust bins for feeding to ruminants or decayed.

3.1.1 Accessibility, Affordability and Acceptability of products

Majority (67%) of the akpu and fufu processors reiterated that their products are accessible, affordable and acceptable within and outside the state, as buyers come from neighbouring states of Benue, Ebonyi, Akwa Ibom, Abia and Anambra patronize the purchase of the products.

3.1.2 Technology of Akpu and Fufu Processing

98% of the respondents affirmed that all the processing stages of cassava into akpu and fufu are still being manually done. While 2% stated that pressing machine is sometimes used during dewatering stage of the process. This assertion by respondents of akpu and fufu processors revealed that processing of this all-important agricultural produce is being manually done and requires attention towards mechanising the process.

4.0 Conclusion and Recommendations

Mechanization Strategies and Economic Sustainability of Akpu and Fufu Production Technologies in Cross River State, Nigeria was studied. It was revealed that apart from yam, gari, potato, rice and other agricultural produce, akpu and fufu pastes are the major sources of food and economic sustainability in Cross River state and environs. Majority of the farmers in Cross River State affirmed from the study that processing of cassava into akpu and fufu is one of the major agricultural activities that is carried out for food provision and economic well-being of the people. The study revealed that majority (67%) of the akpu and fufu processors affirmed that their products are accessible, affordable and acceptable within and outside the state. According to the study 48% respondents process akpu and fufu pastes mainly for consumption while 52% process the products mainly for sales.

Hence from the study the following recommendations should be taken note of:

- Funds should be made available in form of grants and loans to farmers to encourage the production and processing of akpu and fufu.
- It is advised that more researches into the processing of cassava into akpu and fufu should be carried out by scientists and engineers towards mechanising production as most processing stages of the products are still being manually done.

Design and fabrication of the machines for application in the processing stages of akpu and fufu, such as peeling, mashing and sieving to get the paste, dewatering mechanism, and pounding should be encouraged and intensified.

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