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Characterization and Typology of Banana Producing Farms in the District of Houeyogbe in Southern Benin

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Authors' contributions

This work was carried out in collaboration among all authors. Conceptualization authors MZT, CA. Analysis authors CA, MV and AAB. Funding acquisition author MZT. Investigation authors CA, AAB, MZT, MV and CAA. Literature research and data collection authors MV, AAB. Project administration author MZT, Supervision author MZT, CA, CAA, AAF and AF. Visualization authors MZT, CA, CAA, AAF and AF. Writing – original draft authors CA, AAB, MV and MZT. All authors read and approved the final manuscript.

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ABSTRACT

Background: Banana constitutes an important crop in the tropics and participates in food security in many countries of Africa. It is a widely consumed fruit in Benin. Unfortunately, the trend in yields of this crop showed a year to year decrease since 2008 to 2019, leading production to continue falling short of demand. However, there is a paucity of information on farming systems in Benin, an important step to tackle this issue. This study aims at characterizing the types of bananas farming production systems.
Methods: We conducted structured interviews with sixty-two (62) farmers in four villages of Houéyogbé District in southern Benin between November 2015 and February 2016. Farmers were selected randomly in each village from lists based on the recommendation of local authorities and

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extension services officers.
Results: The results reveal three classes of banana farms which operate differently and thus have different features. Group 1 is made up of small-scale farms with low-income farmers. These farmers did not hire labour, did not follow agronomic production practices, and did not maintain their farms well. Such farms can be classed as “backyard crop garden”. Group 2 includes farms with average size and income in whose farmers maintain their fields, conduct inter-cropping, did not use bought planting material but sold it. Exclusively headed by men, Group 3 includes large-size banana farms whose owners had high income, who use fertilizer, and maintain their farms well. Areas planted, seed purchase, leaf-stripping and system of production significantly influence income at the 1%, 5% and 10% thresholds respectively.
Conclusion: Several constraints to banana production have been identified through this study. They include pests and diseases, lack of clean-certified planting material, type of land, amount of fertilizer and maintenance inputs, and market. In addition, production is limited by a lack of knowledge on agronomic practices. Training on macro-propagation, agronomic practices, pests and diseases recognition with control strategy could help overcome these constraints and improve banana production in this district.

Keywords: Bananas and plantains; productivity; banana farming system; banana production constraints; banana farm typology.

1. INTRODUCTION

The banana is a widely consumed food in the world. It is consumed in various ways (boiled, fried, roasted) or processed as chips, flour, juice [1]. It is a staple food in some regions of Africa and can be produced all year round, providing food for households during the lean season [2]. World production of bananas and plantains was estimated between 116,781,658 and 41,580,022 tons in 2019 respectively [3] and Africa is actively contributing to this production. Africa's production of bananas and plantains was estimated in 2019 at 21,481,876 tons and 26,705,333 tons representing 18.39% and 65.90% of the world production [3]. In Central and West Africa, the production and sale of bananas and plantains plays an important role in achieving food and nutritional security while generating employment and contributing to poverty reduction [4]. In some sub-Saharan African countries, bananas feed more people per unit area than any other staple crop. Its production implies low production costs and is not subject to shocks from changes in world prices, unlike crops such as rice, maize and wheat [5]. In Benin, the production is estimated at 22284 tons for 4698 hectares of bananas [3]. Unfortunately, since 2008, the statistics reveal a decline in yields of this crop. Banana yields decreased from 53.704 t/ha in 2008 to 47.433 t/ha in 2019 [3]. Many factors such as edaphic, agronomic and organizational can explain this decrease [2]. According to Ferraton and Touzard [6], it is important to set up a mechanism to identify farmers’ problems and find solutions for appropriate interventions based on prior knowledge on the farming system and their realities by considering the diversity of farms. This study was carried out in order to understand the constraints that farmers face in banana production in Houéyogbé Township and to find effective solutions to tackle them. It aimed at characterizing banana production systems in Houéyogbé in southern Benin and to identify the group of farms in order to make interventions to improve productivity of banana in this area.

