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Production management and marketing of sweet potato (*Ipomea batatas* (L.) Lam) in a farm environment in South Benin

Manhognon Oscar Euloge Faton[*1,2], Zaki Bonou-Gbo[1,2,3], Hervé Soura[4], Mahutin Mariano Djihoulandé[1,2], Fanou Lucie[1,5], Léopold Simplice Gnancadja[1,2]

[1]*Laboratory for Research in Biological Resources/UATM GASA-Formation, Benin*

[2]*Laboratory of Plant Physiology and Study of Environmental Stresses: Research Unit in Phytopathology and Plant Protection, UAC, FAST, Benin*

[3]*Department of Animal Sciences, Higher Agronomic and Veterinary Institute of Faranah, Guinea*

[4]*Higher Institute of Sustainable Development, Yembila Abdoulaye Toguyeni University, Burkina Faso*

[5]*Laboratory of Food Technology and Quality Control, UATM GASA-Formation, Benin*

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ABSTRACT

In Africa, sweet potato is a key crop for food security and nutrition, especially for poor and vulnerable populations. However, its production faces several challenges that limit its development. This study aimed to contribute to improving production and conservation practices of this tuber. A survey was conducted in 35 villages across 15 communes with 335 producers in the southern and central zones of Benin. Informations' collected were on production management, constraints, control methods, storage, conservation, and marketing strategies. Data were gathered with KoboCollect, processed in Excel 2016, and analyzed with R4.5.0. Results show that sweet potato production is overwhelmingly male-dominated (97.17%), with producers averaging 45 years of age and 16.8 years of experience. Most belong to the Fon, Nagot, and Adja ethnic groups, while 56.5% are illiterate. Agriculture is the main activity (87.83%), and land is accessed primarily through rental (44.35%) or inheritance (32.17%). Production is largely market-oriented (94.78%), sold wholesale and measured by basin. Major constraints include post-harvest storage, scarcity of cuttings, and pests such as *Cylas formicarius, Bedellia somnulentella,* and *Agrius cingulata*. Tubers are mainly stored in the field (94.82%), while planting material is self-produced (88.70%) through cuttings or natural regrowth. The absence of professional organizations limits producers' access to credit and structured markets. These findings highlight both the importance of sweet potato in local livelihoods and the urgent need for improved conservation methods, pest control, and organizational structures to support sustainable production.

***Corresponding author:** Manhognon Oscar Euloge Faton ✉ oscarfaton@gmail.com

Co-authors:
Zaki Bonou-Gbo: https://orcid.org/0000-0002-1971-0040

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam.), native to South America, is an annual herbaceous plant with creeping stems. It was domesticated about 8,000 years ago in the Andes Cordillera, from Peru to Argentina (Roullier *et al.*, 2013; Muñoz-Rodríguez *et al.*, 2018), and introduced to West Africa by the Portuguese in the 16th century (Ogunlade *et al.*, 2014). Global production increased by more than 60% between 1993 and 2013, from 88 to 144 million tons (FAO, 2013). Sweet potato plays a crucial role in food security and nutrition, particularly for poor and vulnerable populations (FAOSTAT, 2010). Its tubers are rich in vitamins A and C, iron, calcium, and essential amino acids (Tumwegamire *et al.*, 2014; Sanoussi *et al.*, 2016). In addition to direct consumption, tubers and leaves are widely used in animal feeding (Owori *et al.*, 2007; Drone, 2019). The crop also provides raw materials for the food, cosmetic, and pharmaceutical industries, owing to its high starch, fiber, and micronutrient content (Oluwole *et al.*, 2019). Furthermore, sweet potato can be processed into ethanol, an environmentally friendly biofuel (Wang *et al.*, 2016). As a low-cost, high-yielding crop, sweet potato represents an important income source for smallholder farmers in developing countries. In Benin, it contributes significantly to household nutrition, particularly through orange-fleshed varieties rich in provitamin A (Amagloh *et al.*, 2014).

