Review Article

PROSPECTS AND CHALLENGES OF BREEDING SOME SELECTED TUBER AND ROOT CROPS IN CROSS RIVER STATE, NIGERIA

ABSTRACT

Root and Tuber crops are an important source of food, income, and employment for millions of people in Cross River state, Nigeria. However, the productivity of these crops is limited by several factors, including pests and diseases, poor soil quality, and climate change. Breeding programs have been developed to improve the productivity and quality of tuber crops. This project work aims to review the prospects and challenges of breeding growth tubers and tuber crops in Nigeria. This paper review was therefore aimed at analyzing the current state of breeding some of the selected root and tuber crops (Yam, cassava, sweet potato, cocoyam, carrot, ginger and onions) in Nigeria. In addition, the review also evaluated the effectiveness of breeding strategies, identify the major challenges facing breeders and highlighted the opportunities in breeding these selected crops for future improvement in breeding programmes and provide recommendation for overcoming the identified challenges. The project work will analyze the current state of breeding programs in Nigeria, evaluate the effectiveness of breeding strategies, and identify the major challenges facing breeders. In addition, the project work highlight potential opportunities for future improvements in breeding programs and provide recommendations for overcoming the identified challenges.

Keywords: Root and tuber crops, Cross River, Breeding, Prospects and challenges.

INTRODUCTION

Root crops are a type of edible plant roots that are used as vegetables. They are commonly grown underground, and are usually harvested in the fall and winter seasons. These vegetables are often rich in nutrients, such as vitamins and minerals, and can be consumed in a variety of ways, including raw, roasted, boiled, or mashed. Some common examples of root vegetables include carrots, potatoes, sweet potatoes, turnips, beets, parsnips, and radishes. These vegetables are often used in a variety of dishes, such as stews, soups, and roasted vegetable medleys. Root crops are an important part of a healthy diet, as they are often low in calories, high in fiber, and provide a variety of essential nutrients. Additionally, they can be an important source of carbohydrates and energy for those who follow a plant-based diet. Tuber crops are a vital source of food for people globally, and they play a significant role in agricultural development in Nigeria. Tuber crops are a type of food crop that grows underground, and they are rich in carbohydrates, vitamins, minerals, and fiber (Akinmutimi et al., 2019). Tuber crops are an essential component of Cross River State agriculture sector, providing food and income for millions of people (Onwueme & Sinha, 1991). Cross River State, Nigeria is blessed with various root and tuber crops such as;

- **Cassava (*Manihot esculenta*):** This is the most widely grown root crop in Cross River state Nigeria, with an estimated production of over 54 million metric tonnes in 2020. Cassava is a versatile crop that can be processed into a wide range of products, such as garri, fufu, and starch. Cassava is also an important source of income for smallholder farmers, as it can be grown in marginal environments and is relatively resilient to pests and diseases.

- **Yam (*Dioscorea spp.)*** is another important root crop cultivated in Cross River state Nigeria, with an estimated production of over 46 million metric tonnes in 2020. Yam is a staple food in many parts of Nigeria, and is consumed in various forms, such as boiled, roasted, and pounded yam. Yam is also an important source of income for farmers, as it is highly valued in local and international markets.
- **Sweet potato (*Ipomoea batatas)*** is a root crop that is gaining popularity in Cross River state Nigeria, due to its nutritional value and versatility. Sweet potato is rich in vitamins and minerals, and can be processed into various products, such as chips, flour, and bread. Sweet potato is also a suitable crop for intercropping with other crops, and can help to improve soil fertility and reduce soil erosion.
- **Carrot (*Daucus carota*)** is a crop that is grown in Nigeria, although it is not as widely cultivated as other root crops such as cassava, yam, and sweet potato in Cross River state. Carrot cultivation in Nigeria is concentrated in the northern part of the country, where the climate is cooler and more suitable for the crop. The major carrot producing states in Nigeria include Plateau, Bauchi, and Kaduna.
- **Cocoyam (*Xanthosoma spp.)*** *i*s a root crop that is widely grown in Nigeria, particularly in the southern part of the country. It is a starchy tuber that is used as a staple food in many households, and is also used in the preparation of various local dishes. Cocoyam cultivation in Nigeria is predominantly done by smallholder farmers, who cultivate the crop on a small scale for household consumption and sale in local markets. The crop is known for its ability to thrive in marginal soils and under low rainfall conditions, which makes it a popular choice among farmers in areas with poor soil fertility and limited access to irrigation.

