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ON-FARM FARMERS' PARTICIPATORY EVALUATION OF THE IMPACT OF POSITIVE SELECTION ON SEED TUBER YAM (Dioscorea rotundata Poir) PRODUCTION FROM TWO SOURCES IN EBONYI SOUTHEASTERN NIGERIA

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ABSTRACT

An experiment was carried out with farmer group in Ebonyi State, Southeastern Nigeria, on two hectares of well prepared land with the aid of a tractor and with the aim to find out the impact of positive selection on Dioscorea rotundata seed tuber yam production from two sources in Ebonyi Southeastern Nigeria. The area was divided into Farm A and Farm B. The yam variety used was white yam variety Hembakwasa cultivar. Each hectare of land was planted 10000 seed yam tubers obtained from two different sources. Farm A from the markets vendors and Farm B from farmer saved own seed tuber yam in the farming community. The seed yam tubers were planted on the crest of the ridges at depth of 10cm and at spacing of 1.0m within plant stands and between rows of plants 1.0m. Ten thousand seed tuber yams weighing between 150 and 250g each were planted per stand. All agronomic practices such as weeding, staking, N.P.K fertilizer application 15: 15:15 was carried out on both farms. The farmers were assisted by research scientist to carry out positive selection in farm B only every two weeks while in Farm A the observed crops with symptoms were to be tagged, recorded and allowed to continue growing. The following data were carried out every two weeks: number of plants affected by pathogens, number of yam mixture, number of vigorous and none vigorous yam plants, number of yam plants at harvest, number of yam tuber, number of ware tubers and number of seed yam tubers. Data obtained were analyzed using percentages. Results obtained indicated that sources of seed tuber procurement contributed to lower incidence of pathogen infested plants, more number of vigorous plants, and high number of tubers in Farm B with positive selection compared with Farm A where positive selection was not practiced. High significant number of the yam plants were healthy with yield of very high number of tubers and less varietal mixtures as a result of using healthy pathogen free seed tuber yams from farmers saved own seed at planting coupled with the use of positive selection. If farmers should follow this technique and practice positive selection continuously for several seasons they would progressively have less sick plants in their field.

KEYWORDS: seed tuber, positive selection, farmers saved seed, market vendors and seed sources.

INTRODUCTION

The yam is an important food crop of Nigerians. It is mostly grown in the Forest and Savanna agro-ecological zones in areas more than 1500 metres above sea level where human population density and pressure on arable land is high. Yams are used for local consumption and are sold and purchased in rural and urban markets as table and ceremonial yam tubers (Nweke, 2016). A major problem in yam production is that many seeds tubers for planting a new season's crop carry pathogens especially viruses, fungi and bacteria. These pathogens cause wilt and distort the leaves of growing yam plants leading to lower yields. As a result farmers' especially commercial farmers find it difficult to obtain healthy seed yam tubers for yam production. High quality seed yam tubers are not easily available to small and commercial yam farmers. Yam varieties released by National research Institutes are made available only in small quantity. Seed yam tuber cleaning techniques (such as tissue culture laboratories and bioreactors) are not readily available to farmers, and yam farmers continued to use their last year's harvest crop for planting. When they do not have enough seed yam tubers from their own farms, they buy from the market or from their neighbours. The sources of seed yam procurement have contributed to low yield. The tuber yield results have been very disappointing as a result of buildup of diseases year after year.

Disease build up is the main problem with re-using of vegetative planting materials year after year (Nwankwo & Opara, 2015). Diseases such as viruses build up. These are transmitted through the seed yam tubers. Investigation carried out in farmers' fields and in the markets revealed that more than 80% of seed tubers sampled in the survey carry viruses. Yam mosaic virus is one of the most serious diseases that cause yield

losses. Considering this fact, it became clear that a completely different approach in seed tuber production is required instead of upgrading the quality of seed yam tuber through purchasing from the market or from neighbours.

Positive selection is the selecting of only healthy looking mother yam plants with good agronomic characteristics for seed production and collection. Positive selection is used for both multiplication and maintenance of seed quality in cross pollinating crops that are reproducing through botanical seeds. It is also use in the production of quality declared seeds in clonally propagated crops such as yam, cassava, sweetpotato, cocoyam, ginger, tumeric and others. This technique has led in the selection of landraces of many crops that are well adapted to the conditions under which they were selected. Positive selection does not produce new varieties of crops or landraces but help in fighting crop degeneration caused by plant pathogens. According to Ogburia (2017) positive selection started about 10000 years ago about 8000 BC when early plant breeders domesticated wild plants by artificially selecting the best plants, harvesting the seeds and replanting them. He defined a domesticated plant as one that has been artificially selected by humans. Artificial selection was practiced when humans collected seeds from stronger plants and replanted them. According to him artificial plant selection launched us on the path of technological society we find ourselves today. He reported that farming likely began in areas filled with animal dung, because people noted that seeds planted in these areas grew better.

