



PLANT BREEDING PRACTICES AMONGST RURAL FARMERS FOR SUSTAINABLE FOOD SECURITY IN KATSINA STATE: ISSUES AND CHALLENGES

Abubakar Yusuf

*School of Vocational and Technical Education, Department of Agricultural Education,
Federal College of Education, Katsina*

Correspondence: abubakar.yusuf5@gmail.com,

Abstract

The study examined the issues around challenges of plant breeding practices amongst farmers in the rural areas. Multistage sampling technique was adopted for the study to select 120 farmers. Structured close-ended questionnaire was used to collect information on plant breeding related practices. The data collected was subjected to descriptive statistical analysis of percentages, mean and standard deviation. The result shows that majority (73.33%) of farmers in the rural areas had favourable perception towards plant breeding for increased food production to achieve food security for sustainable livelihood. Findings from the study reveals that the three major plant breeding areas of impact to farmers at the rural level are yield increase (26.5%) with mean $\bar{x} = 4.59$, reduced period of maturity (17.2%) with mean $\bar{x} = 4.32$ and resistance to pest and disease (13.3%) with mean $\bar{x} = 4.44$. The result furthermore reveals that that inadequate extension services on plant breeding practices amongst 39.17% of the farmers is one of the major challenges in the rural areas while 17.50% of the rural farmers were confronted with the challenge of ease of access to modern plant breeding practices and new crop varieties, 15.83% of the farmers are having the challenge of training facilities on plant breeding techniques. Despite the various challenges, plant breeding related practices can generally be improved to achieve food security for sustainable livelihood through the involvement and participation of the rural local leaders at the trial and adoption stage of new breeding technologies.

Keywords: Breeding, crop, food, productivity, security,

Introduction

The world human population is on the increasing rate at daily basis and is projected to reach 9.7 billion people by 2050 (Chawade, *et al.*, 2019). As the population grows, the demand for safe and high nutrient food materials continue to increase which led to unparallel increase in global food production rate. According to Agbowuro *et al.* (2021), since increasing human population outweighs food production increase, agricultural production need to rise by 50 % which translate to the need to increase food crop productivity on the limited arable farm land area. To respond to the need for food requirement for the increasing population as well as greater demand for a balanced and healthy diet to

achieve sustainable food security, it is quite a necessity to produce improved new cultivars or varieties of food crop plants through a sound knowledge of relevant science, particularly crop plant breeding technique. Silvia (2019) pointed out that crop improvement practice is the key to success on increasing crop productivity for food sufficiency. Food is one of the most essential needs of the human beings to sustain life and healthy living. Food security is therefore, very crucial for peaceful coexistence and national economic growth. The level of food security is determined by the availability, affordability, accessibility and utilization of food materials. According to Food and Agricultural Organisation FAO (2019), food security is a state in which

everybody has physical, social, cultural and economic access to safe, sufficient and nutritious food at all points in time to meet daily dietary requirement for healthy life. These made it imperative to evolve plant breeding practices to improve various plant traits to produce food crop plant varieties that can give more yield under biotic and abiotic stresses. Plant breeding has the potential to improve on plants agronomic traits and resolve agricultural productivity problems to enhance food security. It has the capability to solve crop productivity related issues such as higher yield, development of diseases and pests resistance, reduction in maturity period, enhancing quality and nutritive value, elimination of toxic substance from crop, abiotic stresses adaptation and increase shelf-life (Agbowuro *et al.*, 2021).

Plant breeding is the science of changing the traits of [plants](#) in order to produce desired characteristics. ByJu (2020) pointed out that plant breeding involve a purposeful manipulation of qualities in plants to create new varieties with a set of desired characteristics. Thus, Sashi and Sapana (2022) refers plant breeding as simply the integration of crop genetics in plants to produce plants according to plant ideotype through a repetitive process of selection in parents as well as their progenies for desirable traits. According to Flavio (2013), plant breeding can be broadly defined as alterations caused in plants as a result of their use by humans, ranging from unintentional changes resulting from the advent of agriculture to the application of molecular tools for precision breeding. The national agricultural seed council NASC (2021) defined plant breeding as the science of maximizing plant's positive genetic traits