- **Ginger (*Zingiber officinale*)** is a root crop that is grown in Nigeria, particularly in the northern and southern parts of the country. It is an important spice crop that is widely used in local dishes and in the production of herbal medicines. It cultivation in Cross River State is still at a low level. According to a study by Okwu and Ndukwu (2016), ginger has been found to possess various medicinal properties, including anti-inflammatory, antioxidant, and anti-cancer properties. This has increased the demand for ginger in the global market and has also created opportunities for ginger farmers in Nigeria to earn higher incomes from the crop.
- **Onion (*Allium cepa)*** - Onion is a root crop that is widely grown in Nigeria and other parts of the world. It is a good source of vitamins and minerals, and is used in the production of various food products such as stews, soups, and salads.

In addition to these major root and tuber crops, farmers in Cross River state Nigeria also produces other crops such as taro, Beet root, etc. These crops are consumed by millions of people and are also used in various industries, including pharmaceuticals, textiles, and alcohol production.

However, the production of tuber crops in Cross River state, Nigeria is faced with several challenges such as low yield, pest and diseases, and inadequate storage facilities. Due to these challenges, certain breeding programs have been developed to improve the productivity and quality of tuber crops. This paper review was therefore aimed at reviewing the prospects and challenges of breeding some selected root and tuber crops in Cross River state, Nigeria.

BREEDING OF ROOT AND TUBER CROPS IN NIGERIA:

The breeding of root and tuber crops in Nigeria involves the development of new varieties that are high yielding, resistant to pests and diseases, and can withstand adverse environmental conditions. Nigeria has made significant progress in breeding new varieties of tuber crops in recent years. For instance, the National Root Crops Research Institute (NRCRI) has developed high-yielding and disease-resistant varieties of cassava such as TME 419, TMS 30572, and TMS 98/0505 (Awoleye, 2018). These varieties have increased cassava production and improved the livelihoods of farmers in Nigeria. Similarly, the International Institute of Tropical Agriculture (IITA) has developed new varieties of yam, such as the white yam and the water yam, which are high yielding and resistant to pests and diseases (IITA, 2021). The IITA has also developed a new variety of sweet potato called the "Moisture Seeking Storage Root" (MSSR) that can tolerate drought and produce high yields under low rainfall conditions (Egesi *et al*., 2019) (Egesi et al.,2019). The MSSR has the potential to increase food security in Nigeria, especially in areas with low rainfall. Breeding programs are aim to develop improved varieties of root and tuber crops that have higher yield, better nutritional value, and resistance to pests and diseases. Several breeding methods are used, including conventional breeding, molecular breeding, and genetic engineering.

Conventional breeding involves the selection of desirable traits, such as yield, disease resistance, and quality, through the controlled crossing of parent plants. This method has been used successfully to develop improved varieties of yams and cassava in Nigeria (Okogbenin *et al.*, 2013). Molecular breeding such as marker-assisted selection (MAS), involves the use of genetic markers to identify desirable traits and accelerate the breeding process. This method allows breeders to select plants with the desired genes quickly and efficiently, resulting in the development of improved varieties. It has been used to develop improved varieties of sweet

potato in Nigeria (Babaleye *et al*., 2019). Genetic engineering involves the insertion of desirable genes into the genome of tuber crops to confer desirable traits. This method has not yet been widely used in Nigeria due to regulatory and social concerns (Babalaye *et al*., 2019). The breeding of root crops has played a significant role in improving crop yields, resistance to pests and diseases, and quality traits. This paper will discuss the breeding of root crops, including the breeding methods used, examples of improved varieties, and future prospects.