According to a World Health Organization study, more than 127 million children worldwide suffer from vitamin A deficiency. Sweet potato therefore has interesting agronomic capacities such as good productivity, a more or less short production cycle, and a wide adaptation of climate and soil of most varieties. This represents major assets in addressing the challenge of food security in the context of climate change (Glato *et al.*, 2017; Doussoh *et al.*, 2016). In Sub-Saharan Africa, potato cultivation is generally carried out on small, more or less fertile areas with few inputs and results in relatively good yields (Khoury *et al.*, 2014; Doussoh *et al.*, 2016). Benin is a major producer of sweet potato in West Africa, with an estimated annual production of 64,700 tons (FAOSTAT, 2018). It is the second most important food crop after maize (OCIS, 2025), consumed mainly boiled or fried, and plays a critical role in rural household food security (Houngnihin *et al.*, 2016). Sweet potato is especially important during the lean season and contributes to the fight against child malnutrition, particularly through orange-fleshed varieties rich in β-carotene, a precursor of vitamin A (Sanoussi *et al.*, 2013). Despite its socio-economic and nutritional importance, it remains a neglected crop in Benin, underutilized and poorly researched (Doussoh *et al.*, 2016). Production faces multiple challenges, including limited access to quality planting material, low fertilizer use, weak adoption of modern practices, and informal marketing (Kossoube *et al.*, 2018; Ouedraogo *et al.*, 2020). This study aims to identify local varieties, production constraints, and traditional methods of seed protection, conservation, and management.

MATERIALS AND METHODS

Selection of collection area and survey

The studies were carried out in the southern region of Benin located between the parallels 6°15' and 7°30' of northern latitudes and the meridians 1°52' and 2°36' of eastern longitudes. With an area of 17,019 km², it is subject to a sub-equatorial climate characterized by two rainy seasons alternated by two dry seasons (Akoègninou *et al.*, 2006; Doussoh *et al.*, 2016). Rainfall is between 1100 mm and 1400 mm. The temperature varies between 26 °C and 28 °C. The soil is variable from the sandy type to the soil of the bar through the vertisols. According to statistics from INSAE (National Institute of Statistics and Economic Analysis), the population is 4,592,752. Agriculture is the first activity carried out, followed by other activities such as livestock farming and fishing (Dousson *et al.*, 2016). The study area covers 15 municipalities in the departments of Atlantic, Ouémé, Plateau, Zou, Couffo and Mono. The Fon, Adja, Ouémin, Sahoué, Aïzo and Nago communities were the most frequently observed in the field. Following investigations with decentralized agencies of the Ministry of Agriculture, Livestock and Fisheries (MAEP) and using FAO information, 36 villages were selected based on their sweet potato production (Fig.

1). The sample size of the producers to be investigated was obtained using the normal approximation of the binomial distribution proposed by Dagnelie (1998):

$N = \frac{\left(U_{1-\frac{\alpha}{2}}\right)^2 \times P(1-p)}{d^2}$ with $U_{1-\frac{\alpha}{2}}$, the value of the normal random variable for the probability value of 1-α/2; α being the risk of error. For α = 5%, the probability 1-α/2 = 0.975 and we have; p is the proportion of producers who produce sweet potato in the study medium and the margin of error of estimate retained at 5% in this study (Dagnelie, 1998).

