



## Leguminous vegetables production and marketing in Southern Benin

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### Abstract

As a preliminary study that sets ground for the introduction of new leguminous vegetables, this survey assessed the state of production and market characteristics of leguminous vegetables in urban and peri-urban areas of southern Benin. Covering three administrative departments where most vegetable growers and traders are based in Benin, the study used the semi-structured interview approach with 105 respondents including vegetable growers and traders to gather information on diversity, pest and disease management practices, constraints, distribution channel of leguminous vegetable cultivated and willingness to adopt new leguminous vegetable species and varieties. The results showed clear task division between males and females. While a narrow diversity of leguminous vegetable species was grown in Benin, their production is highly market driven. Tunnel type greenhouse and open field farming were practiced in mono-cropping or crop rotation system with the use of poultry manure, animal dungs and mineral fertilizers as mean of fertilisation. The collectors and wholesalers were the most important stakeholders of the distribution channel, followed by the hotels and restaurants. Major constraints include pest and disease infestations, low yield achieved and lack of improved varieties. All respondents were willing to adopt new leguminous vegetable including vegetable soybean “edamame”, peas, pigeon peas, mung bean, faba-beans, common bean. This study provides insights to the current situation and prospects of the legume vegetables sector in Benin, and can be used as decision tool for the introduction of new leguminous vegetable species to promote the sector and make substantial contribution to nutritional security in Benin.

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## Introduction

Food security has long been linked with food scarcity or undernourishment. Yet, this picture is changing as the concept of nutrition security and the importance of dietary diversity is being emphasized (Schreinemachers, Simmons and Wopereis, 2018). While the prevalence of hunger has declined from 991 million in 1990 to 795 million in 2015 (FAO, IFAD and WFP, 2015), an estimated 2 billion people are affected by insufficient intakes of micronutrients around the world (WHO, 2016) and a further 2.1 billion are overweight (Ng *et al.*, 2014). Unlike the usual forms of hunger, malnutrition or hidden hunger inflicts both developed and developing countries (Darnton-Hill *et al.*, 2005) and is caused by the lack of vitamins and minerals essential for the body's physical and mental development, immune system functioning and various metabolic processes (Burchi, Fanzo and Frison, 2011). Thus, a nutritious and varied diet is necessary to maintain good health and achieve the Sustainable Development Goals. Recent studies have revealed the importance of fruits, legumes and vegetables for healthier diets and mitigation of food and nutrition security (Block, 2004; Bayani, 2000; Keatinge *et al.*, 2011). Further, for the prevention of chronic diseases as well as the alleviation of micronutrient deficiencies, the World Health Organization (WHO, 2005) recommends a minimum of 400 g of fruit and vegetables per day. Nevertheless, vegetable consumption is far below this level in many countries (Keatinge *et al.*, 2011).

Vegetable production generally stimulates the rural and urban economy, and generates employment and income in developing countries (Ali and Abedullah, 2002). The fact that it requires only small amounts of land and high profits can be obtained in a relatively short period of time, makes vegetable production attractive especially to youth (Schreinemachers, Simmons and Wopereis, 2018). Yet, public and private investments in agriculture remain largely focused on staple food and oil crops in most countries (Haddad *et al.*, 2016; Pingali, 2015). Consequently, low levels of support from national governments and international donors is directed to public sector vegetable research and development (Schreinemachers, Simmons and

Wopereis, 2018). In Benin, vegetable production is a country-wide activity which is more intensive in the urban and peri-urban areas of southern Benin, and represents an important income generation activity and employment opportunity (Tokannou and Quenum, 2007; MAEP, 2011). National statistics in 2007 reported vegetable production having the potential to contribute to the economic growth of the country through revenues generated from exportations to regional as well as international markets (MAEP, 2011). Furthermore, in the perspective of structural transformation of the National economy, the current Government, in its 2016-2021 Governmental Action Programme, makes the vegetable sector one of the key vehicles of wealth creation and employment (PAG, 2016). However, vegetable production in Benin is still not sufficient to cover even the national demand year-round (MAEP, 2011). In addition, little is known about the diversity of vegetables produced especially the leguminous species, their production state and value chain around the major production areas.