to produce desirable effects to improve crop varieties that yield more, have better resistance to biotic and abiotic stress, and meet consumer expectation. According to Niazian & Niedbala (2020) plant breeding is defined as an active area of science with deliberate effort to change plants nature, and/or utilization of desired heritable variation that exist in the plant gene pool and its related wild species for the development of new improved varieties. According to Bert *et al.*, (2019), plant breeding can be performed through many different techniques ranging from simply selecting plants with desirable characteristics for propagation, to methods that make use of knowledge of genetics and chromosomes, to more complex molecular techniques. The vast diversity of breeding methods can be simplified into three categories: (i) plant breeding based on observed variation by selection of plants based on natural variants appearing in nature or within traditional varieties; (ii) plant breeding based on controlled mating by selection of plants presenting recombination of desirable genes from different parents; and (iii) plant breeding based on monitored recombination by selection of specific genes or marker profiles, using molecular tools for tracking within-genome variation (Flavio, 2013). According to Peter (2014), conventionally, plant breeding is achieved through following Mendel's principles where two parent crop plants that have expression of the desirable characters between them are intercrossed and the subsequent generations examined for plant with the desirable characters in new combination. Peter (2014) outlined the three major steps in any plant breeding programme as presented in figure 1.

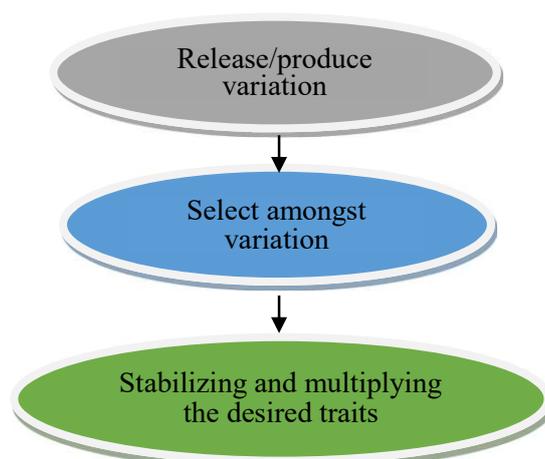


Figure 1: Diagrammatic representation of the major steps in any plant breeding programme

The type and method of plant breeding for crop improvement depends on the societal needs on what the plant provides such as food, pharmaceuticals and industrial raw materials (Kyetera *et al.*, 2019). However, there are different types of plant breeding practices as pointed out by the Crop Science Society of America CSSA (2023).

Backcrossing or introgression: This is where plant with desired traits is crossed with a plant that does not have the desired traits but has several other traits.

Inbreeding: This is where self-fertilization occurs with progeny produced been the same generation after generation to preserve the original traits.

Hybrid Breeding: This is where two different plant breeds are crossed to produce the offspring that are more productive than the parents crop plants.

Mutation Breeding: This is where the mutations in plant genes result in new varieties. It can also be induced in crop plants by exposing them to chemicals and radiation.

Genetic Engineering: This is where gene of interest is inserted within the crop DNA to

produce crop plant with desirable traits (genetically modified crops).

Objectives of the research

The specific objectives of the research are to describe the perception of farmers in the rural areas towards plant breeding practices, identify plant breeding areas of impact to the rural farmers in the study area and identify the challenges of plant breeding practices among the rural farmers in the study area.

Materials and Method

Katsina state is located in the northwestern geopolitical zone of Nigeria. The state borders Kaduna, Kano, Jigawa, Zamfara states and Niger republic. It is the fifth largest state in the country by population (NPC, 2016) with population projection of 9,887,044 people in the year 2023. According to MOI (2020), Katsina state is in the Sahel savanna region of Northern Nigeria located between latitude 11007'49N – 13022'57 North and longitude 60520'03E – 9002'40 East. The state covers a land area of 24,193 square kilometer which translates to a population density of 409 people per square kilometer. Katsina state is situated at an elevation of 513.33m (1684.15 ft) above sea level with subtropical steppe climate. The state experienced a yearly temperature range of 30.89° C (87.6° F) – 39.75° C (103.55° F) and receive an annual rainfall

ranging from 51.61 mm – 60.0 mm (2.03 – 2.40 inch) (NIMET, 2018). Katsina State Rural Community and Agricultural Development RCAD (2021) reported that Maize, Guinea corn, Millet, Groundnut, Cowpeas and Iris potato are the major food crops while Cotton, Tobacco and Sugarcane are the major cash crops produced in Katsina state.

