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Women Participation in Post-Harvest Processing of Maize Using Indigenous Technologies: A Perspective of Kogi State of Nigeria

Adejo Patrick Emmanuel

Abstract

This research was carried out in Kogi State, Nigeria. This study investigated the level of women participation in post-harvest management practices of maize in Kogi State. Women participation in post-harvest handling of crops in Nigeria and particularly in Kogi State is a focal area for researches in the post-harvest subsector of agriculture. Women are found to be actively engaged in making sure that harvested crops are properly stored and processed into forms that are consumable and marketable. Data collected for this study were analysed using descriptive statistics and Chi-square analysis. Results indicated greater percentages (42.26 and 41.67%) of women farmers highly participated in the storage and marketing of maize, but low participation in transportation, grading/sorting/packaging and processing of maize was recorded. It is recommended that women should have access to productive resources (land, labour and credits, technical and economic information) in order to boost their participation in post-harvest management and value addition of maize. This chapter deals with women activities in indigenous post-harvest management of harvested maize which covers storage, processing, sorting, grading, packaging, transportation and marketing. It analyses the peculiarity of women engagement in post-harvest activities in Nigeria, and particularly in Kogi State.

Keywords: maize, women, post-harvest, indigenous, participation

1. Introduction

Agricultural activities are characterized by gender division of labour in the Sub-Saharan Africa and in Nigeria in particular. Thus, women are mostly found to be engaged in post-harvest activities than their men counterpart whose activities revolve round pre-production and actual production operations that are neck twisting and backbreaking, even when women do, their participation in these operations are minimal and largely dependent on the socio-cultural and agrarian setting of the place in question. The Womenfolk plays a key role in agriculture, especially in the activities revolving round harvest and postharvest. However, their contribution is always ignored and relegated to the background. It is reported by [1] that in rural

Pakistan, women carry out 53% of farming activities, and devote 20% more time than men for work. Yet, they face more constraints than men as they are negatively affected by socio-cultural values, economics policies and decision making in the society. Lately, studies have shown that the underlying reasons of food losses are associated with specific socio-cultural and gender dimensions [2, 3].

Maize is a major staple crop in Nigeria and across Africa. It is said to be the second most common cereal food crop after rice [4]. Green fresh maize is cooked or roasted and hawked by women and children, providing a livelihood for many urban poor households. It is also used for animal feeds and in industries such as flour mills, breweries and confectioneries. Thus, increased maize production will enhance food security, serve as import substitution and earn foreign exchange for the country through export to neighbouring food deficient countries and potentially beyond [1]. In most places across the country, women are found to mostly undertake activities that range from harvesting, transportation of harvested crops from the farms to homes, processing, preservation, packaging and marketing [5]. The women equally provide about 60% of agricultural labour force and contribute to well-being of their households through their income generating activities [6].

Historical trends have suggested that the majority of increased maize production in Nigeria reflects an expansion in land under its cultivation rather than an improvement in yields [7]. In 2010, the estimate for Corn production in Nigeria was put to about 8800 Metric tonnes with growth rate of -1.68% and in the year 2012, it rose to about 9410 Metric tonnes for which the growth rate was put to 1.73% . In recent time, Nigeria's yield per hectare is found to be lower than the global yields in the 1960s (1.9 tons/ha). It falls in the range of 1.63 and 1.76 tons per hectare between 2004 and 2007, this is lower than the global average which could be found in the range of 4.88 and 4.93 tons per hectares for the same period [8]. Meanwhile, Kogi State recorded about 333.21 Metric tonnes of corn production with the area under cultivation of 206.60 Hectare in 2009 and in 2010, it increased minimally to 371.30 MT with area under cultivation of 227.05 hectares [9]. Kogi State is one of the 36 states in Nigeria and it is in the North-central of the country.

Maize post-harvest losses in the tropics have been estimated to be about 20% [10]. Estimated losses of Nigeria maize post-harvest to have ranged from 15 to 20%. Nigeria has a land area of 98.3 million hectares and at present about 34 million hectares or 48% are under cultivation. It has been found that more than 60% of maize produced in Nigeria's is used industrially for the production of flour, beer, malt drink, corn flakes, starch, syrup, dextrose and animal feeds. An embargo has been placed on the importation of maize in order to boost local production to meet the consumption demand of Nigeria. This reveals significant room for the improvement of maize production in Nigeria which is necessary if the newly developing trend of exportable surplus is to be sustained and expanded.