Legumes belong to the family of Fabaceae, which from an economic point of view represents the second most important family of cultivated plants (Graham and Vance, 2003). They are important sources of plant protein, carbohydrates, essential minerals, vitamins and several other antioxidants and health promoting compounds (Souci, Fachmann and Kraut, 2000; Bouchenak and Lamri-Senhadji, 2013). While, most of the cultivated legumes are consumed as grain, some species are cultivated to be served as vegetables. These include peas (*Pisum sativum* L.) pigeon pea (*cajanus cajan*), vegetable soybean (*Glycine max* L. Merr) known as "edamame", faba bean or broad bean (*Vicia faba* L.), cowpea [*Vigna unguiculata* (L.) Walp. ssp. *unguiculata* cv.-gr. *unguiculata*], yardlong bean [*Vigna unguiculata* (L.) Walp. ssp. *unguiculata* cv.-gr. *sesquipedalis*], common bean (*Phaseolus vulgaris* L.), mungbean (*Vigna radiata* L. Wilczek) and grass pea (*Lathyrus sativus* L.). Leguminous vegetables constitute an important source of essential micronutrients for humans. Their consumption has been associated with many health benefits, especially with the prevention of cardiovascular and metabolic

diseases (Ntatsi *et al.*, 2018). This is because, legume vegetables contain vitamins and minerals, which due to their role as cofactors of metabolic reactions, coenzymes, regulators of gene transcription, and radical scavenging molecules, contribute to maintain the metabolic functions in cells and tissues (Bouchenak and Lamri-Senhadji, 2013; Ntatsi *et al.*, 2018; Septembre-Malaterre, Remize and Poucheret, 2018). Furthermore, vegetable legumes are short season crops which can be grown more than once a year, easily and quickly harvested while in the need of cash or food. The increasing awareness of their importance for a balanced nutrition led to an expansion in the consumption of leguminous vegetables around the world (Kader, Perkins-veazie and Lester, 2001; Hounsome *et al.*, 2008) and thereby an increase in their market demand. More attention needs to be given to the legume vegetable sector in

order to ensure a timely availability of quality products on the local and international markets.

The objective of this study was to assess the production state of leguminous vegetables and their market characteristics in southern Benin in order to give an insight to the current situation and prospects of the legume vegetables sector and set ground for the introduction of new leguminous vegetables.

### Materiel and methods

#### Study area

The study took place in three administrative departments (Littoral, Ouémé, Atlantique) counting among the major market gardening areas in Benin (Fig. 1). In total, 17 villages in 5 municipalities (Abomey-Calavi, Cotonou, Ouidah, Sèmè-Kpodji and Tori-Bossito) were covered. Soil and climate characteristics of these municipalities are presented in Table 1.

**Table 1.** Characteristics of the major vegetable production areas in southern Benin.

Municipalities	Rainfall (mm)	Temperature (°C)	Major soil type
Abomey-Calavi	1050 - 1150	22.0 - 33.9	Tropical ferruginous soils and sandy soils
Cotonou	1143 - 1206	22.7 - 32.0	Sandy soils
Ouidah	950 - 1150	22.4 - 33.2	Sandy soils and ferrallitic soils
Sèmè-Kpodji	1200 - 1280	22.8 - 32.4	Hydromorphic
Tori-Bossito	1300 - 1500	21.8 - 33.5	Ferrallitic soils, hydromorphic soils, vertisols, tropical ferruginous soils

Source: (Platts, Omeny and Marchant, 2015; AKOMAGNI and GUIDIBI, 2006; KORA and GUIDIBI, 2006; CAPO-CHICHI and GUIDIBI, 2006; NANGBE and GUIDIBI, 2006)

#### Data collection

This research was carried out in two phases: an exploratory survey followed by in-depth survey. The exploratory survey consisted in observations and aimed to obtain an overview of the diversity of the legume species produced by the vegetable growers around the major vegetable production areas in southern Benin and identify the stakeholders. The in-depth phase enabled collect quantitative data through semi-structured individual interviews using a questionnaire. 105 respondents (producers and traders) were surveyed including 47 males and 58 females. Participants were selected using a combined sampling (purposive and random samplings) method. To be included in the sample, the respondent has to be a vegetable producer or trader, following that, systematic random sampling was performed within

each group. The questionnaires covered socio-economic characteristics of respondents, cropping systems with emphasis on diversity of leguminous vegetable cultivated, pest and disease management practices, constraints that hinder their production, the distribution channel and the willingness to adopt new vegetable species/varieties. The productivity of the different species and varieties as well as the production in terms of the quantity harvested/sold every year, was estimated only for the season preceding the survey, because most respondents did not keep record of their production over the years.