In improving the quality of seed yam tubers, the field is first selected. The soil will be well drained and free from hardpans and any soil impediments. The soil will be well prepared with no area for water logging (Onwueme and Sinha, 1991). Healthy looking yam tubers to be used as parent material/seed tuber multiplication are selected and prepared for planting. If for seed tuber multiplication, Ezulike and co-workers (2006) recommended minisett technique and Nwankwo, et al (2017) suggested vine cutting technique.

Preliminary observations concerning the existence of pathogens, and the importance of the impact of positive selection and genetic information as a source of genetic diversity, suggested reasons for an depth investigation on the impact of positive selection for the production of quality declare seed tuber yams. The purpose of this study was to evaluate the impact of positive selection on *Dioscorea rotundata* seed tuber yam production from two sources in Ebonyi Southeastern Nigeria.

MATERIALS AND METHODS

In an experiment carried out with farmer group in Ebonyi State, Southeastern Nigeria, two hectares of well prepared land with the aid of a tractor was obtained and divided into two. The yam variety used was white yam variety Hembakwasa cultivar. Each portion of land measured 1.0 hectare (10,000m^2). Ridges were made and spaced one metre apart. The farmers were asked to sort the variety of yam they want to plant from the markets and to be planted in one hectare marked farm A and in the other one hectare marked B, the farmers were instructed to obtain the seed yam tubers of the same variety in hectare A from known farmers in the farming community. After land preparation and ridging, the seed yam tubers were planted on the crest of the ridges at depth of 10cm and at spacing of 1.0m within plant stands and 1.0m between rows of plants. Ten thousand seed tuber yams weighing between 150 and 250g each were planted per hectare.

All agronomic practices such as weeding, staking, N.P.K fertilizer application 15: 15:15 was carried out on both farms. The farmers were guided with the assistance of research scientist to carry out positive selection in the second field designated farm B. They should do the following in farm B every two weeks: 1. to count number of pathogens (such as viruses, anthracnose, leaf spot and dieback) that affected yam plants and to remove them from the field. 2. Record the number of yam mixture in the field and to remove them. 3. Record number of vigorous and none vigorous yam plants in the field. 4. Record number of yam plants at harvest 5. Record total number of yam tubers harvested. 6. Record number of ware tubers harvested 7. Record number of seed yam tubers harvested.

In farm A, the farmers with the assistance of scientists will count number of pathogens (such as viruses, anthracnose, leaf spot and dieback) that affected yam plants in the farm tagged them, but will not remove them from the field. 2. Record the number of yam mixture in the field tagged them and allow it to continue in the field. 3. Record number of vigorous and none vigorous yam plants in the field. 4. Record number of yam plants at harvest 5. Record the total number of yam tubers harvested. 6. Record number of ware tubers harvested 7. Record number of seed yam tubers harvested. The two farms are not to be visited the same day and week to avoid pathogen transfer. The farms were located 5 kilometers apart.

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Data collected were analyzed using percentages.

RESULTS

After planting, the field is periodically checked for health and vigour of the yam plant every two weeks in both farms. Diseased yam plants were rogued in farm B. Yam plants that were off-types are tagged or rouged also. Very health looking plants were tagged or labeled. At senescence, the plants that were tagged/labeled were harvested first. Those yam plants with satisfactory number of tubers, good tuber size and quality, smooth tuber surface and free from soil borne pests and pathogens were selected as parent materials for yam production. The tubers were stored and the seed tuber yams were later multiplied for distribution to farmers.