- **CASSAVA BREEDING:**

  Cassava is one of the most important staple crops in Nigeria, providing a significant source of carbohydrates for millions of people (Ogunyemi *et al*., 2021). The breeding of cassava involves selecting and crossing plants with desirable traits such as high yield, disease resistance, early maturity, and improved quality (Ospina *et al*., 2018). Breeders use various methods such as conventional breeding, molecular breeding, and genetic engineering to develop new cassava varieties that are adapted to local growing conditions, have higher yields, and improved quality traits such as reduced cyanide content (Ospina *et al*., 2018) (Ospina *et al., 2018*).

- **YAM BREEDING**

  Yams are another important staple crop in Nigeria, providing a source of carbohydrates, protein, and essential minerals (Odoemenem *et al*., 2017). The breeding of yams involves selecting and crossing plants with desirable traits such as high yield, disease resistance, early maturity, and improved quality. Yam breeders use various methods such as conventional breeding, mutation breeding, and tissue culture to develop new yam

varieties that are adapted to local growing conditions, have higher yields, and improved quality traits such as better taste and texture (Asiedu *et al.,* 2012).

- **SWEET POTATO BREEDING**

  Sweet potatoes are an important source of carbohydrates, vitamins, and minerals in Nigeria (Owino *et al.*, 2020). Sweet potato breeding involves selecting and crossing plants with desirable traits such as high yield, disease resistance, early maturity, and improved quality. Breeders use various methods such as conventional breeding, mutation breeding, and tissue culture to develop new sweet potato varieties that are adapted to local growing conditions, have higher yields, and improved quality traits such as better taste, texture, and nutritional value (Owino *et al.,* 2020).

- **CARROT BREEDING:**

  Carrot breeding involves both traditional and modern breeding methods. Traditional methods include selection, intercrossing, and hybridization, while modern methods include marker-assisted selection, genetic engineering, and genomic selection (Bradshaw, 2009). Mass selection is used to identify plants with desirable traits, which are then intercrossed to produce improved offspring. Hybridization involves crossing genetically diverse parents to create offspring with superior traits (Chakraborty *et al.*, 2000). Marker-assisted selection involves selecting specific genes associated with desirable traits using molecular markers, while genetic engineering involves introducing a specific gene from another organism into the carrot genome (Bradshaw, 2009). Genomic selection involves

using high-throughput genotyping and phenotyping technologies to select for complex traits.

- **COCOYAM BREEDING:**

  Cocoyam farming in Nigeria is often done using traditional methods, with little or no use of modern technologies such as improved varieties, fertilizers, and mechanization (NRC, 2006). This has limited the productivity and profitability of the crop, and has also made it vulnerable to various biotic and abiotic stresses such as pests, diseases, and climate change. Efforts are underway in Nigeria to develop improved cocoyam varieties that are resistant to pests and diseases, and that can yield higher quantities of tubers (IITA, 2015). There are also efforts to promote the adoption of modern farming technologies among cocoyam farmers, such as improved seed varieties, fertilizers, and irrigation.

INTEGRATION OF NEW BIOTECHNOLOGY IN BREEDING ROOT AND TUBER CROPS

Progress based on traditional genetics has been very important and has led to the current number of varieties of root and tuber crops in Nigeria (Bradshaw, 2009). However, the barriers between species do not allow all of the transfer of genes which would be interesting to realize. Furthermore, variation in the chloroplast and mitochondrion genomes is not exploited because of their maternal transmission. Fixing characteristics is also a long and difficult process in spite of the use of the gene, as it is for combining in the same genetic background the various sources of resistance to a disease. Cellular and molecular biology has made all of these possible and has brought solutions to additional problems (NRC, 2006). The contributions of biotechnologies to traditional selection are numerous, including:

(i) Decreasing the breeding duration

(ii) Exploring genetic diversity by facilitating interspecific crossings

(iii) Enhancing the understanding of the genome and controlling the contribution of new characteristics.