According to [11, 12] the post-harvest operations of maize include drying, shelling, threshing, storage and marketing. Apart from the foregoing activities [13], added grading and sorting, packing and bagging, transportation, loading and unloading. Post-harvest management of maize can be categorized into four major stages [5]. The first stage is farm-gate operations which include de-sheathing and packing harvested maize cobs together when they are mature.; the second is transportation, when cobs are transported from farms to homesteads; the third is homestead activities which constitutes drying and grading of cobs, shelling of cobs and drying the grains, winnowing of grains, application of pesticides, packing grains at household level and the fourth stage is storage of maize where grains are stored for later use. Studies have shown that proper post-harvest handling can improve earnings of maize growers especially for the women folk [14, 15]. This study focused on

assessing the level of women participations in post-harvest management on maize in Kogi State of Nigeria.

2. Methodology of the study

This study was carried out in Kogi State, Nigeria. The State consists of 21 Local Government Areas. The State is located between latitude 6° 30'N and 8° 5'N and longitude 5° 51'E and 8° 00'E. The state is made up of four agro-ecological zones, namely: Zone A with the headquarter in Aiyetoro Gbede; Zone B has its headquarter in Anyigba; Zone C with headquarter in Koton Karfe; and Zone D has its headquarter in Alloma. This delineation or stratification of the State into these Zones was done By Kogi State Agricultural Development Projects (KSADP) in order to ease their extension service delivery for optimum results in the State.

The state is well endowed with river valleys and swamps lands for dry season farming. Maize is one of the major crops grown in the state and thrives well in virtually all the agro-ecological zones of the State. For the purpose of this study registered farmers were randomly selected. A total of 168 farmers were selected for the study. A three stage random sampling technique was used. In stage one, four (3) extension blocks were randomly selected from each of the agricultural zones (A, B, C, D), that gives a total of 12 extension blocks. There are five blocks in each zone. In stage two, three (2) extension cells were randomly selected from each block, making a total of 24 extension cells. There are 8 cells in each zone. In stage three, five (7) registered farmers were randomly selected from each cell. There are 80 farmers in each cell. A total of 168 farmers were used for study. Structured questionnaire and interview scheduled were used to elicit information from the respondents. The data collected was analysed using both descriptive and inferential statistical tools. The hypothesis for the study was tested using Chi-square (X^2) statistics. The calculation of Chi-square statistics is given as follows:

$$X^2 = \frac{\sum (f_o - f_e)^2}{f_e} \quad (1)$$

where χ^2 = Chi-square value.

f_o = the observed frequency of levels of women participation in post-harvest operations in the Zones (A, B, C and D).

f_e = the expected frequency of levels of women participation in post-harvest operations in the Zones (A, B, C and D).

df = (R-1) (C-1).

Decision rule: the Null Hypothesis is rejected when χ^2 Computed \geq χ^2 Tabulated under the degree of freedom.

Null hypothesis (Ho): there is no significant difference in the levels of post-harvest operations of maize in the various agro-ecological zones (A, B, C and D) of the study area.

3. Results and discussion

3.1 Indigenous post-harvest handling of maize by women farmers

The post-harvest management of maize can be discussed under the following subheadings: Storage, processing grading/sorting/packaging, transportation/loading and unloading and marketing of Maize as contained in the **Table 1**.

3.1.1 Storage of maize

The analysis of level of women participation in the post-harvest operations as presented in **Table 1** shows that 16.07, 36.91, 42.26 and 4.76% of the women maize farmers rated their participation in storage of maize as low, moderate, high and no participation respectively. Drying and storage of maize grains have always been considered as part of the domestic activities normally performed by women. This is an indication that women farmers in Kogi State participated highly in the post-harvest operations of maize. This result is in consonance with that of [16] who reported that 42.2% of women actively engaged in drying and storage of maize in five agro-climatic zones of rural Punjab, India. The construction of the storage facilities are mostly done by men. Although, women sometimes hire the men and youth in helping them construct the crib as shown in **Figure 1**. This construction of crib in the study area is in line with the report of [2] that carried out a study on gender post-harvest activities in Zambia, that the male support their female counterpart in constructing the storage facilities.

Effectiveness of the preservation of maize, like that of other cereal grains and food legume, is largely hinged on the ecological conditions of storage; the physical, chemical and biological features of the grain; the period of storage; and the type and the features of the storage facilities. Maize can be stored for a long period of time in the raw form. Its shelf life is largely anchored on the prevailing weather conditions (temperature and humidity) and other factors like the moisture, pests in the stored maize and diseases. Hence, it is worthy of note that proper post-harvest management of maize involve consideration of the above factors in order to improve the shelf life of maize. The recommended quality of maize is highly dependent on control harvesting strategies employed.