2. MATERIALS AND METHODS

2.1 Study Area

This study was carried out between November 2015 and February 2016 in the District of Houéyogbé located in the department of Mono in southern Benin. Houéyogbé lies between 6°20' and 6°40' north latitude and 1°45' and 1°57' east longitude, and covers an area of 320 km^2, extending 16.25 km from north to south and 13.75 km from east to west [7]. The climate in Houéyogbé is sub-equatorial. Houéyogbé benefits from two rainy seasons and two alternating dry seasons. The average maximum and minimum temperatures are 33.03°C and 20.74°C respectively with an average rainfall of 936 mm. Houéyogbé has a ferralitic soils, hydromorphic soils and a valley zone. These characteristics favour the development of agricultural production. Houéyogbé is characterized by 9689 agricultural households with a population of 50215 individuals [8]. Major agricultural products in Houéyogbé include cereals, palms, bananas and plantains. The

choice of this municipality is linked to its high production of bananas and plantains.

2.2 Data Collection

A total of 62 producers / farmers were randomly selected from four different villages namely: Doutou (11.29%), Houéyogbé (12.90%), Sê (35.48%) and Zoungbonou (40.32%). These villages were chosen based on the recommendation of local authorities according to their high production of bananas. Informations on the socio-economic characteristics of producers, the farming systems and the constraints they faced were collected using a structured questionnaire.

2.3 Statistical Processing and Analysis

Data were analysed using descriptive statistics to describe the socio-economic situation of the surveyed producers, the characteristics of their farms, and their cropping and production systems. A multiple correspondence analysis followed by the hierarchical ascending clustering coupled with "k-means" was carried out to refine this description by a typology of farms. Finally, multiple linear regression was used to identify factors influencing income distribution in production. Table 1 presents the variables included in the model. Different charts and tables were presented. All the analyses were performed using R v. 3.6.1 statistical software.

3. RESULTS

3.1 Socio-demographic Characteristics of Farmers

The banana and plantain farmers lived predominantly in monogamous households (56.45%), which are majoritively headed by men (77.42%). In contrast to many parts of Africa, where women farmers are the majority, only 22.58% of the producers surveyed are women, 6.45% of whom are widows (Table 2). The average age of the producers surveyed was 43.73 years (42 years old for men and 49 years old for women). Less than half (40.32%) of the producers were under 40 years old. The average number of individuals living in producers' households was seven. Fifty-five percent of producers had at least a primary education level. The most educated child in the household is a boy (61.00%) and has reached at least secondary school (61.29%), while less than 40% of girls in the household attend school. Most of the farmers surveyed were natives (74.19%) of their respective villages and had practically never left the community (69.00%). Considering the experience of producers in banana production, the average was 12.60 years (Table 2). The results also reveal that a significant part of producers (64.52%) is well experienced (more than 5 years of experience) in banana production.

3.2 Characteristics of the Farms and Constraints on Production in Houéyogbé

3.2.1 Place of banana production in households

Banana production ranks third among cultivated food crops (Table 3). It is considered the most important crop and being ranked first by 24.19% of producers. The main reason why producers adopted this crop in Houéyogbé is because it is a cash crop. The majority of households both consume bananas and commercialise banana production for their financial needs. The second reason listed by farmers (35.48) was crop productivity, while the market availability came at the third position (29.03%). Family decision-making regarding banana farming in the households of the producers surveyed is led by the male for the majority of respondents (61.29%). Annual income from production varies from US$ 17.94 (10,000 XOF) to US$ 5383.00 (3,000.000 XOF) (Table 3) and less than a quarter of the producers (22.58%) had an income between US$ 17.94 and US$ 71.77. Only eight producers (12.90%) earned more than US$ 897.17 (500,000 XOF). The average income earned by bananas producers in Houéyogbé was US$ 534.39 (297,822.6 XOF) (Table 3).

3.2.2 Land management

The banana production area in Houéyogbé was at least 100 m² (0.01 ha) and at most 80,000 m² (8 ha). Only 17.75% of the producers had an area of 10000 m² (1 ha) of banana plantation, and these were only men (Table 3). The maximum area held by women was 0.8 ha and mostly obtained via rental, purchase or inheritance. Purchasing is the second most common method of land acquisition (30.65%). Some farmers (21.00%) hold more than one plot.