The results of what was obtained are presented in Table 1

Table 1: Parameters assessed during positive and none-positive selection for two years and combined years

	Results 2016				Results 2017				Results 2016 and 2017 combined			
Data collected	Results in hectare **A**	%	Results in hectare **B**	%	**Results in Farm A**	**%**	**Results in Farm B**	**%**	Results in Farm **A**	%	Results in Farm **B**	%
Total number of yam planted	10,000	100.0	10,000	100.0	**10,000**	**100.0**	**10,000**	**100.0**	10,000	100.0	10,000	100.0
Number of virus infected yam plants	2,050	21.0	221	2.2	**2,360**	**24.0**	**42**	**4.2**	2.205	22.1	131	1.3
Number of anthracnose infected yam plant	220	2.2	124	1.2	**113**	**1.1**	**55**	**1.0**	167.0	1.7	90.0	0.9
Number of leaf spot infected yam plant	61	0.6	67	0.7	**122**	**1.2**	**8**	**1.0**	91.5	0.9	38.0	0.4
Number of dieback infected yam plant	31	0.3	1	0.01	**15**	**2.0**	**0**	**0.0**	23.0	0.2	0.5	0.0
Number of none vigorous yam plants	39	0.4	29	0.3	**5,008**	**50.1**	**13**	**0.1**	1,043	10.4	21.0	0.2
Number of vigorous yam plants	7,599	76.0	9,558	96.0	**2,047**	**20.5**	**9,355**	**94.0**	6,319	63.2	9,521.0	95.2
Number of mixed yam plants	411	4.1	2	0.02	**350**	**4.0**	**0**	**0.0**	381.0	3.8	1.0	0.0
Number of plants at harvest	7,669	77.0	9,700	97.0	**7,055**	**70.6**	**9,355**	**94.0**	7,262.0	74.0	9,528.0	95.3
Total number of tubers harvested	10,299	>3.0	12,069	>21.0	**8,405**	**84.1**	**15,809**	**>58.1**	9,352.0	94.0	13,939.0	>39.4
Number of ware tubers harvested	7,202	70.0	9,7I1	80.5	**5,121**	**61.0**	**13,655**	**86.4**	6,162.0	65.9	11,683.0	84.0
Number of seed tubers harvested	3,097	30.1	2,358	19.5	**3,274**	**39.0**	**2,154**	**14.0**	3,186.0	2.7	2,256.0	1.6
Number of diseased tubers	139	1.3	92	0.8	**366**	**4.4**	**109**	**1.0**	253.0	3.0	147.0	1.1
Number of rotten tubers	16	0.2	11	0.09	**201**	**2.3**	**11**	**0.07**	109.0	1.2	18.0	0.1
Number of tubers attacked by pests	211	2.0	101	0.8	**291**	**3.5**	**26**	**0.2**	251.0	2.7	119.0	0.9
Number of good tubers	9,933	96.4	11,865	98.3	**7,547**	**89.8**	**15,663**	**99.1**	8,740.0	93.5	13,656.0	98.0

Folia Biotic Stresses of the yam plants: The result in 2016 indicated that in Farm A, the number of yam plants infected with Yam mosaic virus was 2050 which represented 21.0% of yam plants in the field. Two hundred and twenty (220) yam plants which accounted for 2.2% of yam plants in the field were infected with Anthracnose

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disease, 0.6% which numbered 61 yam plants were attacked by leaf spot a fungal disease and 31yam plants that is 0.3% were attacked by Die back disease. The farmers counted the number of plants showing symptoms of those diseases, tagged them and allowed them to continue growing in the field.

The same year in Farm B, 221 yam plants which represented 2.2% of the yam plants in the field were attacked by Yam mosaic viruses. Anthracnose disease attacked 124 yam plants which accounted for 1.2% of the yam plants growing in the field. It was observed that 67 yam plants that is 0.7% were affected by leaf spot disease while only one yam plant which accounted for 0.01% was attacked by Dieback disease. The source of seed tuber yam procurement may be reason for low pathogen attack in farm B.

The vigour of the yam plant: In Farm A the number of none vigorous yam plants was 39 which was 0.4% of all the cultivated yam plants while the number of vigorously performing yam plants in terms of foliage growth and luxuriance was 7599 which represented 76.0%. The number of mixed up yam plants was 411 which represented 4.1%. In Farm B, number of none vigorous plants was 29 which was 0.3% of all the plants growing in the yam farm while 9558 or 96.0% was the number or percentage of vigorous plants in the field. The number of yam mixture in the field was two (2) which accounted for a low rate of 0.02%. Farmer appreciate selecting the seed tubers they want to plant in their farms rather than purchasing from market vendors.