Multistage sampling technique was adopted for the study to select 120 farmers. Two (2) local government areas were purposely selected at the first stage from each of the agricultural zones (Zone I Ajiwa, Zone II Dutsin-ma and Zone III Funtua). At the second stage, two (2) village areas were also purposively selected based on the predominance of food crop production practices to include Farfaru and Bugaje from Jibia LGA, Daderam and Tambu from Daura LGA in zone I Ajiwa, Makera and Shema from Dutsin-ma LGA, Yargoje and

Danmarke from Kankara LGA in zone II Dutsin-ma, Gozaki and Kuringafa from Kafur LGA, Dabai and Kahutu from Danja LGA in zone III Funtua. At the third stage, random technique was used to select ten (10) farmers from each of the selected village area. Sample size of six (6) local government areas where 120 rural farmers from twelve (12) village areas was used for the study. Structured close-ended questionnaire was adopted to collect information on the respondent's perception on crop improvement through plant breeding practices, crop breeding area of impact to the farmers and the challenges facing farmers on crop breeding related practices. The data collected was subjected to descriptive statistical analysis of frequency, percentages, statistical mean and standard deviation. Map of Katsina state showing the location of selected local government areas is presented in figure 2.



Figure 2: Map of Katsina state showing the location of the selected LGA's

Perception of the rural farmers towards plant breeding practices in the study area is presented in Table 1.

Table 1: Farmer's perception towards plant breeding practices in the study area

Statements	Statistical mean	Standard deviation(σ)
• Plant breeding practices are commonly adopted by the rural farmers for increased crop productivity	4.09	1.05
• The programme of breeding evolved is to identify new traits for crop plant diversification	4.08	0.94
• Plant breeding activities addresses the need to improve crop plant genetic constitution for better output	4.03	0.86
• Farmer's preference and welfare are the major concern of plant breeding programme	4.01	0.88
• Adoption of plant breeding practices can increase food production to meet future food demand of the population	3.99	0.96
• Classical plant breeding technique is the best method of crop improvement at the rural level	3.74	1.36
• The practice of plant breeding offers opportunity to increase food crop production without necessarily increasing farm size	3.71	1.32
• Crop plant breeding programmes were measures meant to eliminate from the rural farmers the local varieties of food crops	3.67	1.35
• Crop improvement through breeding is not compatible with culture of the rural farmers	3.64	1.06
• Crop diversification is achieved through good crop production and management practices	2.06	0.87
• Plant breeding cannot change the natural composition of crops	1.68	0.61
• Plant breeding programmes placed much emphasis on industrial needs to improve market	1.52	0.61
• Plant breeding programmes are not necessary to satisfy future food demand of the population	1.47	0.55
• Plant biotechnology is the only technique of crop improvement in crop production	1.45	0.61
• Crop plant breeding does not improve the local crop varieties	1.38	0.58
• Higher production food crops is obtained only on farm of larger size	1.28	0.45

Source: Field survey, 2023

The result shows that the farmers had different perception of plant breeding using the ranked mean. Considering the mean score value of the different plant breeding related practices the result reveals that some farmers had positive perception while some had negative perception towards the statements related to plant breeding. The statements with positive perception are those with mean score greater than the grand mean ($x = 2.67$). These are: plant breeding practices are commonly adopted by the rural farmers for increased crop productivity ($\bar{x} = 4.09$), the programme of breeding evolved is to identify new traits for crop plant diversification ($x = 4.08$), plant breeding activities addresses the need to improve crop plant genetic constitution for better output ($x = 4.03$), farmer's preference and welfare are the major concern of plant breeding programme ($x = 4.01$), adoption of plant breeding practices can increase food production to meet future food demand of the population ($x = 3.99$), classical plant breeding technique is the best method of crop improvement at the rural level ($x = 3.74$), the practice of plant breeding offers opportunity to increase food crop production without necessarily increasing farm size ($x = 3.71$), crop plant breeding programmes were measures meant to eliminate from the rural farmers the local varieties of food crops ($x = 3.67$), crop improvement through breeding is not compatible with culture of the rural farmers ($x = 3.64$). Some farmers had unfavorable perception towards the