Maize harvesting is done by separating the cob from its main stalk. The appropriate period of harvesting maize is when the stalk is dried and moisture of grain as about 20–17% [17]. Maize that is harvested dry contains 15–20% moisture at the time of harvesting. After harvesting, the husks are removed from the cob. Then shelling is done to separate the grants from the rest of the cob. In many village settings, the shelling is done by hand, or by rubbing the cob over a roughened piece of metal. However, the use of mechanical shellers for maize is fairly wide spread in West Africa, and adopting the mechanical method for shelling their maize.

Post-harvest operations	Low (1) Freq.	Moderate (2) Freq.	High (3) Freq.	No participation (0)
Storage	27 (16.07)	62 (36.91)	71 (42.26)	8 (4.76)
Processing	60 (35.71)	47 (27.98)	28 (16.67)	33 (19.64)
Grading/sorting/packaging	54 (32.14)	29 (17.26)	39 (23.21)	46 (27.38)
Transportation/loading and unloading	67 (39.88)	45 (26.79)	34 (20.24)	22 (13.10)
Marketing	32 (19.05)	46 (27.38)	70 (41.67)	20 (11.91)

Field Survey, 2014.

Note: multiple responses.

The figures in parenthesis represent percentages (%).

Table 1.

Distribution of maize farmers according to the level of women participation in the post-harvest operations of maize (n = 165).



Figure 1.
Maize cobs stored in a typical crib in Bassa, Kogi State.

In order to reduce the moisture content of maize, it has to be dried to 10–11% moisture content before storing it [18]. Some have advocated drying it to moisture of 13–14% [19]. However, the former seem to increase the shelf life of stored maize because the dryer the maize, the better it is stored. For proper drying of maize, it may be left spread on a mat or any platform over several days; it could also be taken to the drying machine which blows hot air over the grains. After it must have been dried to the desired moisture content, the maize grains can then be stored in silos (metal or earthened) or in bags over a long period of time without deterioration. However, if the grains have not been thoroughly dried, they will deteriorate and become mouldy during storage.

In many rural parts of West Africa, maize is not shelled before being stored. Instead it is stored on the cob, with or without the husk [7]. Quite frequently, the maize is hung over domestic fireplaces where the fire helps make it dry, keep it dry and discourage weevil attack. More commonly, the maize is stored in large circular cribs or bins, built of bamboo and palm material, on raised platforms. Fires are occasionally built underneath the bins to promote drying and to control insect pests in the stored cobs. In these methods, shelling is done only just before the maize is to be utilized or taken to market. Factors that governed the design of storage structures included: tribal inheritance, availability of local building materials, social, economic and cultural standards of the people and local customs.

Even though farmers have adopted some innovations in post-harvest management of their crops, farmers continue to be glued to their indigenous post-production practices because of their effectiveness and reliability over time. For example, farmers in the eastern part of Kogi State do not use industrial dryer on the corn that are meant for the next planting season as they believe it will destroy the viability of planting. Instead, they prefer the indigenous way of storing it on cobs local silos or cribs, basket or hung near fire [14]. Effective management during the post-harvest period, rather than the level of sophistication of any given technology, is the key in reaching the desired objectives.

3.1.2 Processing of maize

Spoilage of harvested maize is prevented wholly or partly either by appropriate storage or by processing it into various storable products. Maize is consumed in many forms in different parts of the world, from maize grits, maize porridge, polenta and corn bread to popcorn and products such as maize flakes [11]. With respect to processing of maize as indicated in **Table 1**, it was found that 35.71, 27.98, 16.67 and 19.64% of the women maize farmers said their participation in processing of maize into consumable and marketable forms was low, moderate, high and no participation respectively. This result is in agreement with a study by [2, 16] that processing activities was low among women in Punjab, India and Malawi. Processing activities in this study is associated with those of both primary and secondary transformation of maize into consumable forms. This primary processing includes threshing, winnowing, cleaning, soaking, dehulling, grinding, while the secondary processing are activities involves changing maize into forms ready for the table. They are activities such as boiling, steaming, roasting, frying, crushing, blending, cooking and baking. Primary processing of maize is very essential in the study area as maize flour is highly demanded for across all the agro-ecological zones of the State.