#### Data analysis

Data were processed using Excel sheet and analysed with the R software version 3.4.4. Frequencies were computed and bar plots were drawn to assess (i) most

cultivated varieties, (ii) source of seeds, (iii) frequency of cultivation, (iv) production constraints, and (v) marketing channels and actors. Cultivated plots size, average production, and prices of *P. vulgaris*, the most widely grown vegetable species, were compared among municipalities using analysis of variance (ANOVA) followed by the Student-Newman and Keuls (SNK) test (Dytham, 2011). Assumptions for performing ANOVA were examined using Shapiro-Wilk and Levene tests respectively for normality and homoscedasticity (Thomas, Vaughan and Lello, 2012). Data were not normally distributed; thus log-transformation were performed before analyses. A Multiple Correspondence Analysis (MCA) was performed to better understand the reasons that lead to abandonment of leguminous vegetable cultivation. Plots were generated in the package ggplot2 (Wickham, 2009) while MCA were performed using the package FactmineR (Lê, Josse and Husson, 2008).

## Results

### General characteristics of the respondents

Both males 44.76% and females 55.24% were involved in the survey. While all traders interviewed during this survey were females, only one was found leading a production farm. Actual experience in leguminous vegetable ranged from 6 months to 62 years with an average of 17 years across respondents. Most respondents (56.25%) have lower experience between 6 months and 10 years. Increasing market

demand was reported by all respondents as the main reason leading to the choice to grow and trade leguminous vegetables.

### Diversity of the cultivated species, source of seeds and cropping system:

Two leguminous vegetable species were grown by the respondents, mainly *Phaseolus vulgaris* (common bean) and *Phaseolus spp* (unidentified Chinese provenance) (Plate1). Only 2.19% of the producers were involved in the production of *Phaseolus spp* "haricot chinois", which is exclusively sold to the Chinese community and the Chinese restaurants. Concerning *P vulgaris*, eight varieties were recorded, these include: "Phenomene" climbing pole bean (52.22%), "Kora" a dwarf type of snap bean (37.36%), "hybrid" (2.42%), "variété chinoise" (1.2%), "variété hollandaise" 1.2%, "variété Japonaise" (1.2%), "kilométrique" also known as "Kaha" (1.2%) and "Monel" (1.2%) (Fig. 2). Most respondents (75%) revealed that they buy *P vulgaris* seeds from local vegetable seed companies (Fig. 3). While 17.86% of respondents affirmed that they produce their own seed and the remaining 7.14% claimed that the seeds were brought to them by their relatives from abroad (Fig. 3). Concerning *Phaseolus spp* "haricot chinois", the grower affirmed that the seeds were first given to him by the clients (Chinese) and he multiplied it himself for the subsequent years.

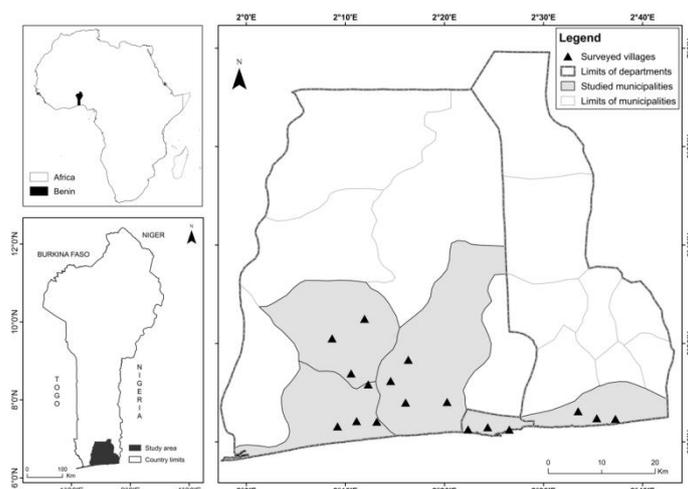
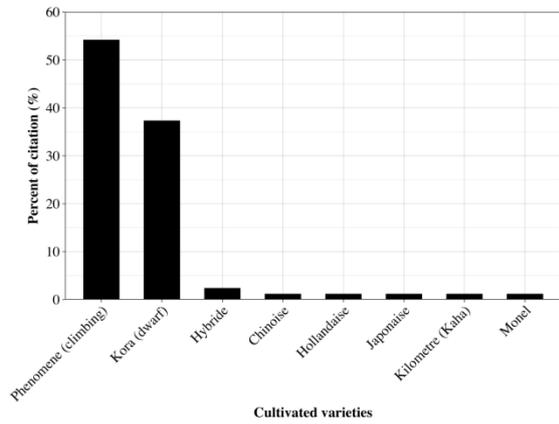
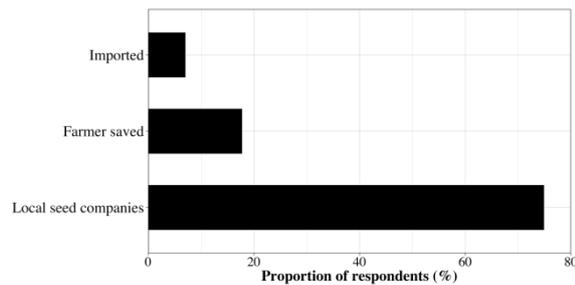