Plant count at harvest and number of tubers harvested: In Farm A the number of plants harvested was 7669 which represented 77.0% of the yam plants cultivated in the field. Twenty three percent (23.0%) might have been dead as a result of biotic or abiotic factors. However, the total number of tubers harvested was 10,229 with an increase of 3.0%. Normally, yam plants in general give one tuber per yam plant. The increase in number of tubers more than the number of yam plants at harvest might be an indication that many of the yam plants produced more than one tuber per plant. Plant vigour might have played a big role. The higher the vigour of the plant, the higher the expected yield performance. Of the number of tubers harvested, 70.0% which was 7,202 tubers were ware yam tubers, while 3097 tubers or 30.0% was seed tuber yams. The yield of ware tubers to as high as 70.0% is an indication that the soil nutrient is high enough to sustain yam production.

The number of yam plants harvested in Farm B was 9,700 which accounted for 97.0% which indicated that only 3.0% of the yam plants did not survive. This was a significant low number which should have a negative impact on the yield of the crop in that farm B. The total number of tubers harvested was 12,069 which was 21.0% increase far more than Farm A while the number of ware tubers was 9,711 and seed tubers 2,358 which accounted for 80.5% and 19.5% respectively.

Biotic stress of the harvested tubers: Of the total number of yam tubers harvested in farm A, 139 tubers which represented 1.3% were diseased while 16 tubers which accounted for 0.2% were rotten. The number of tubers attacked by pests of various kinds was 211 which were 2.0%. All these indicated that the yam tubers were not free from attack of diseases and pests. However, significant high number of 9,933 tubers was good which represented 96.4%. The number of seed tubers attacked by pests and diseases in Farm B was 101 which was 0.8% of all the seed tubers harvested. Farmers carefully selected seed tubers that were pest -free when planting to avoid pests infestation in their field. That may be reasons for having low pest infestation in Farm B. Total number of good tubers in Farm A was 9,933 or 99.3% of all the yam tubers harvested in Farm A while in Farm B, total number of good tubers harvested was 11,865 which accounted for 98.3%. However, number of rotten tubers was 11 which represented 0.09%. This indicated that obtaining seed yam tubers directly from farmers has good advantage which included high yield of the seed tubers planted (Table 1).

Second season planting: The previous year's harvests in both farms were used for second season's planting. Positive selection was not carried out on Farm A but was continued on Farm B. Farm A was planted with the seed yam tuber bought from market vendors while Farm B was planted with seed yam tubers bought directly from farmers who saved their own seed tuber yams for planting. Positive selection was carried out from farmers saved seed yam planted in farm B by removing all diseased yam plants continuously in the second season's planting. The number of yam plants rogued/removed was recorded while diseased yam plants from farm A (that is market vendors) were not removed but tagged so that it will not be counted twice.

Folia biotic stresses of the yam plant: In 2017, the same number of seed tuber yams was planted that was 10,000 seed tuber yams (100%). The number of virus infested yam plants increased from 2050 in 2016 to 2360 yam plants infected with viruses in 2017 amounting to 24.0% of all the yam plants cultivated in farm A. In farm

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Impact Factor 3.802

B, where positive selection was carried out, the number of virus infected yam plants reduced from 221 infected yam plants in 2016 to as low as 42 yam plants in 2017 which accounted for 4.2% of yam plants growing in that yam field.

The number of plants affected by Anthracnose disease although in 2016 was 220, however the number of affected plants reduced to 113 yam plants which accounted for 1.1% in 2017 in farm A. The same year the number of Anthracnose affected yam plants in Farm B in 2016 was 124 but reduced to 55 yam plants which represented 1.0% of all the plants in farm B. Dieback is another serious disease of yam which normally happens when the soil is wet. The observation on the yam plants in farm A in 2016 was that the number affected by the disease in 2016 was 31. In 2017, the number reduced to 15 yam plants or 2.0% of the yam plants in farm A. In farm B, in 2017, there were no incidences of Dieback disease or 0.0% of dieback disease in all the yam plants in farm B.

The vigour of the yam plant: The number of yam plants that was not growing vigorously in 2017 in farm A rose from 39 to as high as 5008 yam plants equivalent to 50.1% of the number of yam plants growing in farm A while in farm B the same year, the number of none vigorous yam plant was 13 which was 0.1% of the yam plants growing in farm B. The number of vigorous growing yam plants in farm A in 2017 was 2,047 which accounted for 70.5% of all the yam plants in farm A. However, in farm B, the number of vigorous yam plants was 9,355 yam plants which represented 94.0% of the yam plants growing in farm B.