Traditional methods of processing maize into flour using pestle and mortar, grinding stones and manually operated mills vary in detail depending on culture and geography [10]. The principles however, are the same in Kogi State, Nigeria. Maize processing essentially begins with soaking the grain and then grinding it between stones or pounding it in a mortar and pestle arrangement. During pounding or grinding the bran is removed. The grain is winnowed at intervals to remove the bran from the kernels. The dehulled grain is then pulverized into flour by further grinding or pounding. Processing of maize into desirable end products usually involves primary processing (cleaning, grading, soaking dehulling, grinding and sieving) and secondary processing (blending, cooking, frying and baking).

In most West African countries, maize is commonly used to make local beer (*Burukutu*). For example, malt is gotten from maize grains left to germinate for 4–5 days [10]. The malt is then exposed to the sun to stop germination. The grains are lightly crushed in a mortar or on a grinding stone. The malt is cooked and the extract is strained off, cooled and allowed to stand, after 3 days of fermentation it is ready to be drunk as beer. In some part of Nigeria like in the East of Kogi State, millet is mostly mixed with maize for the above process of brewing except that yeast is added and left for some few hours instead of fermentation for 3 days. Threshing is mostly done by farmers beating the maize cobs in mortar using a pestle or beating the cobs with a stick while they are still spread on the floor or rocky areas covered with sack. Using improved method of threshing, the maize in its cobs could be conveyed to the shelling machine (Thresher/Sheller) of which very few of them were available at the time of this study or further processing including dehulling and grinding machine. **Figure 2** depict a typical mortar and pestle for threshing maize, while **Figure 3** shows women dehulling and grinding maize grains. Winnowing and sun drying can be carried out before dehulling and grinding. **Figure 4** illustrates woman winnowing and sun drying maize.

Cornflakes are a hydrothermically treated maize product of world-wide popularity. They owe their success to their high nutrient value combined with low caloric content and good digestibility. Flaking is a process consisting of cooking fragments of cereal kernel, to a certain consistency, pressing the cooked mass between rollers to form flakes, and toasting the flakes at an appropriate temperature.



Figure 2.
Mortar and pestle for threshing maize grains from the cobs.



Figure 3.
Women dehulling and grinding maize grains.

3.1.3 Sorting, grading and packaging of maize

In terms of sorting, grading and packaging of maize in the study area as shown in **Table 1**, 32.14, 17.26, 23.21 and 27.38% rated their participation to be low, moderate, high and no participation respectively. This result indicates that the participation of women farmers in Kogi State in the grading/sorting/packaging of maize was rated low. Sorting and grading are done during threshing of maize whereby, maize grains are winnowed with the lighter grains separated in as it is thrown from the container into the air taking into cognizance the direction of the wind; and bad grains can also be separated from the good ones by hand picking the bad grains as shown in **Figure 3**. However, packaging is done by putting the grains into woollen or polythene bags, while labelling is done by using chalk or ink inscribed on the bag with any sign or words for identification. Indigenous



Figure 4.
A woman winnowing and sun drying maize.

value added products like maize porridge (*ekwo*, *ogidigbo agidi*) are packaged in banana leaves or other broad leaves that can be folded around the semi-solid porridge. The proportion of the respondents that did not respond may be due to fact that they are used to their indigenous way of grading/sorting/packaging of maize and too, that the improved grading and packaging available may not be cost effective for the farmers. For instance, the improved bagging system (triple bags), at the time of this report were sold at N300 per triple bag as against the N50 per single ones.

3.1.4 Transportation of maize by women farmers

With respect to transportation of maize, 39.88, 26.79, 20.24 and 13.10% of the women farmers said their participation was low, medium, high and no response respectively. This means that the participation of women farmers in Kogi State in the transportation of maize was rated low. Transportation is done indigenously by using their head with a basket or any other container to carry the maize cobs or grains. The load could be transported using wheelbarrow or bicycle to convey harvested maize from farm to home or markets or from stores at home to the market. It is noteworthy, that women are sometimes helped by their men counterpart especially those that are married in terms of transportation of maize particularly in the area of loading and unloading, if the harvested maize is bulky. However, in some cases, improved transportation, such as lorry, pick-up van, trucks, etc., could be employed for bulkier loads especially at farm gate where many small-scale farmers put their produce together for buyers (bulk assemblers) (**Figure 5**).

3.1.5 Maize marketing by women farmers

Maize like most agricultural commodities can be marketed freshly harvested or processed. In Kogi State, local market places which are normally held at an interval of 4–5 days are the points of convergence of the farm produce, including maize. Maize processing would further enhance the chances of success in its marketing. In terms of marketing of maize in study area as reflected in **Table 1**,



Figure 5.
Wheelbarrow for conveying load.