Fig. 1. Map showing the geographical location of the villages surveyed.



**Fig. 2.** Cultivated varieties of *Phaseolus vulgaris* in three departments in Southern.



**Fig. 3.** Source of seed.

With regard to the production, two different production techniques were used by the respondents namely protected and open field production. For the protected scheme, tunnel type greenhouse facilities and off-ground methods are used with a mono-cropping system (Plate 2). Crop rotation was the most practiced for the open field production, with both mono-cropping and intercropping. Organic fertilizers such as poultry manure and animal dung are used by the producers in addition with mineral fertilizers (NPK) for the management of the soil fertility. Regarding pest and disease management, all respondents affirmed to rely more on chemical pesticides.

*Production and distribution channel*

The results showed that most vegetables production units across the study area were led by men (97.91%). The production acreage for leguminous vegetable ranged from 40 to 800 m<sup>2</sup>, thus averaging 190.09 m<sup>2</sup> per grower. The ANOVA and SNK post hoc tests showed significant difference in the average land size ( $p > 0.05$ ) across municipalities (Fig. 4). While the

smallest plot size as well as the lowest average value were found at Sèmè-Kpodji (40m<sup>2</sup> and 102 m<sup>2</sup> respectively), Tori-Bossito had the largest plot (800 m<sup>2</sup>) and showed the highest average value (300 m<sup>2</sup>). Significant differences ( $p=0.005$ ) were found in the quantity of *P vulgaris* produced across municipalities. The per farmer average production varied from 14.7kg to 51.23kg with Tori-Bossito being the most productive area and Sèmè-Kpodji, the least. (Fig. 5).



Legend: (a) *Phaseolus vulgaris* and (b) its fresh pods; (c) *Phaseolus spp* (unidentified Chinese provenance) and (d) its fresh pods

**Plate 1.** Different species of leguminous vegetables cultivated in three departments of Southern Benin.



Legend: (a) Tunnel greenhouse production; (b) Open field production; (c) A producer taking water from a storm for irrigation.

**Plate 2.** Legume vegetable (Fresh bean) production system in Southern Benin.

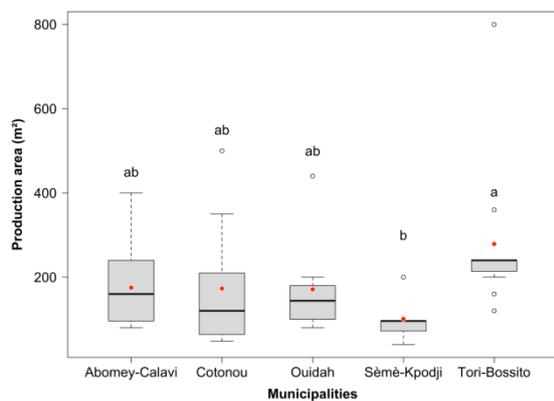


Fig. 4. Plot size variation across the study area.