statements related to plant breeding with mean less than the grand mean. These are: crop diversification is achieved through good crop production and management practices ($x = 2.06$), plant breeding cannot change the natural composition of crops ($x = 1.68$), plant breeding programmes placed much emphasis on industrial needs to improve market ($x = 1.52$), plant breeding programmes are not necessary to satisfy future food demand of the population ($x = 1.47$), plant biotechnology is the only technique of crop improvement in crop production ($x = 1.45$), crop plant breeding does not improve the local crop varieties ($x = 1.38$), higher production food crops is obtained only on farm of larger size ($x = 1.28$). Figure 3 shows a clear distinction amongst rural farmers on their perception towards plant breeding practices. It shows that more than half (73.33%) of the rural farmers in the study area had a favourable perception towards plant breeding practices while 26.67 % had unfavourable perception. The favourable perception translates to high level of awareness and potential for the adoption of crop improvement practices for higher crop productivity. These results were in accordance with the finding of Takam-Fongang *et al.* (2019) which established that favourable perception of the crop improvement significantly influence the adoption of plant breeding practices for higher yield. The distribution farmer's perception towards plant breeding practices in the study area is presented in figure 3.

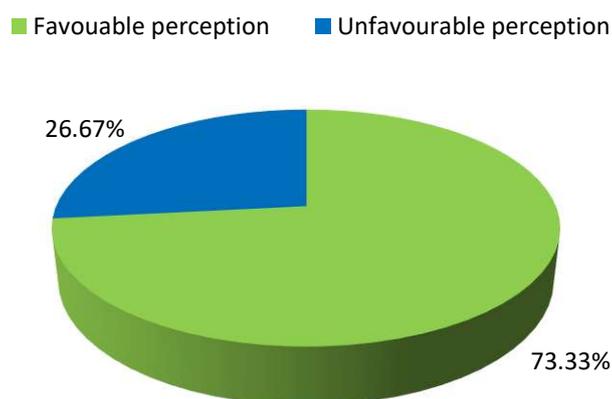


Figure 3: Farmer's Perception towards Plant Breeding Practice

Table 2 present results showing the different plant breeding areas of impact for increased food crop production to achieve food security.

Table 2: Plant breeding areas of impact to the rural farmers

Area of breeding	Statistical mean	Standard deviation (σ)
Yield increase	4.54	1.19
Crop adaptation	4.47	1.24
Resistance to pest and diseases	4.44	1.30
Reduced period of maturity	4.32	1.22
Improvement in nutritive value	4.31	1.28
Prolong shelf-life	4.16	1.43
Enhancement of compositional traits	4.03	1.50
Flood/draught tolerance	3.69	1.60
Minimal agronomic management	1.43	0.75
Crop quality in terms of appearance & taste	1.27	0.69

Source: Field survey, 2023

Result of study shows that the areas of impact to the rural farmers include yield increase mean ($x = 4.54$), crop adaptation ($x = 4.47$), resistance to pest and diseases ($x = 4.44$), reduced period of maturity ($x = 4.32$), increased nutritive content ($x = 4.31$), prolong shelf-life ($x = 4.16$) and enhancement of compositional traits ($x = 4.03$). When comparing mean score of individual response with the grand mean score ($x = 3.99$), the result reveals that the rural farmers benefitted from the adoption of plant breeding practices. Alemayelu (2017) reported similar findings in the study on review on impact of plant breeding in crop improvement. Figure 4 shows that from the

result of the study, majority of the rural farmers (80.1%) adopted plant breeding practices and benefitted from the practices with 26.5% of the rural farmers benefitting from yield increase, reduced period of maturity (17.2%), resistance to pest and disease (13.3%), prolong shelf-life (9.7%), improvement in nutritive content (7.5%) and crop adaptation, (5.9%) through the use of improved seed varieties. This is a similar trend reported by Agbowuro *et al.* (2021) in the study on plant breeding: a potential tool for sustainable food security in sub-Saharan Africa. The plant breeding areas that benefitted farmers in the study area are presented in figure 4.

