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Farmers' Utilization and Knowledge of Phaseolus Bean Diversity in Togo, West Africa: implications for its sustainable conservation and promotion

Ame Mensah Espère HOUNGO
2028969711@ufs4life.ac.za
Université de Kara
Atti TCHABI
Université de Kara
Koffi Kibalou PALANGA
Université de Kara
Komi AGBOKA
University of Lomé
Essohouna Modom BANLA
Centre de Recherche Agronomique Savane Sèche-Institut Togolais de Recherche Agronomique (CRASS-ITRA)
Moustakimou SIBABI
Université de Kara
Kpatcha KAMDE
Université de Kara

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Ame Mensah Espère HOUNGO*
Atti TCHABI
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Kpatcha KAMDE

Abstract

Phaseolus beans play an essential role in the livelihoods of smallholder farmers in Africa due to their high nutritional value and contribution to income diversification. However, in Togo, they are increasingly neglected and threatened with extinction. This study aims to promote their sustainable production and conservation by documenting indigenous knowledge related to cropping **systems**, varietal diversity, and uses. An ethnobotanical survey was conducted in all regions of Togo. Producers were identified using the snowball sampling method, supported by the Institute of Advisory and Technical Support (ICAT). In total, 937 producers across 240 villages were interviewed, and 94 local varieties were recorded. The most used differentiation criterion (50% of villages) was based on "Color; Shape; Spots." Local varieties were categorized into round-shaped ("V", 54 varieties) and flattened or kidney-shaped ("L", 40 varieties). Most producers cultivated only one or two varieties (313 men vs. 315 women). Nationally, the most cited varieties were L3 (37.67%), V13 (20.28%), and L13 (18.57%). Production is mainly for family consumption, especially in the Central (90.98%), Kara (86.27%), Maritime (79.09%), West Plateaux (64.71%), and East Plateaux (60.81%) regions, though some are sold. Other plant parts

Ame Mensah Espère HOUNGO*(✉), **Atti TCHABI, Koffi Kibalou PALANGA, Moustakimou SIBABI, Kpatcha KAMDE**
Laboratoire des Sciences Agronomiques et Biologiques Appliquées, Université de Kara, Kara, Togo
University of the Free State, Bloemfontein, South Africa
e-mail : houngoame@gmail.com

Komi AGBOKA
Laboratoire de Recherche sur les Agroressources et la Santé Environnementale (LaRASE), École Supérieure d'Agronomie (ESA), Université de Lomé, Lomé, Togo
West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL), Université de Lomé, Lomé, Togo

Essohouna Modom BANLA
Centre de Recherche Agronomique Savane Sèche-Institut Togolais de Recherche Agronomique (CRASS-ITRA), Kara, Togo

leaves, dry pods are used in traditional medicine, mystical practices, and potash production. The highest ethnobotanical use value (VUET = 2.00) was recorded among the Gangam ethnic group, although no significant difference was found across ethnicities (P = 0.4699). These findings highlight the diversity and sociocultural value of Phaseolus beans in Togo and support their conservation and sustainable use.

Keywords: *Phaseolus* beans, Ethnobotanical survey, Varietal diversity, Susta, overall ethnobotanical use value and Family consumption

Introduction

Legumes are essential for providing protein-rich products and for introducing nitrogen into cropping systems (Julier & Louarn 2022). Agronomically, legumes are unique in their ability to utilize atmospheric nitrogen through symbiotic fixation, allowing them to grow independently of soil nitrogen, unlike most other crops (Jeangros). They contribute significantly to soil fertility maintenance as they convert atmospheric nitrogen into nitrogen compounds that can be used by plants, thus enhancing soil fertility (Lisciani et al. 2024). The presence of legumes in agricultural ecosystems helps maintain and/or increase biomass and vital microbial activity in the soil (Rajput et al. 2024).