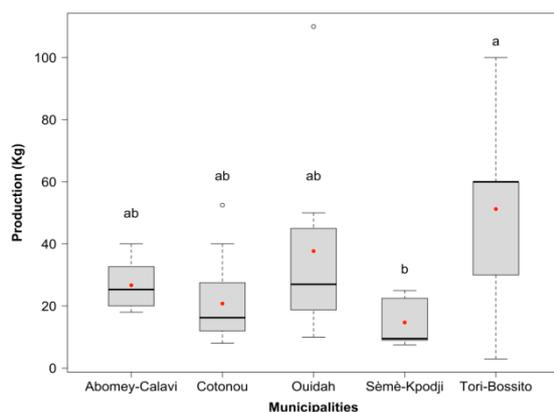


Fig. 5. Variation in of *Phaseolus vulgaris* production (Kg) across the study area.

Regarding the per kilogram price of fresh bean, the statistical analysis showed significant difference among average prices across municipalities ( $p=0.002$ ). It appeared that, in Cotonou and Abomey-calavi the kilogram of fresh beans was sold at a higher price as compared with the other municipalities, especially Tori-Bossito where the average price was the lowest (Fig. 6). On other part, the key actors involved in the distribution channel of *P vulgaris* include the collectors and/or wholesalers, hotels and restaurants, the retailers and direct consumers (Fig. 7). All leguminous vegetables growers affirmed not to deal directly with the consumers. They claimed that most of the production (60.87%) are sold to the collectors and/or wholesalers, while 21.74% are sold to the hotels and restaurants, 14.49% to the retailers and the remaining 2.9% are consumed by the growers themselves. Similarly, all the traders affirmed that they import a big part of their leguminous vegetables sale provision from neighbouring countries including

Togo and Burkina Faso. The main reasons to that include: the insufficient domestic production, the low quality of the available varieties as compared with the imported ones and the consumers preferences.

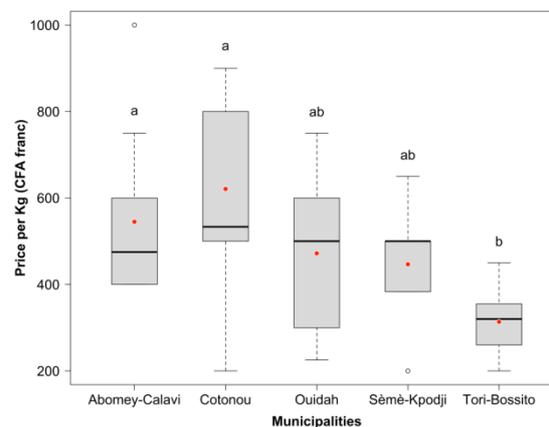


Fig. 6. Variation in price perkg of *Phaseolus vulgaris* across the study area.

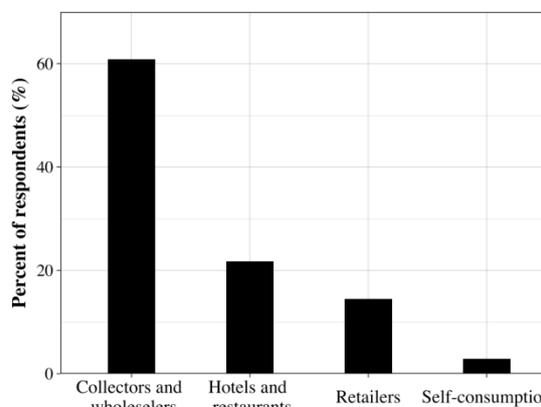
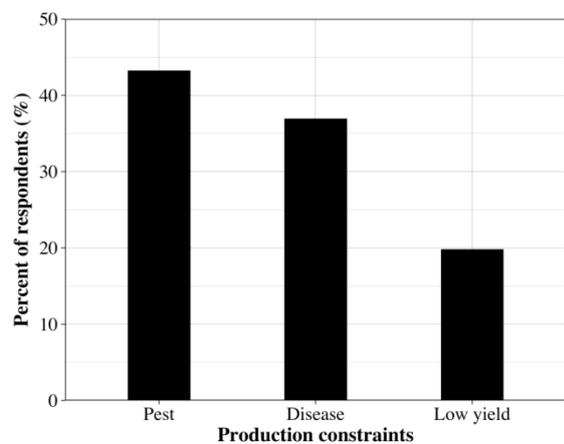


Fig. 7. Distribution channel of *Phaseolus vulgaris* in Southern Benin.