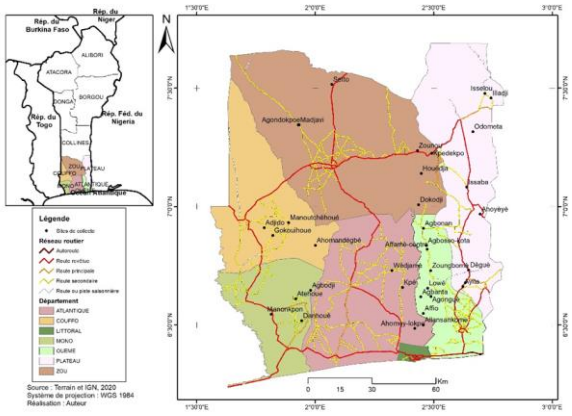

Fig. 1. Presentation map of the study area

Methods

A survey was conducted in April 2023 among 335 male and female producers, using a participatory prospecting method in groups or individually, at home or on their land (Orobiyi *et al.*, 2013). Interviews were conducted in all selected villages with the support of a local interpreter when the local language of the area is not understood. Interviewees were sweet potato producers whose identification was facilitated by village chiefs (Kombo *et al.*, 2012). The focus groups took into account information such as production constraints and control methods used, the inventory of different local sweet potato varieties; while data on socio-demographic aspects (age, household size, gender, socio-cultural group), the seed system and conservation techniques were collected at the individual level.

Statistical analysis

The data collected were subjected to a rigorous process, including the analysis, processing and analysis of socio-demographic data, constraints and marketing systems. The Microsoft Excel 2016 spreadsheet was used for data analysis and processing. Quantitative data were described using R 4.5.0 software.

RESULTS

Socio-demographic characteristics of sweet potato producers

The results of the survey carried out in the study area show that the majority of sweet potato producers are men, i.e. 97.17%, while women represent only 2.83% of the sample. Aged from 25 to 68 years, these producers have an average age of 45.44 ± 9.866 years. The variability noted at the age level is also recorded in the experience of producers in the production of sweet potato and ranged between 2 and 35 years, with an average of 16.79 years ± 8.142 years. According to these respondents, 60% have a high-income level compared to 13.043% with an average income and 26.957% with a low income. In total, ten (10) socio-cultural groups were registered with a majority share with the surveyed producers belong mainly to the Fon ethnic group (26.08%), followed by the Nagot (19.13%), the Adja (12.17%), the Aizo (6.95%), the Sahoue (6.08%), the Yoruba (5.21%), the Chi (5.21%), the Oueme (2.60%), the Holli (2.60%) and the Tori (1.73%). The discussion with producers in the majority of villages is provided by a translator indicating a higher proportion of producers who have not been educated at all, i.e. 56.52% of the population surveyed. According to survey data, the Christian religion is the most practiced in the study area with 77.39% of respondents against 22.61% who group those of Muslim and endogenous religions.

Professional situation and method of land acquisition

Most of the sweet potato producers surveyed (87.83%) are mainly involved in agricultural production. Apart from this sector of activity, crafts and commerce represent the other sectors of activity sharing an equal proportion of 6.09%. These producers invest in sweet potatoes as a secondary activity to improve their income. Indeed, this producer population can be divided into three

groups, namely the high-income group occupying 60%, followed by the low-income producer group with a rate of 26.96% and the last middle-income producer group with a rate of 13.04%. Furthermore, the economic situation of sweet potato producers also has a significant impact on the way in which agricultural production land is acquired and secured. Data collected during this study indicate that producers have difficulty buying land, as arable land is purchased by the lowest proportion of producers 23.48%. The strategy most used to have access to land is the rental or lease according to 44.35%, allowing the latter to produce over a minimum period of 3 years to 5 years. Finally, inheritance is the second most important method of obtaining land, as it has given 32.17% of respondents the opportunity to start producing essential sweet potatoes, suggesting that the family bond has a positive impact on the development of agricultural production in general and sweet potatoes in particular. These producers hardly belong to a professional organization (99.13%) thus playing on obtaining agricultural credit for the development of their activity.

Terms of sale of sweet potato tubers

The data collected during the present study indicate that the major reason for the production of sweet potato is the marketing reported by 94.78% of the respondents indicating that the small proportion of the harvest is intended for self-consumption (5.22%). Various measuring instruments are used and include respectively the basin (66.96%), the bag (20.87%), the basket (11.30%), and the bachet (0.87%). The use of these instruments is necessary for the wholesale of sweet potato which predominates (73.04%) in the farms visited, followed by retail (26.96%). To better sell and limit crop losses, some producers choose to sell exclusively near the fields 45.21% while others, 26.96% harvest the tubers the day before the market for their transport to the market place of sale. The remaining 27.83% has no specificity on the place of sale; the latter release the tubers to customers according to the urgency and the place that is suitable for them.