Beans of the *Phaseolus* genus hold a prominent position among legumes due to their high yield and rich nutritional value. This genus includes over 50 identified species, among which several are widely cultivated, notably *P. vulgaris* (common bean), *P. coccineus* (runner bean), *P. lunatus* (lima bean), *P. acutifolius* (tepary bean), and *P. polyanthus* (Frijol de la vida) (Maréchal et al. 1978; Baudoin et al. 2002; Freytag & Debouck, 2002; Roméro et al., 2013). These species have significant economic importance, as they account for over 90% of the global bean production (Godderis, 1995). It is the primary food legume for over 300 million people in Latin America as well as in Central and East Africa (Godderis, 1995; Broughton et al. 2003). These legumes are highly appreciated in gastronomy for their textures due to their high protein and starch content (Pujolà et al. 2007; Estelle et al. 2018). It has also been reported that eating pulses helps control cardiovascular disease (Barrett & Udani 2011), diabetes (Rubyogo & Nounamo 2013), obesity and colorectal cancer (Curran 2012). Kidney beans (*Phaseolus vulgaris* L.), for example, are also an excellent source of important nutrients such as fibre, protein, carbohydrates, B vitamins, iron, copper, magnesium, manganese, zinc and phosphorus (Remond & Walrand 2017), as well as phosphorus, calcium and potassium (Mojica & de Mejía 2015). It is an important staple grain legume in the Great Lakes region of Africa and is a major source of protein for people in the region, particularly small-scale farmers (Mazina et al. 2014). Beans are an inexpensive source of nutrients for people of low socio-economic status in African and Latin American countries (Mojica & de Mejía 2015; Loko et al. 2018). They are widely grown in the tropics for their edible green leaves, their green pods eaten as vegetables, and their dried seeds harvested when ripe (Estelle et al. 2018; Mazina et al. 2014; Rodríguez De Luque & Creamer 2015).

Among these legumes, beans of the *Phaseolus* genus stand out, comprising 80 species, of which five have been domesticated: *Phaseolus acutifolius* A. Gray, *Phaseolus coccineus* L., *Phaseolus dumosus* Macfad, *Phaseolus lunatus* L., and *Phaseolus vulgaris* (Fagbédji et al. 2022; Baudoin, J-P.; Rocha, O.; Degreef, J.; Maquet, A.; Guarino, L 2004). In tropical Africa, the most widespread species are *Phaseolus lunatus* and *Phaseolus vulgaris* (Fagbédji et al. 2022; Brink & Belay 2006). These species are crucial crops for many smallholder farming communities in Africa. They provide an essential

source of protein and nutrients for rural families, especially the poorest and most vulnerable (Missihoun et al. 2017; Estelle et al. 2018). Besides, consumption of these beans offers numerous health benefits. The seeds are used to manage chronic conditions such as diabetes and cancer, as well as other ailments like dropsy, swellings, edema, gout, and tumors (Baudoin, J-P.; Rocha, O.; Degreef, J.; Maquet, A.; Guarino, L 2004). Pregnant women also used the beans, believing in their ability to ease labor or childbirth (Baa-Poku & Asante 2020a).

In Africa, the cultivation of *Phaseolus* beans is deeply rooted in local culture and culinary traditions (Milognon et al. 2020). They are often incorporated into various dishes, including *Attassi* (beans mixed with rice), *Abobo* (boiled beans served with oil and *gari*), and *Djohoungoli* (boiled beans mixed with maize flour) (Milognon et al. 2020). The pods are eaten as a vegetable, and dry seeds are boiled to make sauce (Baa-Poku & Asante 2020a; Akoègninou A., Van der Burg W.J., & Van der Maesen L.J.G 2006).

Despite the nutritional, medicinal, and agronomic potential of beans from the *Phaseolus* genus, recent decades have witnessed a growing neglect of their cultivation, marked by a decrease in the number of producers and in the land area dedicated to this crop. In light of this situation, it becomes crucial to understand the extent to which Togolese farmers utilize and preserve the diversity of *Phaseolus* beans. This research thus investigates the level of knowledge, management practices, and socio-economic factors that influence the conservation of this diversity.

Materials and Methods

Study Area

The present study was conducted across the entire Togolese territory in West Africa. Togo is bordered by Ghana to the west, Benin to the east, and Burkina Faso to the north, with an opening onto the Gulf of Guinea to the south. It covers an area of 56,785 km² and features diverse landscape, ranging from coastal beaches to savannas and mountainous regions. The climate varies from a tropical humid zone in the south to a semi-arid climate in the north, influencing agricultural practices in different regions. The population, consisting of over 8 million people (KOLAGBE 2024), includes numerous ethnic groups with rich cultural traditions. The country's economy primarily relies on agriculture, which serves as a vital source of livelihood and income for a large portion of the population (Taondyandé et al. 2012).