3.2.3 Banana growing system

Result revealed that most of the bananas producers adopt the system of inter-cropping on their farms (75.80%) (Table 3). This represents

79.16% of the men and 64.28% of women. Crops inter-cropped were maize and chilli (35.48%), sugar cane (29.03%) and cassava (11.29%). In that system, women gave priority to maize and chilli pepper, while men gave priority to maize, chilli pepper and sugar cane. This trend can be explained by the fact that maize and chilli are staple foods for the population in Benin, whereas sugar cane is a cash crop grown mainly for commercialization. The majority of producers (45.16%) grew plantain. The main reason for 77.42% of plantain production in this area was the demand for it. Thus, the availability of the local and neighbouring markets is the main determinant in the choice of plantain production in this area. It is worth mentioning some of the characteristics that influence the choice of varieties to be produced. These characteristics are taste (46.77%), high yield (22.58%), processing quality (20.97%), and short cycle (12.90%) (Fig. 1).

3.2.4 Labour for production

All farming activities are carried out by 17.74% of producers using family labour (Table 3). Men constitute the most used agricultural labor force for all types of activities. Women were most involved in activities such as fetching plant materials for planting, harvesting, transporting for marketing and leaf-stripping. In general, young boys were more involved in mulching, transporting suckers and fruits/bunch. As for girls, they were more involved in transporting food for consumption. Hired labour was mainly used by 82.26% of producers for soil preparation, planting, weeding, mulching and pesticide application when applicable.

Table 1. Variables used in the linear model

Variables	Description of the variables
Gender	Dummy variable=1 si male, 0=female
Age	Age of farmer (Years)
Experience	Experience in banana production (years)
Surface area	Area used for production (m²)
Purchase of Plant material	Dummy variable =1 if purchase, 0=otherwise
Leaf-stripping	Dummy variable =1 if yes, 0= otherwise
Plant material sale	Dummy variable =1 if yes, 0= otherwise
Farming system	Dummy variable =1 if yes, 0= otherwise
Income	Dependent variable (US$)

Table 2. Socio-demographic characteristics of producers

Variables	Number	Percentage (%)	Means	Standard-deviation
Gender				
Male	48	77.42		
Female	14	22.58		
Marital status				
Married monogamous		56.45		
Married polygamist		29.03		
Single		6.45		
Widower		6.45		
Divorced		1.61		
Level of education				
Uneducated	22	35.48		
Literacy in local languages	6	9.68		
Primary school	15	24.19		
Secondary school	11	17.74		
Superior	8	12.91		
Age			**43.73**	**14.13**
[17-37]	17	54.84		
[37-57]	34	27.42		
[57-77]	11	17.74		
Experience			**12.60**	**10.88**
[0-6]	22	35.48		
[6-11]	16	25.81		
[11-16]	6	17.74		
[16-26]	11	11.29		
[26-46]	7	9.68		

Table 3. Characteristics of the farms

Variables	Number	Percentage (%)	Means	Standard-deviation
Area planted (m²)			9046.61	18005.34
[0 -1000]	30	48.39		
[1000 – 5000]	12	19.35		
[5000 – 10000]	9	14.52		
[10000 – 50000]	7	11.29		
[50000 – 100000]	4	6.45		
Rank of bananas in agricultural production			2.94	1.49
1	15	24.19		
2	8	12.90		
3	17	27.42		
4	14	22.58		
5	5	8.06		
6	2	3.23		
7	1	1.61		
Cultivation system				
Banana-manioc association	7	11.29		
Banana and sugar cane association	18	29.03		
Banana-corn and pepper association	22	35.48		
Non-associated culture	15	24.20		
Labour force				
Family	11	17.74		
Employee	51	82.26		
Temporary	40	64.51		
Permanent	11	17.74		
Sources of planting materials				
Self-production of planting materials	40	64.52		
Free supply of planting materials from neighbours	25	40.32		
Paying of planting materials from the neighbours	22	35.48		
Supply of planting materials on the village market	6	9.67		
Purchase of planting materials outside the village	8	12.90		
Incomes (US$)			534.39	956.82
[17.94 - 71.77]	14	22.58		
[71.77 - 179.43]	19	30.65		
[179.43 - 897.17]	21	33.87		
[897.17 - 1794.33]	4	6.45		
[1794.33 - 5383.00]	4	6.45		