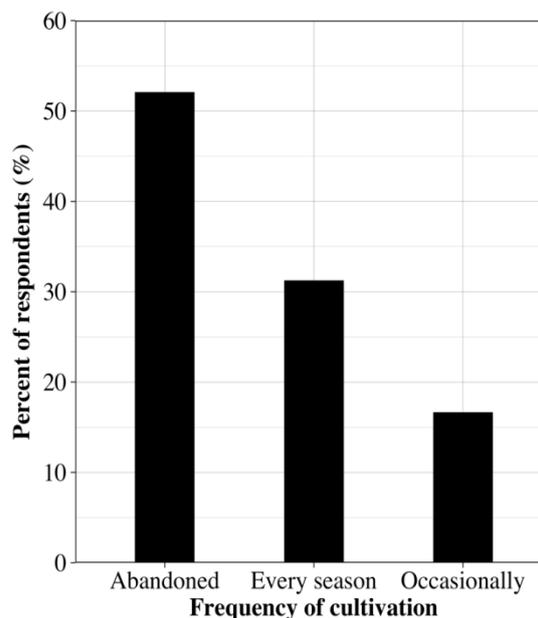
#### Production and distribution constraints

Several constraints affect leguminous vegetable production around the growing areas (Fig. 8). The major constraints reported by the respondents include pest and disease infestations and low yield of available varieties (Fig. 8; Plate 3). The study also revealed that while up to 52% of the leguminous vegetable growers interviewed abandoned the production, 31.25% are still fully involved and the remaining 16.67% grow fresh beans only occasionally and to satisfy specific demands (Fig. 9). Reasons leading to abandonment include production constraints and decrease in sales.

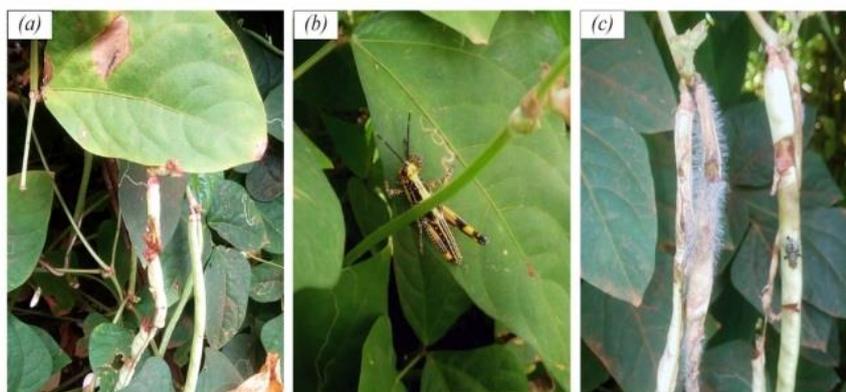
Further, all vegetable traders surveyed during the study revealed that the domestic production of vegetable fresh beans is decreasing as result of the consumers preferring the imported varieties to the ones locally produced.



**Fig. 8.** Constraints in production of *P. vulgaris* in Southern Benin.



**Fig. 9.** Frequency of leguminous vegetables cultivation by respondents.



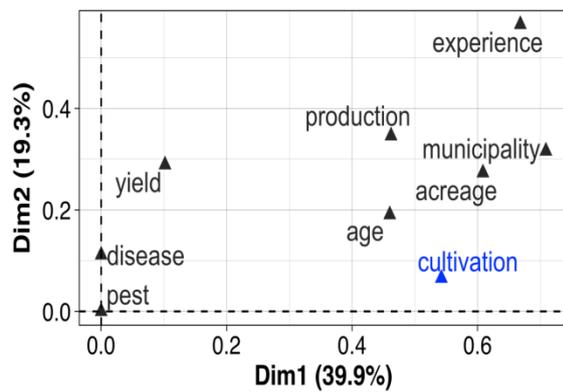
**Plate 3.** Pest and disease infestation in *Phaseolus vulgaris* production farm.

Legend: (a) Diseased *Phaseolus vulgaris* plant; (b) Grasshopper attack in a *Phaseolus vulgaris* farm; (c) Fungi attack of *P. vulgaris* pod.