The number of variants or varietal mixture in farm A was 350 which was 4.0% although it was a bit lower than in 2016 may be most of the variants did not survive to increase the number of varietal mixtures in the farm. In 2017 in farm B, due to positive selection and the removal of variants in the yam farm B, no mixtures of different varieties was observed.

Harvesting of the yam crop: During harvest, number of yam plants that survived up to harvest time in 2017 was 7,055 or 70.5% in farm A while in farm B, number of yam plants harvested was 9,355 or 94.0% of the planted yam crop. The high percentage of survivability was an indication that only healthy seed tuber yam was selected and planted that year. In the same year 2017, in farm A, total number of tubers harvested was 8,405 which represented 84.1% of all the tubers harvested while the same year at farm B where positive selection took place the total number of tubers harvested was 15,809 which accounted for additional increase of 58.1% of tubers harvested. Also the same year, the total number of ware yam tubers from farm A was 5,121 or 61.1% while the number of seed tuber yams sorted out of the total tubers harvested was 3,274 seed tubers or 39.0% of all the yam tubers harvested. When it was compared with farm B that had positive selection measures, it was observed that number of ware tubers was 13,655 which was 86.0% of the yam tubers harvested while the number of seed tubers was 2,154 which was 14.0% of all the total number of yam tubers harvested.

Biotic stress of the harvested tubers: The number of Pathogen infested tubers in farm A in 2017 was 366 or 4.4% of the yam tubers harvested, and that of farm B was 109 or 1.0% of the total figure of the yam tubers harvested in 2017 showing that pathogen infested tubers decreased drastically when positive selection measures are carried out. It was also observed that number of rotten tubers in farm A in 2017 was 201 which accounted for 2.3% of the total yam tubers harvested from the farm while in farm B the number of rotten tubers was 11 which represented 0.07% of tubers harvested in that farm. The number of tubers attacked by pests in farm A was 291 or 3.5% of all the tubers harvested while in farm B, it was observed that 26 tubers which represented 0.2% of the tubers harvested were pests infested which showed a decrease in pests infestation.

Nevertheless, number of very good yam tubers harvested in farm A in 2017 was 7,547 which accounted for 89.8% of all the tubers harvested in that farm. In farm B, the number of good tubers was 15,663 which represented 99.1% of all the yam tubers harvested from that farm that year. The high percentage of healthy tubers harvested indicated evidence of utilization of positive selection in maintenance of yam farms.

The result for the two years combined indicated that in farm A, out of the 10000 yam plants, the mean of 2205.0 yam plants which represented 22.1% of all the yam plants growing in the farm A was affected by virus disease complex of yam. In farm B, out of the 10000 yam plants in the farm B, the mean of 131.0 was attacked by virus disease which accounted for 1.3% of all the planted yam plants in farm B.

ISSN 2349-0292
Impact Factor 3.802

Results for the two years: The combined results also indicated that the mean number of yam plants attacked by Anthracnose was 167.0 or 1.7% of all the yam plants growing in farm A, while in farm B the mean number of yam plants attacked by Anthracnose was 90.0 or 0.9%. This indicated that positive selection had a good impact in disease reduction in yam crop field. The mean number of plants that reacted positively to leaf spot disease was 91.5 which represented 0.9% of the yam plants growing in farm A. In farm B, there was significant reduction of the disease to as low as to mean of 38.0 plants which accounted for 0.4%. When compared to farm A where there was no positive selection. The mean number in both years that were affected by Dieback disease was 23.0 or 0.2% in farm A while in farm B the mean number of yam plants affected by the disease was 0.5 or 0.0% of all the plants growing in farm B.

Yam plant vigour: The combined result indicated that the mean number of none vigorous yam plants in farm A was 1043.0 amounting to 10.4% of all the plants growing in farm A. In farm B, the mean number of non-vigorous yam plants was 21.0 or 0.2%. This indicated that measures were taken to maintain healthy growing yam plants in farm B. The mean number of very vigorous plants in farm A was 6319.0 or 63.2% and in farm B, the mean number was 9521 or 95.2%. There were more healthy and vigorous yam plants in farm B than in farm A as a result of the positive selection. The mean number of yam mixtures in farm A was 3.8% of the yams growing in farm A while in farm B, the mean number was 1.0 or 0.0% of yam plants in farm B (0Table 1). This showed that positive selection was used to clean up the yam in farm B by removing all variants leaving only one particular variety to continue to grow in farm B until harvest.