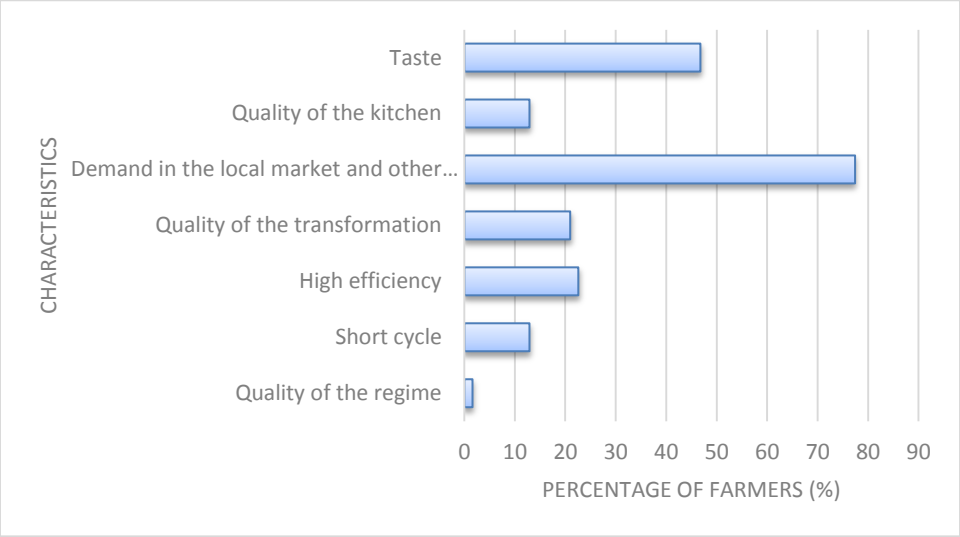

Fig. 1. Characteristics sought on bananas

3.2.5 Sources of planting material and technical support

Planting material used for production comes from a various sources. A producer may have multiple sources (Table 3). Most producers (64.51%) used planting materials from their own fields, some from their neighbours free of charge (40.32%) or with a lump sum (35.48%). Meanwhile, others collected material from local markets (9.67%) and/ or outside the village (12.90%). As far as technical assistance, 92.00% of producers said they received no technical support on banana agronomic practices. Fortunately, some farmers revealed that there was knowledge exchange between themselves on diseases, symptoms and control measures.

3.2.6 Analysis of constraints

According to some farmers (33.87%), the most important constraints are banana diseases, pests and the unavailability of clean plant materials (17.74%) (Table 4). In addition, lack of fertilizer inputs (12.90%), limited access to land (11.29%), unavailability of market (8.06%), high cost of inputs when available (6.45%), slumps due to low farm-gate banana prices (3.22%) by customers, lack of credit (3.22%), lack of technical support (1.61%) were also identified as constraints limiting production. Field observation revealed that 54.84% of the producers surveyed were confronted with Banana Bunch Top Disease (BBTD) caused by the Bunchy top banana virus.

Table 4. Constraints related to banana production in houéyogbé area

Constraints	Percentage (%)
Diseases and pests	33.87
Limited access to land	11.29
High input costs	6.45
Lack of input	12.90
Lack of clean plant materials	17.74
Low field edge price	3.22
Market unavailability	8.06
Lack of funding	3.22
Plant lodging	1.61
Lack of technical support	1.61

3.3 Conventional and Organic Production Systems and Determinants of Production Income

Most banana producers in Houéyogbé (80.65%) were involved in organic farming (Table 5). Only 19.35% of the producers used NPK chemical fertilizers in their production system, and very few producers (12.90%) use chemical pesticides in their production systems. The average banana production per farm in Houéyogbé was estimated at 1,489.11 kg. The average yield is 8.79 t/ha, with a significant difference at the 1% threshold between the organic production system (5.81 t/ha) and the conventional production system (21.21 t/ha). The average annual income per hectare is US$ 3154.37 (1,757,962 XOF). This is significantly higher at the 5% threshold for producers using a conventional production system US$ 7,613.24 (4,242,933 XOF) compared to those not using chemical inputs US$ 2084.24 (1,161,570 XOF). From all the initial explanatory variables, only area, plant materials purchase, leaf-stripping (technique that removes leaves with necrosis), and production system significantly influence income at the 1%, 1%, 5% and 10% thresholds respectively (Table 6).