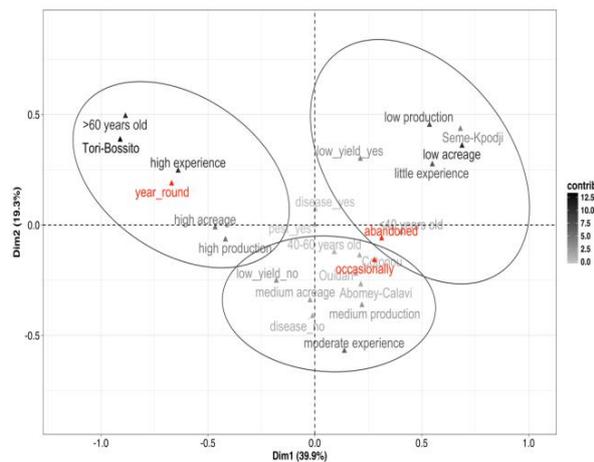
The MCA results show that the first two axes captured 59.24% of the total variation in the data. Therefore, good enough to describe the causes of progressive abandonment of *Phaseolus vulgaris* cultivation in market gardens. Variables related to municipalities where the respondents are based, experience in leguminous vegetable production, area cultivated (acreage), age, and overall production had higher contribution on axis one. In the second dimension, the most influencing variables were related to the experience of the respondent, the overall production,

the yield, the age of the respondent, the cultivated plot area, and the municipality of the respondent (Fig. 10). Fig. 11 shows the projection of all variable categories in the space defined by the first two dimensions. The fig. shows that those who abandoned leguminous vegetables cultivation especially *Phaseolus vulgaris* were under 40 years, with little experience (6 months to 6 years) and dedicated small land size (up to 96 m<sup>2</sup>) for its cultivation. Additionally, they experienced low yield and most of them had their production unit in Sèmè-Kpodji.

Concerning the respondents who cultivated *P. vulgaris* year-round, they are over 60 years, had long lasting experience (17 to 62 years) in its cultivation, have their garden on larger areas (160 to 800 m<sup>2</sup>) leading to higher overall production and most of them have gardens in Tori-Bossito. as per those who were still cultivating the crop occasionally to satisfy specific demands, most of them garden from Cotonou, Abomey-Calavi and Ouidah municipalities. The respondents which fitted in this group, were adults in 40 to 60 range with moderate experience (6 to 17 years).



**Fig. 10.** Projection of the variables analysed in the first two dimensions of a multiple correspondence analysis.



**Fig. 11.** Bi-Plot corresponding to the multiple correspondence analysis performed on the eight variables.

Legend: Contrib = contribution of the different modalities.

**Discussion**

*Gender, diversity, production and commercialization trends*

In Southern Benin, leguminous vegetables production is a market oriented Urban and Peri-urban Agriculture which involves both male and female in its value chain. The study revealed clear task division, with men handling the production and women the commercialization. This corroborates the characterisation made by (Kessler, 2002) on farming systems in five West African capital cities including Cotonou, and could be explained by the fact that women often face more difficulties in accessing land, resources and services, also dealing with cultural constraints might be harder for women men (Van Veenhuizen and Danso, 2007). Concerning the number of legume species cultivated, very narrow specific diversity was found across the study area. Only two species of beans are grown namely *Phaseolus vulgaris* (common bean) and a Chinese provenance (*Phaseolus spp.*, unidentified). Besides, the Chinese provenance (*Phaseolus spp.*, unidentified) was cultivated by only one grower on demand of his clients (Chinese). Consequently, *Phaseolus vulgaris* was the only species that were produced by most respondents to satisfy the larger part of the market demand. Although eight varieties of *Phaseolus vulgaris* are in use, the market is still not satisfied with the quality offered and mainly rely on imported vegetable. This emphasizes the need to introduce new legume vegetable species and varieties to address the demands and help mitigate “hidden hunger”. Several other leguminous species that are grown across the country and study area including cowpea (*Vigna unguiculata* L.) and soybean (*Glycine max* L. Merr) are consumed only as pulse in the country while they are used as fresh vegetable elsewhere (Ntatsi *et al.*, 2018). Despite the fact that the nutritional importance of these species as fresh vegetable and their commercial potential is well documented (Ntatsi *et al.*, 2018; Schreinemachers, Simmons and Wopereis, 2018), they are not yet adopted by the vegetable growers in Benin.