Plant count at harvest and number of tubers harvested: Mean number of yam plants that survived up to harvest in farm A was 7262.0 or 74.0% while in farm B, mean number of survived yam plants was 9528.0 or 95.3%. This showed a considerable difference. High significant numbers of the yam plants were healthy and were able to grow, establish, yield and were harvested seven months after planting. The mean number of tubers harvested in farm A was 9352.0 which represented 94.0% of the yam plants that survived up to harvest while in farm B mean total number of tubers was 13939.0 which gave yield increase of up to 39.4% more than the number of plants per hectare in farm B. This has been as a result of using healthy pathogen free seed tuber yam at planting coupled with the use of positive selection.

Number of tubers harvested: Of the number of tubers harvested in farm A, a mean of 6162.0 was obtained which represented 65.0% was ware tubers while in farm B, mean number of ware tubers was 11683.0 which represented 84.0% of all the tubers harvested in farm B. This showed that using healthy seed tuber yam gives high yield. The mean number of seed tuber harvested in farm A was 3186.0 which was 2.7% of the total tubers harvested, while in farm B, the mean number of tubers was 2256.0 which accounted for 1.6% of the total tubers harvested in farm B. This result revealed that healthy and vigorous yam plants produced more ware yam tubers when compared with the two farms.

Health of tubers harvested: The health of the tubers in farm A indicated that mean number of 253.0 or 3.0% of the total yam tubers harvested were pathogen infested, while in farm B the mean number of pathogen infested tubers were low up to 147.0 which accounted for 1.1% of the mean total number of tubers harvested. The mean number of tubers observed in farm A that were rotten was 109.0 or 1.2% while in farm B the mean number of rotten yam tubers was 18.0 or 0.1% of the number of yam plants in the farm. The mean number of pests infested tubers in farm A was 251.0 which represented 2.7% of the total number of tubers harvested while in farm B, mean number of 119.0 or 0.9% were attacked by pests. However, it was observed in farm A that mean number of healthy tubers harvested was 8740.0 which gave 93.5% of the mean total number of tubers harvested. In farm B, mean number of harvested good tubers was 13656.0 or 98.0%. which suggested that positive selection had significant impact on the tuber yield increase of the yam plants.

DISCUSSION

From the results, it was observed that disease incidences were less on farmer saved seed tubers in farm B than in seed tubers purchased from the markets planted in farm A. Farmers select seed tubers they would like to plant in their farms and sold whatever remains in the markets. In some areas such as Ikwuano in Abia State of Nigeria, farmers refuse to sale or give out their seed tubers even to neighbours until they have planted up their farms. Whatever that is a leftover is sold in the market. In such instances, they select disease free planting tubers for planting and sell the balance which may be diseased later in the market. Farmers only sell their seed tubers in the market before planting when they are in dire need for money. Positive selection was not carried out in farm A while in farm B, where it was done; there was very low rate of virus infected yam plants. Virus diseases are

systemic in clonally propagated crops and could manifest itself anytime the viral load is high (Nwankwo and Opara, 2015). Diseased/sick plants should constantly be removed from the yam farm because sick yam plants could transfer the diseases they are carrying through contacts caused by winds blowing in the farm, or through rain splash on diseased plants to healthy plants, or through physical contact from workers in the farms, or through insect vectors which move from sick plants to health ones, or through implements used in working in the farm, or through flood water washing debris from sick plants and transfer it to healthy plants (Cooke, 2006) . When clonally propagated plants such as yam accumulated much of these diseases from various sources, they broke down. This led to yield lost. This showed further evidence that positive selection when practiced judiciously without having pity on the crop by uprooting and removing them from the yam field will go a long way to protect the remaining crops in the yam field.

It was observed that there were varietal mixtures in farm A. This accounts for the danger in buying seed yam tubers from the market vendors. Their main aim was to sell their wares. They do not care whether there would be mixtures or not. So seed yam tubers for specific need should not be purchased directly from market yam tuber vendors except if you are conversant with the variety of yam you want to plant and can detect it. Yam vendors sell different types of yam tubers and there are bound to be mixtures. The low rate of varietal mixtures was of no surprise since yams seed tubers planted were collected from the farmers themselves who are very well acquainted with the yam varieties and could give you the variety you want. This suggested reasons why seed tuber yam should be purchased directly from the farmers' saved own seed yam tubers. The high percentage of survivability was an indication that only healthy seed tuber yam was selected and planted that year. Healthy seed yam tubers for planting are sorted and stored by farmers. Farmers knew that healthy seed tubers give high vigours which translate to good yield. Therefore good seed tubers are saved for next season's planting. The high percentage survivability (97.0%) showed the wisdom of sorting for healthy seed tuber yam from a reliable source such as from farmer saved seed tubers which are reliable and trustworthy. This suggested why using good healthy seed tubers for yam production are necessary and from a reliable source for commercial yam production.