3.4 Typology of Banana-producing Farms

After a multiple correspondence analysis (MCA) (Fig. 2) followed by a hierarchical clustering consolidated by the K-means method (Fig. 3), three groups of banana farms were identified. The first group, on the left above axis 1 and comprising 11.29% of the farms (Fig. 2), is made up of farms with a small area, low income, not using hired labor and not following good agronomic practices (labour, soil preparation, planting, weeding and fertilization) in their farms (Fig. 2). All the individuals (100.00%) in class 1 have an area of less than 1000 m², do not carry out field fertilization, and rank bananas third among their crops. Three-quarters (75.00%) of these individuals have an income of less than US$ 897.17 and half have an income of less than US$ 71.77. Individual 9 represents the paragon of this class (individual in the centre of the class) and individual 51 is the most characteristic or representative of this class (Fig. 3).

The second group includes most (70.96%) of the farms. It includes farms using less than one hectare who practiced leaf stripping, mulching, soil preparation, weeding and intercropping. Most of farmers in this group had only one field and did not buy plant materials but do sell it (Fig. 2). Eighty-seven-point fifty percent (87.50%) of the farms with an income between US$ 71.77 and US$ 897.17 belong to this group as well. 78.00% of those that practiced weeding and soil preparation fall in this class. The farms (100.00%) that had a size between 1000 and

10000 m² belong to this class. The majority (81.00%) of farmers in class 2 had an income between US$ 71.77 and US$ 897.17. All the farms in this group (100.00%) carried out soil preparation and weeding. Individual 5 represents the paragon of this class and individual 23 is the most characteristic of this class (Fig. 3).

The third group located on the right above axis 1 and comprising 17.14% of the farms, includes farms having of 3 to 4 plots with an area between 1 and 13 ha. Some of them did not practice leaf-stripping or mulching but did buy planting material (Fig. 2). Their (100.00%) income lies between US$ 1794.33 and US$ 5383.00, and they are mostly represented by men. In this class, 83.00% of farm owned three plots. The majority of farmers (91.00%) used fertilizer and other chemical inputs. At least 63.60% had an area between 1 and 5 ha. Individual 45 is the paragon of this class and individual 62 is the most characteristic of this class (Fig. 3).

Table 5. Conventional and organic production system and annual income per hectare

Variables		
Qualitative variables	**Number**	**Percentage (%)**
Use of chemical pesticides	8	12.90
Use of chemical fertilizers (NPK)	12	19.35
Farming Systems		
Conventional	12	19.35
Organic	50	80.65
Quantitative variables	**Means**	**t-Statistic (p-value)**
Average production (kg)		
Conventional	4650.00	
Organic	730.50	
All	1489.11	t=-5.59 (p=0.0000***)
Yield (t/ha)		
Conventional	21.21	
Organic	5.81	
All	8.79	t=-3.34 (p=0.0013***)
Income per hectare per production system (US$/ha)		
Conventional	7613.24	
Organic	2084.24	
All	3154.37	t=-3.36 (p=0.0014***)

Table 6. Factors influencing income (logarithm of income) from banana production

Variables	**Coefficients**	**Erreur-standard**	**T-Statistic**	**P-value**
Intercept	10.07	0.39	25.705	2.0 E-16***
Farming system	0.77	0.40	1.94	0.057.
Area	2.69 E-5	9.07 E-6	2.969	0.00436**
Purchase of plant materials	0.76	0.275	2.752	0.00793**
Leaf-stripping	1.074	0.407	2.635	0.01082*
Multiple R-squared	0.5138			
Adjusted R-squared	0.4797			
F-statistic	15.06			
Akaike Informative Criterion (AIC)	1.3217			
Shapiro-Wilk normality test				
W = 0,9583				0.03395*
Rainbow test Rain=1,1855				0.3314
Goldfeld-Quandt test				
GQ = 1,408				0.1943
Durbin-Watson test				
DW = 2,0346				0.5193
Variance Inflation Factors (VIF)				
VIF_Farming System	1.607			
VIF_ Area	1.723			
VIF_ Purchase of plant materials	1.086			
VIF_ Leaf-stripping	1.092			

*Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

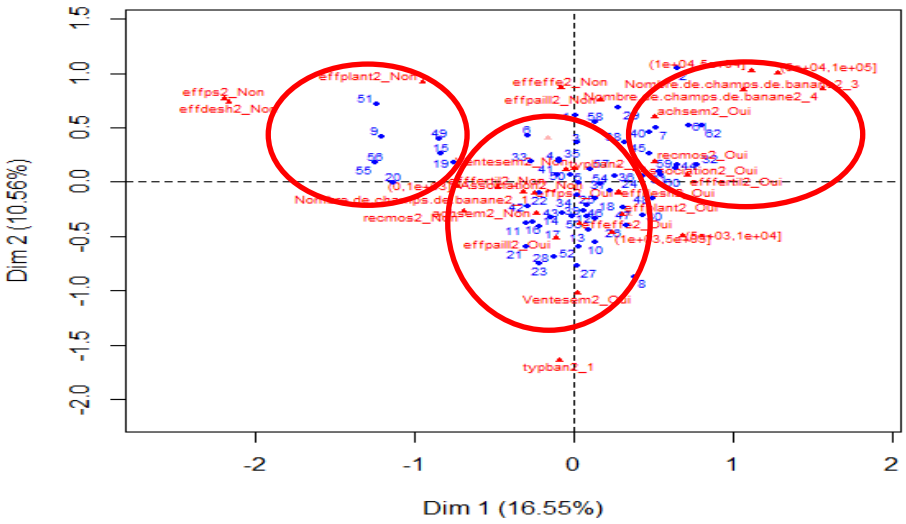

Fig. 2. Representation of active modalities and farms on axes 1 and 2 using a factor map

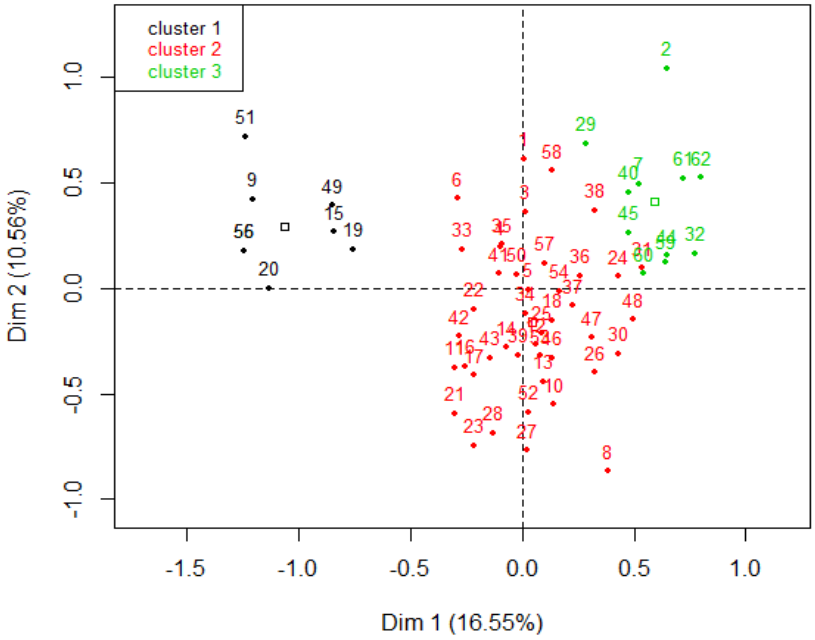

Fig. 3. Representation of the farm groups on axes 1 and 2 using a factor map

4. DISCUSSION

The characterization of banana and plantain production farms in the district of Houéyogbé reveals that men are dominant (77.42%). The high percentage of men involved in this activity is explained by the fact that bananas production requires several farming steps and significant muscular efforts. Men are considered as heads of households and are the decision-makers. Although different generations of producers are engaged, youth are more involved in the production. The rate of young people under 37 years is higher than that found by Mialoundama Bakouétila et al. [9] in Mouyondzi district in Congo and Adigbonon et Allagba [10] in Akpro-Missérété and Adognon et Medenou [11] in Adjarra in Benin. This might be explained by the fact that most people engaged in the production are native from the area and that there is not much smuggling in fuel as happens in Adjarra. The survey showed also that most of youth who travelled out usually returned to their respective villages to capitalize experiences gained elsewhere. More than 50% of those farmers are educated, a number less than those reported in