Production constraints and peasant struggle strategies

In order to understand how production is managed, data were identified on the different constraints that occur in the study area and that have an impact on sweet potato production, both biotic and abiotic in nature. Analysis of these data reveals that many constraints hinder the production of sweet potato in southern Benin, with a predominance of post-harvest storage difficulties (32.88%), followed by insufficient cuttings or vines (23.64%) for production. Other abiotic factors such as insufficient rainfall (10.40%), flooding (5%) and flooding (4.72%); then biotics such as insects and diseases (13%), also have a significant impact on sweet potato production. These factors can lead to a decrease in the quality and quantity of production.

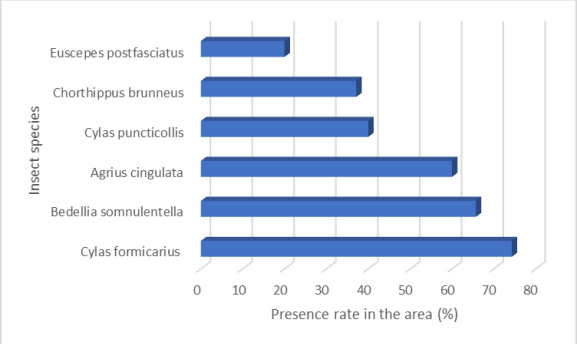

Fig. 2. Insect incidence in the study area

Referring to the catalog of sweet potato pests, producers recognize certain species of insects that harm the production of sweet potato. Of the seven identified in total, three are more present in more than 50% of the villages surveyed and concern respectively *Cylas formicarius* (74.29%), *Bedellia somnulentella* (65.71%) and *Agrius cingulata* (60%) (Fig. 2). The species *Euscepes postfasciatus* is the least represented (20%) in the study area. It would therefore be important to put in place specific control strategies for these insects, in order to minimize the impact of their devastation on sweet potato crops.

In addition, other problems raised by producers, such as the lack of an association, unequal prices, non-mechanization of activities and the specific absence of

a market, are all factors that discourage producers from expanding their crops on additional land.

These problems cause significant damage to yield and most producers, 92.30%, do not use plant protection products to control pests. This trend is mainly due to a lack of knowledge of the products available on the market (45.45%); insufficient financial means for agricultural work (35.07%); and the lack of control of the crop rotation system (19.48%) for those who do not wish to go towards chemical control.

Tuber conservation strategies by farmer

Agricultural practices relating to the conservation of sweet potato tubers are a major concern for all producers in the production area. Indeed, sweet potato is known not to be preservable over a long period of time. However, the data collected reveal the existence of two traditional short-term conservation techniques for tubers. This is the field conservation implemented by 94.82% of producers. This method is mainly used by producers who grow on farmland where there is no risk of flooding. The mature tubers are not harvested but left on the mounds or ridges until sale. However, this technique is not applicable to all varieties because some are very vulnerable to pests according to these producers. The second method of conservation practiced by 5.18% of producers is the storage of the tubers harvested in a cool place away from light for about twenty days. The heap can be covered with herbs or not, then lightly watered. However, growers who use this method face the risk of tuber rot due to the heat that emanates from inside the pile as they are unable to assess the actual moisture available in the warehouse.

Producers' management of sweet potato seeds

The central material of plant production is the seed intended for production. Vegetative multiplication is the voice by which sweet potato is mainly produced. Cuttings intended for this production are acquired in two different ways. Some farmers opt to purchase vines or tubers from their counterparts (11.30%), while others prefer to set up nurseries of sweet potato cultivars using cuttings from the previous season (88.70%) or tubers from these cultivars, to meet their own needs for the new season. Similarly, during the rainy season, vines or cuttings regrow from the tuber fragments left in the soil after harvesting, which are recovered for new production. In addition, it should be pointed out that in low-lying areas, cuttings of different local varieties are frequently available, which facilitates the exchange of planting material between producers thus indicating the high proportion reserved for self-production of semen.