Figure 6.
The researcher observing the triple bagging system in front of a warehouse in the market.

19.05, 27.38, 41.76 and 11.91% of the women maize farmers rated their participation as low, moderate, high and no participation respectively. Women in Kogi State were found to be mostly responsible for price taking and giving in maize grain marketing. This does not mean that men do not take part in marketing of maize; but their activities in marketing of maize are minimal when compared to women involvement in same. One important feature of the markets in the study area is the presence of warehouses in and around the market which makes it easier for marketers to store their goods. **Figure 6** depicts a typical market with warehouses.

One problem faced by both small and large scale maize farmers in food processing particularly if they are into traditional foods, is how to market their products at a price that will guarantee a reasonable margin of profit. The chances of success of a large scale commercial venture producing traditional food could be further enhanced, especially if they are part of a group or chain of industries, and if some of the materials which they plan to produce will be utilized by one of the other arms of the industrial establishment.

Post-harvest operations	Chi-square (X^2) value	P-value
Storage	11.22 [*]	0.10
Processing	8.99 ^{NS}	0.10
Grading/sorting/packaging	0.85 ^{NS}	0.10
Transportation/loading and unloading	13.29 [*]	0.05
Marketing	16.70 [*]	0.01

^{*}Significant.
^{NS}Not significant.

Table 3.
Chi-square analysis on the level of women participation in post-harvest operations of maize in the various zones (A, B, C and D) of Kogi State, Nigeria.

Level of participation in storage of maize			
Zones	Low	Medium	High
A	8	15	18
B	3	25	30
C	10	10	12
D	6	12	11
Level of participation in processing of maize			
Zones	Low	Medium	High
A	10	12	6
B	20	18	10
C	20	11	4
D	10	6	4
Level of participation in grading/sorting/packaging of maize			
Zones	Low	Medium	High
A	13	8	10
B	18	8	10
C	10	6	9
D	13	10	10
Level of participation in transportation of maize			
Zones	Low	Medium	High
A	14	11	4
B	15	22	12
C	20	6	8
D	18	6	10
Level of participation in marketing of maize			
Zones	Low	Medium	High
A	6	10	20
B	6	18	31
C	10	4	6
D	10	14	13

Table 2.
Frequency distribution of respondents according to their level of participation in post-harvest operations in the various zones of Kogi State.

3.2 Tests for hypothesis on the level of women participation in post-harvest operations in the various zones (A, B, C and D) of Kogi State

Table 3 shows the analysis of Chi-square on the level of post-harvest activities among farmers in the various zones (A, B, C and D respectively). This was achieved using the observed frequencies in **Table 2**. The result indicated that there was a significant difference ($P \leq 0.10$, $P \leq 0.05$ and $P \leq 0.01$ respectively) their level of post-harvest operations in storage, transportation and marketing. This implies that the null hypothesis which was stated that 'there was no significant difference in the levels of post-harvest operations of maize in the various agro-ecological zones (A, B, C and D) of the study area' was rejected in each case. This may not be unconnected with the fact that maize thrives well in all the agro-ecological zones of the State and by extension, a high participation of women in the post-harvest activities should be expected across the zones of the state all things being equal. There were no significant differences in in terms of grading/sorting/packaging and transportation. This could be tied to the fact that these marketing functions are activities that relatively depend on the presence of designated market places; hence, these post-harvest operations may be higher in the areas where these markets were found, and lower if otherwise.

4. Conclusion

It can be inferred that there is generally, a high participation of women farmers in the storage of maize in the study area, but low participation in transportation, grading/sorting/packaging and processing of maize were recorded. This could be due to some factors that might have directly or indirectly affected the participation of respondents. The differences that occurred in the level of participation by women in post-harvest management of maize at the various agro-ecological zones of the State because of the peculiarity of the dominance of some post-harvest handling operation in a particular zone. This can be seen as a point to harness and integrate the indigenous knowledge on post-harvest handling of maize from these areas in order to boost their post-harvest activities. Their low level of participation in some of the post-harvest operations could be tied to the fact that they had inadequate access to information and other productive resources. If they have access to productive resources, they could improve their level of participation in post-harvest activities. The adequate knowledge and attitude about the appropriate indigenous post-harvest technology to be used by the farmers for maize in a particular agro-ecology will go a long way to boost farmers' participation in post-harvest management of maize. It is obvious that despite the existence of various improved post-harvest technologies in Nigeria, most of the women in the study area are still glued to some indigenous technologies for the reason that they might have tested and are familiar with these indigenous technologies and perhaps, they have little or no access to the improved or modern ones.

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