The number of seed tubers attacked by pests and diseases in Farm B was very low of all the seed tubers harvested. Farmers carefully selected seed tubers that were pest-free when planting to avoid pests infestation in their field. This may be reasons for having low pest infestation in Farm B. This indicated that obtaining seed yam tubers directly from farmers has good advantage which included high yield of the seed tubers planted (Table 1). This high percentage of good and healthy tubers was as a result of using good healthy seed yam tubers as planting material during the planting season. Nwankwo and co-researchers (2015) in their work on sweetpotato, reported that number of root yield in sweetpotato is a function of yield. It is the number of roots or tuber per plant per plot that farmers first observe before confirming if a crop is high yielding or not. Farmers use number of tubers to assess the yield performance of crop and the size of tuber to assess the nutrient status of the soil to produce crop.

The application of the technique of positive selection in yam fields helped the farmers to understand that many of the crops in their field are sick and could not give them the needed high tuber yield. Seed tubers of yam from fields where positive selection was applied were healthy and gave high yields. Most of the crops look healthy as indicated by their vigorous growth and yielded highly, the tubers harvested from the crops could be used for home consumption as food, sold in the markets for income generation or for next season's planting as planting material. Positive selection makes valuable contribution to commercial yam production in fighting declining yields that are attributed to low seed quality and pathogen load.

According to Lone (2007) seeds are the most important input in all crop based agriculture and prerequisite to majority of the world's food production. Seeds provide the basis for crop improvement, allowing farmers and plant breeders to develop cultivars with high levels of adaptation. Seed management is a key element in addressing the challenges of responding to farmers' different requirements, preferences, increasing production and achieving food security.

The formal seed yam tuber supply system has been significantly low in Nigeria. The informal farmer to farmer seed tuber distribution methods continued to be the prevailing system of seed tuber supply for small scale yam farmers in Nigeria. However, little is known about how these systems function. Farmers require seed tubers of good quality and with characteristics they need for their particular agro-ecological conditions and objectives. These aspects cannot be assessed when acquiring seed tubers of yam. It is difficult to know the traits and

performance of yam plant that will grow from the seed yam tubers just by looking at the seed yam tubers. This can only be assessed when the planted seed yam tubers grow and established. The quality of seed yam tubers for planting is made up of a range of factors such as age of the seed yam tubers, ability of the seed yam tubers to germinate, pathogen load of the seed yam tubers, dormancy period of the seed yam tubers, storage method of the seed yam tubers and others. All these affect the germination and establishment of seed tubers into full grown yam plant.

Mere visual inspection of the seed yam tubers, size of the tubers, damage by insects or pathogens, and other characteristics such as the plant growth characteristics, yield, and ability to perform in a particular environment cannot be assessed visually to know whether the yam plant can be high yielding when planted. Yam plants being a clonal crop exhibits a high genotype by environment interaction which means that their yield performance across different agro-ecological environment depends on its specific genetic make-up. That is a yam genotype which performs well in one environment, may not do so in another environment. Therefore, before obtaining seed yam tubers, information such as the yam agronomic traits, culinary characteristics, environmental adaptation, soil type, diseases and type of disease response and seed yam tuber quality must be required. These information cannot be given by market seed tuber yam vendors. Among traditional yam farmers, selecting seed yam tubers saved from their own harvest gives the farmers confidence that they have selected quality seed yam tubers that will germinate and grow to the farmers standard and conditions in the farmers fields. Farmers selected yam varieties based on the characteristics they need since the performance of the yam plants from the selected seed yam tubers were from a particular ecological and management conditions. A yam variety that may be appropriate for one farmer may not be appropriate for another farmer as a result of cultural, social and ecological reasons. Using the seed yam tubers you selected by yourself minimizes risk, the characteristics of the yam plant selected is known and assured. The farmer knows how the seed tuber yam was stored, the management of the yam field and the performance of the yam plants under the particular environment where they were cultivated plus the consumption characteristics and marketability attributes.