PROSPECTS OF BREEDING ROOT AND TUBER CROPS IN NIGERIA:

The breeding of tuber crops in Cross River state, Nigeria has enormous prospects for enhancing food security, reducing poverty, and improving the livelihoods of farmers. Breeding programs have the potential to significantly improve the productivity and quality of tuber crops in Nigeria. Furthermore, the use of molecular breeding and genetic engineering can accelerate the breeding process and improve the efficiency of breeding programs. The breeding of tuber crops in Nigeria has the potential to promote export and generate foreign exchange for the country. Nigeria has a comparative advantage in the production of some tuber crops such as yam, which has a high demand in foreign markets. The development of high-quality and disease-free yam varieties will increase export earnings and enhance the country's foreign exchange reserves.

Root and tuber crops are important sources of food and income for millions of people around the world, particularly in developing countries. These crops are not only nutritious, but also have various uses in the food, feed, and industrial sectors. As such, the prospects of root and tuber crops breeding are significant

CHALLENGES OF BREEDING ROOT AND TUBER CROPS IN CROSS RIVER STATE

Despite the potential benefits of breeding programs, the breeding of tuber crops in Cross River state is faced with several challenges, which include inadequate funding, poor infrastructure, and inadequate research facilities. The government's funding for research and development in agriculture is inadequate, and this has limited the capacity of research institutions to carry out research on tuber crops (Omoregie *et al.*, 2020).

Also, the lack of modern infrastructure such as laboratories, equipment, and research facilities has limited the capacity of research institutions to carry out research on tuber crops. The inadequate infrastructure has also limited the capacity of farmers to access new varieties of tuber crops that have been developed. In addition, the lack of infrastructure for storage, transportation, and processing of tuber crops limits the commercialization and adoption of improved varieties. Another challenge is the lack of availability of quality germplasm for breeding programs. This limits the genetic diversity available for breeding and hinders the development of improved varieties.

Furthermore, the breeding of root and tuber crops in Nigeria is faced with the challenge of inadequate human resources. There is a shortage of trained personnel in the field of agriculture, particularly in the area of plant breeding. This has limited the capacity of research institutions

CONCLUSION

Root and tuber crops are vital stable food crops for most communities in the developing world. Despite the challenges in breeding these crops, their main role as energy contributor, providing a number of desirable nutritional and health benefits cannot be ignored. The major root and tuber crops that are used as staple or secondary staple foods are cassava, sweet potato, cocoyam, and yam. Minor ones include the carrot, galic, ginger and Hausa potato. They produce more than 240 million tons annually on 23 million hectares and contribute 5.4 per cent of the total energy needs of the humans from 61.1 kg tubers per head annually. It is estimated that with breeding, this contribution will be double in the near future.

Root and tuber crops such as yam, cassava, sweet potato, carrot, and onions due to their high demand, need a continued improvement of quality traits to meet the needs of a changing and demanding world. However, the genetic improvement of these crops is hampered by several factors, including tetrasomic inheritance, high level of heterozygousity and incompatibility barriers. Nowadays, molecular breeding helps the breeders in the rapid identification of desirable genes, to produce quality traits like starches with modified amylase to amylopectin ratio or to produce root and tuber crops with a higher nutritional value. Equally important is the fact that basic studies have contributed to elucidate our knowledge of the genetics, biochemistry and physiology of several quality traits, making breeding efforts less empirical and more predictable. Since most quality traits are genetically controlled, breeding work can successfully meet the quality of root and tuber crops and fulfill the needs of a changing and demanding world.

Breeding of root and tuber crops in Nigeria is faced with several challenges such as inadequate funding, poor infrastructure, inadequate research facilities, and shortage of human

resources. To overcome these challenges, there is a need for increased government funding for research and development in agriculture, improved infrastructure, and the provision of training and capacity building programs for researchers and farmers.

Addressing the challenges facing the breeding of root and tuber crops in Nigeria will require concerted efforts from all stakeholders, including the government, research institutions, and farmers. With sustained efforts, Nigeria can achieve its goal of enhancing food security, reducing poverty, and improving the livelihoods of farmers through the breeding of growth tubers and tuber crops.

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