Congo by Mialoundama Bakouétila et al. [9]. Education being an important pillar of improved farming, it could be critical in production improvement and adoption of technological innovations of other farmers. Banana production is ranked first by 24% of them. This proportion is generally low compared to other locations [9]. Indeed, Congo as well as Cameroon are Central African countries, an area reputed to be a major producer of banana and plantain compared to Houéyogbé where production has just started to emerge. Bananas in Central Africa are in most cases associated with food crops not cash crops [12, 9]. This low proportion of farmers ranking first banana production can be explained by the fact that land is often not available for production and the high cost of labour in this area. Also knowing the banana production cycles, they prefer to cultivate other crops for income, and cover the family needs.

Again, diseases and pests are the primary factors limiting banana production in Houéyogbé. The observed plant lodging among bananas farms in Houéyogbé, could be a consequence of climatic changes. With the impact of climate change, many diseases emerged. The majority of producers in Houéyogbé obtain their planting material from their own farms or neighbors. As the distribution system of planting material is at the heart of any production system, there should be a way to improve the system. Perhaps farmers should be discouraged from this tradition of sharing planting material locally, given that it can explain why disease spread [13]. It is easy in this situation to justify the high prevalence of diseases and pests, more specifically the BBTD responsible for production losses in that area and in other communities where losses up to 100% were recorded [2]. This disease has been observed in more than 50% of the producers surveyed, who have little knowledge of its symptoms, means of transmission and control methods. The lack of technical assistance can justify why farmers have no knowledge about the diseases.

Knowledge on disease diagnosis and management is a very important parameter for effective disease and pest control [14-16] so it is urgent that there should be a program of training for these farmers. Moreover, according to Atkinson et al. [5] the effectiveness of support to agricultural innovations necessarily depends on the recognition of farmers' needs, such as widely available and affordable planting materials, the dissemination of knowledge for their effective use, and the access to markets. Although banana and plantain production were considered as backyard crops in Benin, they contribute significantly to household food security [2].

The analysis of banana production systems in the district of Houéyogbé has shown that there is a diversity of banana production systems. They are distinguished by the banana cultivated area, income, use of casual labor, field fertilization, field maintenance, cropping system and agronomic practices. The first category is made up of farms practicing traditional banana production, without maintenance. Banana production in Benin is for the most part traditional and is carried out on very small areas [10]. These are the house gardens [17]. For these farms, the banana plants are often dense, in tufts, with limited spacing. This system of culture is used in Cameroon according to Temple et al. [12] to increase the resistance of the mother plant to the phenomenon of lodging and to spread production over the year, providing them with a more regular production. These types of farms that use so-called “food-producing” strategies described as “house garden” have characteristics similar to those of the commune of Houéyogbé. Their cropping system is described as "extensive monoculture" where the farmer does not use fertilizer inputs, an irrigation system, or selected varieties [9]. According to the same author, producers use this traditional cropping system in order to sustainably manage their farms and maintain their livelihoods. An improved form of "house garden", but still traditional characterizing the farms in the second group of this study are in an intermediate situation compared to those in classes 1 and 3, particularly in terms of area cultivated and income from the sale of bananas. However, its characteristics are closer to those in group 3. In contrast to group 1, they use intercropping and follow agronomic practices. They still use subsistence-type strategies by which the producer gives priority to food self-consumption.

The surplus is then marketed, providing them with permanent income, enabling them to meet the family's needs [9]. Moreover, the production is in spatially separated clumps with a few other food crops including macabos (produced for its tubers) in Cameroon [12]. This contrasts with the plantations in Cameroon that use same strategy but have a larger surface area of 1 to 4 ha, unlike those in the commune of Houéyogbé, where they have less than 1 ha and more than 1000 m².