The ability to select and saved seed yam tubers from season to season are highly valued and act as recognition for a good farmer. Sometimes farmers purposefully request for external seed yam tubers. This request may come up as a result of crop failure or poor harvest, or seed yam tuber loss through fire, theft, flood, foraging animals, pathogens or insects infestation. Seed yam tubers could also be lost through family consumption as a result of famine, sold to cover other needs more urgent at the time or disposed to try a new variety.

There are dangers when obtaining seed yam tubers from market vendors as this will be accompanied by lack of adequate information. There is the fear of varietal mixtures leading to loss of genetic purity. Genetically pure landraces could be obtained from farmers living in the same farming community and who saves seed yam tubers by themselves and never bought from the markets. If they ever need additional seed yam tubers, they prefer obtaining it locally or from other farmers in the same community so as to maintain genetic purity. Obtaining seed yam tubers from formal seed sectors and other non-local seed yam sources are less trustworthy and risky than seed yam tubers obtained from farmer to farmer seed yam tuber exchange or sources.

As yam is a major crop in yam growing belt of Nigeria, differences in agro-ecological conditions results in complementary growing seasons. For instance, during rainy seasons which are bi-modal, all river banks and basins are flooded. In dry seasons, the areas are dry making it easier for land preparation and planting of the yam crop. A hectare of land cultivated with yam crop requires about 10,000 seed yam tubers costing two million Nigerian naira (USD 5555.6). During rainy season which is the main season for yam cultivation, seed tuber yam harvested from dry season cultivation is used for planting the main season crop. For over the years, some farmers in Nigeria have developed a technique which drastically reduces the cost of purchasing seed yam tubers needed for planting an entire production area. These farmers multiply their own planting material using minisett technique (Ezulike et al., 2006) and vine cutting technique (Nwankwo et al., 2017). These farmers use one year for seed yam tuber multiplication for next season planting. Selecting and maintaining quality seed yam tubers for use for commercial yam production require that farmers make use of positive selection to remove crops that have already accumulated pathogens knowing that yam crop being clonally propagated are pathogen accumulator over the years.

Farmers and yam breeders sometimes travel to yam growing regions to select appropriate seed yam tubers with good characteristics for planting. This they do by going to the farmers' fields to select yam plants themselves. They have specific criteria they are looking for. Although high tuber yield in number and in fresh weight may

not be the ultimate, traits such as tuber size, early maturity, tuber flesh colour, ease of harvest, foliage density and vine diameter are not overlooked. Others include: greenness of the leaves, leaf architecture, which include the spread and appearance of the leaves, the leaf internode distance, the spineness of the vines, and tuber surface texture are also equally important. The economic part of the yam plant is the tuber, the marketable attributes of the tuber is very important to the farmer. The Breeder at harvest may travel back to the farmers fields to look at the tuber shape, tuber length, tuber diameter and tuber skin colour, tuber flesh colour, tuber surface texture, If these merits the Breeder's assessments as how it will be of benefit to the farmer, the yam tubers are collected from the farmers for breeding purposes. The tubers are multiplied and subjected to second stage of positive selection prior to planting the seed yam tubers for use in the hybridization block. Poor performing yam plants are discarded. The best yam plants in the evaluation field are selected as parent plants. No seed tubers are collected from farms with plants showing symptoms of virus infection. The same selection criteria already mentioned are applied again. Yam breeders normally collect seed yam tubers from farmers immediately after harvest to avoid storage pests' infestation. These are treated and stored for hybridization block establishment. Positive selection assists yam breeders to eliminate possible sources of diseases and abnormality in crops to be used for breeding purposes.

CCONCLUSION

Sources of seed tuber procurement contributed to lower incidence of pathogen infested plants, more number of vigorous plants, and high number of tubers in Farm B with positive selection compared with Farm A where positive selection was not practiced. High significant number of the yam plants were healthy with yield of very high number of tubers and less varietal mixtures as a result of using healthy pathogen free seed tuber yams from farmers saved own seed at planting coupled with the use of positive selection. If farmers should follow this technique and practice positive selection continuously for several seasons they would progressively have less sick plants in their field. Attention should be focused on enhancing the quality of farmer saved seed yam tuber. The agronomic practice of positive selection can improve yield and is workable when farmers understand more about major pathogens (viruses and bacteria wilt management) attacking their crops in the field.

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