The marketing channel of leguminous vegetables across the areas involves two types of intermediaries,

the wholesalers and the retailers. The main role of these market actors is to offer the farmers a market outlet for their products. Thus, they serve as a link between producers and consumers and other vegetables buyers. Growers also sell a portion of their produce to the restaurants and hotels, as a result, farmers primarily use three channels to market their products, that is, the wholesalers, retailers and restaurants/hotels. Most transactions between growers and buyers occur at the farm gate and the products are transferred from growers to the final consumers through conventional marketing channels (local markets and supermarkets). The highly perishable nature of the produce could be one reason why growers avoid all transaction with the final consumers and market much of their produce in bulk at harvest time. Concerning the price of the Kilogram of *Phaseolus vulgaris*, the results showed that it varies according to the municipality. *Phaseolus vulgaris* prices were higher in Cotonou and Abomey-Calavi, as compared to the other municipalities especially at Tori-Bossito where the prices were quite low. This could be explained by the fact that Cotonou and Abomey-Calavi are highly populated and urbanized areas where commodities tend to be expensive. Besides, in line with observation made by (Van Veenhuizen and Danso, 2007), land access, high cost of labour and cleaned water could also significantly affect vegetable production and pricing in urban areas. Also, a higher consumption rate of legume vegetables is observed in urban areas and this could lead to unbalanced ratio between offer and demand.

#### *Major bottlenecks of leguminous vegetables production and distribution*

Three major production constraints have been reported by the respondents namely: pest and disease infestations and low yield. The high occurrence of pests and diseases could be due to the mono-cropping system used by some vegetable growers and the cultivation of the same species on a plot of land for several years. This results in a build-up of pathogens in the soil which affect greatly the crop in the subsequent years. Further, intensive irrigated vegetable production (with a high number of harvests per year) may lead to nutrient mining (Obuobie *et al.*,

2006). In addition, it appears that the vegetable growers lack knowledge on sustainable cropping techniques especially the relatively young growers with lower and medium experience, which prevent them from producing the crops in quantity and quality for the international markets. The lack of well adapted varieties is also an important constraint that prevent the domestic production to meet the national demand and be competitive on the international market.

#### *Perspectives of leguminous vegetable production and commercialization*

The increasing awareness of the benefit that leguminous vegetable could provide for a balanced nutrition led to an expansion in its consumption around the world (Kader, Perkins-veazie and Lester, 2001; Hounsome *et al.*, 2008). As result, the market demand of leguminous vegetable has significantly increased in the recent years. This study has explored the willingness of the vegetable growers and traders to adopt new species/varieties if they are given the opportunity and support. All the respondents were willing to produce or sell new varieties and species of leguminous vegetable, provided, proper research work is conducted for sustainable introduction, technical support and market outlet ensured. The adoption of new leguminous species and their consumption as fresh vegetable could be important as way of diversifying people's diet, improving nutritional security of the poor resource farmers and providing them with new source of income.

#### **Conclusion**

This study investigated the state of leguminous vegetable production and commercialization in southern Benin in order to provide baseline data for future research works and serve as decision making tool for policy makers. The result showed a very low diversity of the cultivated leguminous vegetable species across the study area. In addition, the absence of improved variety as well as the high infestation of pests and diseases hinder the development of the leguminous vegetable sector and drive most of the growers to abandonment. Interestingly, the increasing awareness on the nutritional importance of leguminous vegetable has led to a growth of the markets creating

thereby a good perspective for the sector in Benin. To cope with these challenges proper breeding programmes, have to be undertaken on the species and consumers' preferences tested for the new species. This study provides a decision tool for the agricultural extensionists, decision and policy makers, as for the orientation to give to the vegetable sector in Benin.

#### List of Abbreviations

NPK: Nitrogen, Phosphorous, Potassium (fertilizer ratio)

SNK: Student-Newman and Keuls

ANOVA: Analysis of variance

MCA: Multiple Correspondence Analysis

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#### Authors contributions

EEA designed the study and participated throughout in the manuscript writing. HSS led the manuscript drafting, KMTK led the data analysis, AA and MH actively participated in data collection, AAE and BS participated in manuscript writing. All authors read and approved the final version of the manuscript.

#### Availability of data and materials

Collected and analysed data during the current study are available upon reasonable request from the corresponding author.

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