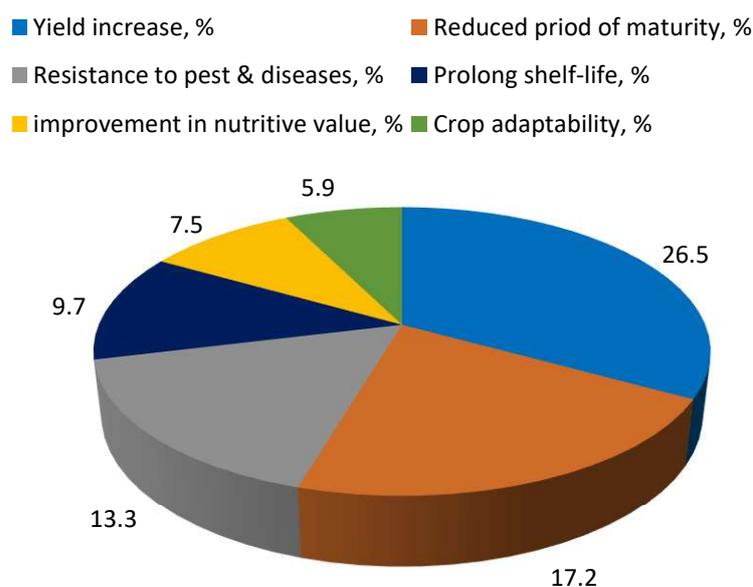


Figure 4: Plant breeding areas that benefitted farmers in the study area

Plant breeding practices amongst the rural farmers are considered as the means through which crop productivity can be improved. However, the breeding practice for crop improvement by the rural farmers is

associated with some constraints. The distributions of various challenges associated with plant breeding practices amongst the rural farmers in the study area were identified as presented in Table 3.

Table 3: Challenges associated with plant breeding amongst the rural farmers

Challenges	Frequency	Percentage
• Ease of access to modern plant breeding practices and new crop varieties at the rural level	21	17.50
• Continuous fluctuation of environmental conditions due to climate change	11	9.17
• Lack of training facilities on plant breeding techniques at the rural level	19	15.83
• Low participation level of the private sector in plant breeding	13	10.83
• Inadequate extension services on plant breeding practices	47	39.17
• Insufficient financial resources of the rural farmers	9	7.50

Source: Field work, (2023)

Result of the study shows that inadequate extension services on plant breeding practices amongst 39.17% of the farmers is one of the major challenges in the adoption of plant breeding practices in the rural areas. The result reveals that 17.50% of

the rural farmers were confronted with challenge of ease of access to modern plant breeding practices and new crop varieties while 15.83% of the farmers are having the challenge of training facilities on plant breeding techniques. These affect adoption

and management of plant breeding practices amongst the rural farmers. These results are in accordance with the report of Vos-Fels *et al.* (2019). Furthermore, the result reveals that an average of 2 rural farmers from each of local government area were confronted with the challenge of the effect of climate change (9.17%), inadequate participation of the private sector in the promotion of plant breeding practices in the rural areas (10.83%) and low financial status (7.50%) for effective management of plant breeding practices in crop production operations. The challenge may be due to the fact that the activities of farmer's financial support programme of the government such the anchor borrower placed much emphasis on crop production at large scale level other than crop improvement especially at the rural level. A similar finding on these challenges on crop improvement practices for achieving food security has been reported by Swiderska (2016).

Conclusion

Plant breeding practices are the main crop improvement techniques that involved the development or genetic alteration of existing crop varieties to produced new varieties with better performance than old varieties. These practices have no doubt increased crop improvement opportunities for several food crops to achieve food security for sustainable livelihood in Nigeria. However, plant breeders and other stakeholders have an enormous task of re-engineering the use of biotechnology tools in plant breeding for the general acceptance of the product by the farmers in the rural areas. The rural farmers are generally concerned with three components of plant breeding of yield increase, reduced period of maturity and resistance to pest and diseases. Crop plant breeding on nutritive value and storage life – span were not given the required attention by the farmers in the rural areas. Despite the fact that crop productivity has generally been improved at the rural level through plant breeding practices, there is the need to bring the breeding programmes closer to the rural farmers by the involvement and

participation of the local leaders at the trial and adoption stage of new breeding technologies. Extension services on plant breeding practices need to improve its scope and coverage for the provision of solutions to many of the constraints such on-farm training on plant breeding technique associated with plant breeding practices in the rural areas.

Recommendations

Plant breeding practices has no doubt improved crop productivity by the production new crop varieties with better performances. However, the following are recommended for wider acceptability and better adoption in the rural areas.