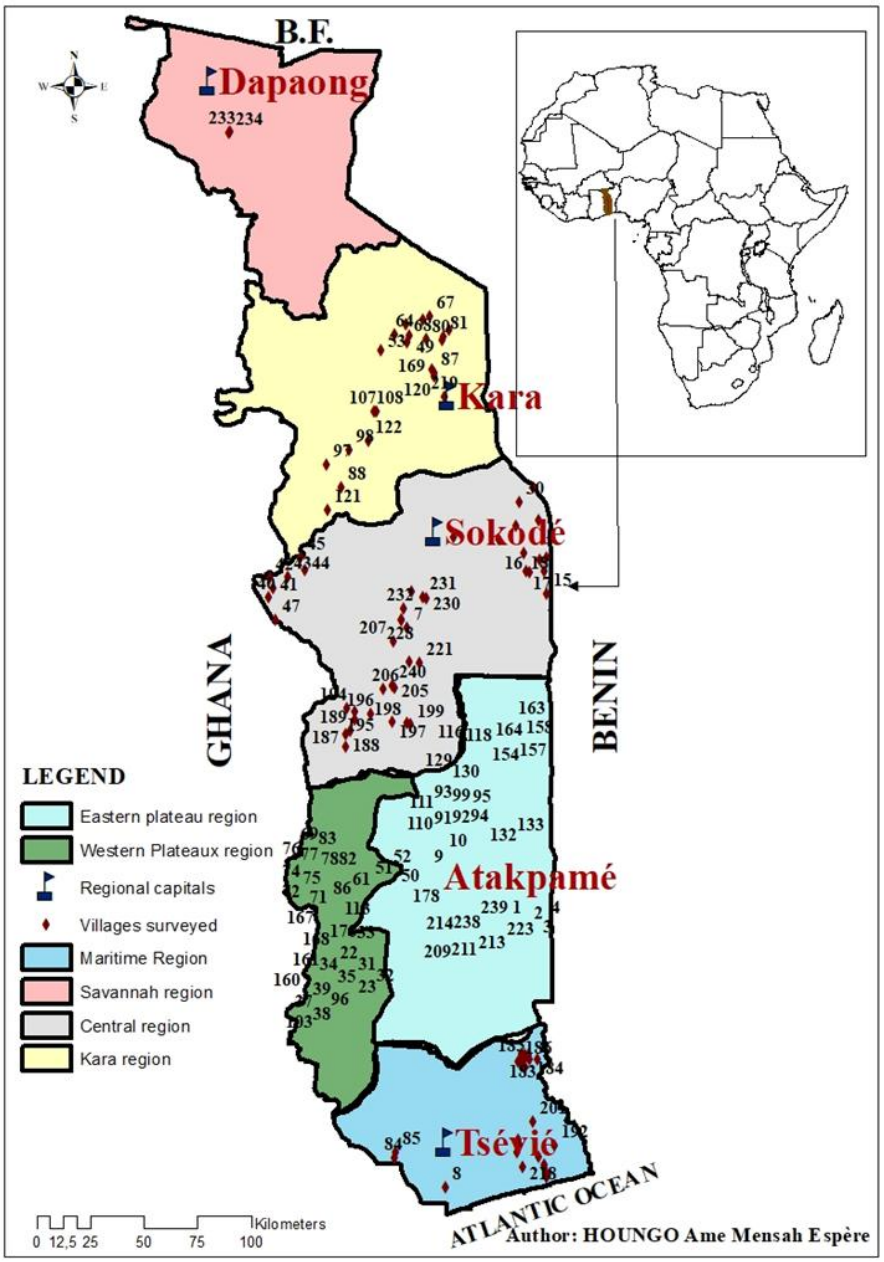


Figure 1: *Map of the study areas*

Ethnobotanical Surveys and data Collection

The identification of bean production areas followed a progressive approach combining institutional data, local knowledge, and field observations.The first prefectures, the first villages and the first producers surveyed were pre-identified with the support of the Institut de Conseil et d'Appui Technique du Togo (ICAT-TOGO). From these, the rest of the prefectures, villages and bean producers were identified using the snowball method described by (Biernacki & Waldorf 1981). In each village, the survey was facilitated by the support of the CTGEA (Conseillers Techniques en Gestion d'Entreprises Agricoles), who acted as a guide in identifying and bringing together the producers and in interpreting the local languages. In each village, the producers were grouped together in a public place and each producer held a sample of each morphotype of bean that he grew or had in his possession. A group questionnaire was completed on the spot, followed

by an individual questionnaire in private. The questionnaires used in this study are structured into two types: a group questionnaire and an individual questionnaire. The group questionnaire aims to collect data on bean accessions, their characteristics, current status, cultural significance, as well as production and marketing constraints. The individual questionnaire is designed to gather detailed information on the profiles of producers, their agricultural practices (sowing, crop rotation, storage), the impact of climate change, and pests affecting the crop. These questionnaires combine ethnobotanical and agronomic approaches to provide a comprehensive analysis of bean production systems.At the beginning of each interview (group questionnaire), the objectives of the survey were explained to the growers in the local language and their consent was obtained. The socio-demographic information of the producers, the morphotypes grown locally, their characteristics as well as the different uses were collected based on the methodology of (Ayenan et al. 2017).

The bean growers were classified into three groups according to age. Thus, young people (age < 40 years), adults (40 ≤ age ≤ 60 years) and old people (age > 60 years) (Moutouama FT, Biaou SSH, Kyereh B, Asante WA, Natta AK. 2019; Fagbédji et al. 2022).