DISCUSSION

Sweet potato cultivation is subject to various biotic and abiotic constraints. Most of the constraints identified in this study were already recorded by other authors in 2014 indicating that the most important agronomic constraints are post-harvest storage difficulties, shortages of cuttings or vines, insects and diseases, as well as problems related to rainfall (Agre *et al.*, 2015; Dossou-Aminon *et al.*, 2014) and flooding. These findings are consistent with the findings of James *et al.* (2010), who identified crop diseases, pests and weeds as major biotic constraints, to which they add soil salinity, drought and soil fertility as major abiotic constraints

The incidence caused by insect pests could be reduced, or avoided, by adopting integrated cropping practices with good management of available resources. It would therefore be possible to control these insects by using methods such as crop rotation, selection of resistant varieties, use of natural insecticides such as neem (*Azadiractha indica*) extracts, and regular monitoring of the crop for signs of infestation. Various strategies for integrated weevils control have been developed by Prayogo *et al.* (2023), including the use of traps, entomopathogenic nematodes and repellent plants.

Conventional tuber preservation methods used in Benin, such as conservation on mounds or in humid environments, allow, according to Harouna *et al.* (2015), only the conservation of tubers for a limited period, i.e., from two to three weeks at most, depending on the variety. These techniques are

similar to those used in Niger and include tree-sheltered storage, stand-keeping, and granary conservation (Harouna *et al.,* 2015). The most frequently observed damage results from the deterioration of tubers, either due to relatively high humidity or due to the attack of post-harvest pests. This damage can be explained by a temperature that is well above the average required for storage, i.e. 15 °C, as well as by poorly controlled humidity. According to a study conducted by Oluwole *et al.*, (2019), the optimal temperature for the conservation of sweet potato is 13°C to 15°C with a relative humidity rate of 85% to 90%. It is therefore imperative to improve these techniques, as has been the case in East African countries, such as Zimbabwe, where harvested tubers are mixed with ash powder; justifying this technique by the absorption of moisture by ash, which is also a repellent of parasites (Mutandwa and Gadzirayi, 2007). According to another study conducted by Oke and Workneh (2013), Ghana has implemented a sweet potato storage system called "banking" which consists of storing tubers in perforated plastic bags and stacking them on wooden shelves. According to these authors, this method would have allowed the quality of the sweet potato to be maintained for up to six months (Oke and Workneh, 2013).

With regard to the seed system in Benin, investigations show that it is purely traditional and remains informal, unstructured compared to those in other African countries such as Burkina Faso, Rwanda and Uganda, where specialized structures for the production and distribution of improved sweet potato seeds have been observed (Gibson *et al.*, 2009). These traditional ways of producing or acquiring seeds are cheaper for producers. However, seeds according to Ngailo *et al.* (2013) have low phytosanitary qualities and cause the spread of viral and bacterial diseases. Following the recommendations of Cacaï *et al.* (2012), *in vitro* cultivation techniques could be used to improve the quality and seed availability of sweet potato, as well as other root and tuber plants in Benin (Cacaï *et al.*, 2012). An effective method for the production of healthy sweet potato cuttings involves the use of sweet potato cuttings taken from selected plants and grown (CNRA, 2015) under controlled conditions.

CONCLUSION

Sweet potato (*Ipomoea batatas*), is a crop of great value both nutritionally and economically. This study highlighted the multiple challenges faced by producers, including post-harvest storage, propagation difficulties, insects and pests, as well as floods. Despite these barriers, sweet potato is a resilient crop that can be grown under difficult conditions, providing a potential source of income for farmers. To enhance the value of this crop, training programs for farmers in plant health treatment and seed management, as well as storage and transport infrastructure are needed to facilitate the marketing of products.

It would be wise to collect and study the peasant diversity of this species in order to set up genetic selection programs to obtain varieties that are resilient to climatic hazards. Producers must also be made aware of the importance of structured seed management to improve the quality and productivity of their crops.

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