1. The stakeholders on plant breeding practices should create a means of sensitization of farmers in the rural areas on other important areas of plant breeding such as crop nutritive value and shelf – life.
2. The trial and adoption of new plant breeding technologies should be made closer to the rural farmers through involvement and participation of the local leaders.
3. The use of plant biotechnology tools should be re-engineered towards the preference of the local farmers not purely on market and industrial needs.

References

- Agbowuro, G. O., Salami, A. E., & Afolabi, M. S. (2021). Plant breeding: A potential tool to sustain food security in sub-Saharan Africa, *Journal of Pure and Applied Agriculture*, 6(1), 1 – 6
- Alemayehu, D. (2017). Review on impact of plant breeding in crop improvement, *International Journal of research Studies in Agricultural Science*, 3(9): 26 – 35
- Bert, L., Bertrand, C. & Matty, D. (2019). Review: Improving global food security through accelerated plant breeding, *Plant Science*, accessed from <https://doi.org/10.1016/j.plantsci.2019.110207>

- ByJu, C. (2020). What is Plant Breeding? It's definition? Its objectives, types and steps involved, <https://byjus.com>
- Chawade, A., Ham, J. Blomquist, H. bagge, O. Alexanderson, E. & Ortiz, R. (2019). High – throughput field phenotyping tools for plant breeding and precision agriculture, *Agronomy*, 9(5): 258, <https://doi.10.3390/agronomy9050258>
- Crop Science Society of America [CSSA] (2023). What is crop breeding? accessed from <https://www.crops.org/aboutcrop>
- Food and Agriculture Organization [FAO]. (2019). The state of food security and nutrition in the world, *Proceedings of the UN Committee on World Food Security*, Rome, Italy, accessed from <https://www.fao.org>
- Flavio, B. (2013). Traditional and modern plant breeding methods with examples in Rice (*Oryza sativa* L), *Journal of Agricultural and Food Chemistry (JAFC)*, 61: 8277 – 8286
- Takam-Fongang G.M., Kamdem C.B, Kane G.Q. (2019): Adoption and impact of improved maize varieties on maize yields: Evidence from central Cameroon. *Review of Development Economics*, 23: 172–188. <https://doi.org/10.1111/rode.12561>
- Rural Community and Agricultural Development [RCAD], (2021). *Annual technical report*, Ministry of Agriculture, Katsina State 2021 Report
- Kyetere, D., Okogberian, E., okeno, J. Sanni, K. Mundaradz, J., & Adbourhame, I. (2019). The role and contribution of plant breeding and plant biotechnology to sustainable agriculture in Africa, *Africa Focus*, 32(2): 83 – 108
- Ministry of Information Katsina State [MOI], (2020). *Yearly news bulletin*, accessed from <http://www.wikipedia.org>
- National Agricultural Seed Council [NASC], (2021). Plant variety protection act, *Fact sheet 2021*, <https://www.seedcouncil.gov.ng>
- Niazian, M., & Niedbala, G. (2020). Machine learning for plant breeding and biotechnology. *Agriculture*, 10: 436, <https://doi:10.3390/agriculture10100436>
- Nigerian Metrological Agency [NIMET], (2018). *Annual climate review bulletin*, Katsina State Office, Katsina, Nigeria
- National Population Commission [NPC], (2016). National census and house survey, *National Population Commission Report*, Headquarters, Abuja, Nigeria
- Peter, C. (2014). Plant breeding and crop improvement, <https://www.researchgate.net/publication/227986002>
- Shashi, L., & Sapana, T. (2022). Advances from conventional to modern plant breeding methodologies, *Plant Breeding Biotech*, 10(1): 1 – 14, <https://doi.org/10.9787/PBB.2022.10.1.1>
- Silvia, R. (2019). Plant breeding for food security, *International Journal for Rural Development (IJRD)*, 53(2), <https://www.rural.com>
- Swiderska, K. (2016). Achieving food security, sustainability and resilience using genetic diversity and indigenous knowledge, *Institute of Environment and Development (IIED)*, <https://pubs.iied.org/17410IIED>
- Vos-fels, K. P., Andreas, S & Lee, T. H. (2019). Q & A: Modern crop breeding for future food security, *BMC Biology*, 17:18, <https://doi.org/10.1186/s12915-019-0638-4>