Generally larger, and more engaged in banana production as their main activity, the farms in the group 3 are characterized by a large production area and higher income in comparison to others. The size of the farm, the higher income, as well as the agronomic practices carried out show the beginning of intensification in banana production by this category. Most of them use chemical fertilizer that lead to high yields (21.21 t/ha in average) compared to the two others clusters. However, these yields are lower than those recorded in Ivory Coast by N'Guetta et al. [18] that achieve 38.1 t/ha. The characteristics of these farms are similar to those of plantain producers in Cameroon who are oriented towards market and who own an area of more than 4 hectares of banana plants [12]. The yield could increase if technical assistance is given. Most producers do not use chemical (chemical fertilizers and chemical pesticides) in production. This is an environmental advantage at the community level but that does not allow them to be competitive compared to those who use chemical inputs in production. They obtain an average yield of 5.81 tons per hectare while those using chemical inputs have an average yield of 21.21 t/ha. The yields obtained in so called 'organic banana production' in Houéyogbé are comparable to those reported by Nkapnang Djossi [19] and those of Nkendah and Akeyeampong [20] on banana production in tropical Africa. According to Nkapnang Djossi [19] banana yields are 5.4 t/ha, 7.6 t/ha, 5.1 t/ha, 2.9 t/ha, 4.4 t/ha, 11 t/ha and 6 t/ha for Cameroon, Republic of Congo, Equatorial Guinea, Central African Republic, Democratic Republic of Congo, Ghana and Nigeria respectively. Yields estimated by Nkendah and Akeyeampong [20] were 7.0 t/ha, 16.6 t/ha, 4.6 t/ha and 8.1 t/ha respectively for Ghana, Cameroon, Gabon and Côte d'Ivoire. Knowing that banana production in tropical Africa is generally carried out in a traditional way with an extensive system, which does not allow yields in the order of 30-40 t/ha compared to research stations and agro-industries data [21,20,19]. It is worth mentioning that intensification of production is necessary to achieve higher yields. However, it is important to provide guidance to producers on the use of inputs in order to not damage ecosystems following this intensive use of chemical pesticides and fertilizers. Leaf stripping is a practice that positively influences the yield and income of banana producers in Houéyogbé. Leave stripping is a technique that removes leaves with necrosis and significantly reduces the amount of inoculum and control spp [22]. In case of disease control such as Sigatoka disease (fungal disease caused by *Pseudocercospora musicola*), farmers use mechanical control that is not effective when used in a random way. Another control strategy consists in using herbicide. Gomez Balbin and Castano Zapata [23] after their work on integrated pest management (IPM) of cercosporiosis in bananas report that IPM including leaf stripping provides effective control of the disease. Leaf stripping outside the control of cercosporiosis results in photosynthetic efficacy on the rest of the leaves present on the banana tree [24,25]. The results of the present study indicate that banana and plantain in Houéyogbé are not efficient and not competitive, but ecological. There is a need to support producers by providing them with new techniques and tools to improve their productivity and income while preserving biodiversity.

5. CONCLUSION

This study of cultivation practices in the banana sector in a locality in Benin has led to the identification of three types of banana-producing farms there. They are distinguished by the practice of cultivation activities, the use of inputs, the use of paid labour, the area sown, the cropping system, and the income. Some are purely traditional (house gardens), others are intermediate and some are tending to modern (more market-oriented). These characteristics and specific operations to each group do not spare them from constraints that hinder the development of this sector. The constraints are essentially related to diseases and pests, particularly Banana bunchy top disease (BBTD), which causes significant economic losses and threatens household food security. The non-availability of healthy plant materials, which implies the use of plant materials from dubious sources, is a means of spreading diseases. However, in this Township, there is no technical assistance on banana production, on diseases recognition and management although this knowledge was very important parameters for good production. Moreover, there was a lack of use of agronomic practices for banana production. It is urgent at the level of agricultural policy to encourage initiatives to promote the expansion of its production while ensuring that the productivity, income and environmental sustainability of this production be improved. Thus, training on macro propagation to obtain healthy plant materials, on banana agronomic practices, on recognition and control of diseases

and pests could improve the production in the area. Also, training specific to each category of farm could help them maximize their productivity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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