Data Analysis

The data collected was entered into Office Access and arranged in Excel before being analysed using R software version 4.3.3. Quantitative data (the proportion of producers by bean use category and the number of local variety per locality and per household) were analysed using descriptive statistics (frequencies and averages). The correlation between bean use and age category, ethnic group, region of residence and gender was studied using Fisher's Exact test under the conditions described by (Crawley 2012).

The importance of *Phaseolus* beans in the socio-demographic group was assessed by calculating the global overall ethnobotanical use value (VUET) as described by (Phillips O. Gentry AH 1993a; Phillips O. Gentry AH 1993b) and by Zavinon and Adoukonou (2019) (Zavinon F. Sagbadja HA 2019) using the formula:

$$VUET = \frac{\sum_{i=1}^{n} VUEi}{\mathrm{N}}$$

With VUE_i, the total number of uses of beans cited by a person and N the total number of respondents in a socio-demographic group of producers.

The proportion of each feasible use of beans by each category of socio-demographic group was calculated for each region using the formula described by Friedman et al (1986) (Friedman J. Yaniv Z. Dafni A. Palewitch D 1986):

$$FL = (F/\Sigma F) * 100$$

Where F is the number of respondents for a given bean use and ΣF = the sum of the number of respondents for all uses.

The difference analysis between the numbers of local varieties held according to gender was done using the non-parametric Mann-Whitney test, as the normality assumptions were not met. To compare the value of VUETs, the Kruskal-Wallis test was used because the data do not follow a normal distribution. Similarly, a correlation analysis was carried out to check the association between the number of local varieties held per household and parameters such as grower age, grower experience and household size.

Results

Socio demographic characteristics of respondents

The combination of two survey methods, namely the pre-identification of production zones and potential producers, along with the snowball sampling

technique, enabled the identification of 937 Phaseolus bean producers across 240 villages in Togo. The Plateaux region accounts for the majority of these producers, with 450 located in the Plateaux-East and 242 in the Plateaux-West. The Central (111) and Maritime (87) regions have an average number of producers, while the Savanes region has only three producers (Table 1).

Statistical analysis reveals that production is predominantly carried out by women (55.71%), compared to 44.29% men ($P < 0.01$). However, regional disparities are evident. In the Central region, men dominate, representing 61.26% of producers, while women account for 38.74%. Conversely, in the Plateaux-West (37.19% men), Plateaux-East (45.78%), and Maritime (29.89%) regions, women are significantly more represented (62.81%, 54.22%, and 70.11%, respectively). The Savanes region is unique, with production exclusively carried out by men (100%), while the Kara region shows an equal gender distribution (50% each).

The average age of the surveyed producers is 45.88 years, with a range of 15 to 100 years. No significant differences in average age are observed across regions. Additionally, the majority of producers have an average of 14.06 years of experience in Phaseolus bean cultivation, with notable regional variations. The Maritime region stands out with the highest average experience (25.91 years), while the Savanes region has the lowest (3 years on average) (Table 1).

In terms of education, 37.54% of producers have never attended school, 35.76% have a primary education, 26.22% have a secondary education, and only 0.49% hold a university degree. Regional differences are significant: in the Plateaux-East (62%) and Maritime (73.56%) regions, the majority of producers have no formal education. In contrast, in other regions, most farmers have at least a primary education. The Plateaux-East region is notable for having 0.67% of producers with a university education, while the Savanes and Maritime regions have none (Table 1).

The average household size is 6.45 members, with no significant differences across regions. Household sizes range from 1 to 88 members, with the largest households observed in the Maritime region (average of 7.75 members) and the smallest in the Plateaux-West region (average of 5.95 members)

Table 1: *Socio-demographic characteristics of bean growers surveyed in six regions of Togo.*

Variables	Savanes (n=3)	Kara (n=44)	Centrale (n=111)	Plateaux-ouest(n= 242)	Plateaux-est (n= 450)	Maritime (n=87)	Overall (n=937)	Significance Level
Gender (%)* **								
Male	100a	50.00b	61.26b	37.19c	45.78c	29.89d	44.29	***
Female	0c	50.00a	38.74b	62.81a	54.22a	70.11a	55.71	***
Education level (%)* **								
Uneducated	0.00c	34.09b	32.43b	23.14b	62.00a	73.56a	37.54	***
Primary	66.67a	29.55c	44.14b	40.08b	18.00d	16.09d	35.76	***
Secondary	33.33a	34.09a	23.42b	36.78a	19.33c	10.34d	26.22	***
University	0.00c	2.27a	0.00c	0.00c	0.67b	0.00c	0.49	***
Ages (Years)								
Average	44.67a	46.80a	44.72a	50.66a	43.32a	46.89a	45.88	ns
Range	36-49	18-80	23-77	19-100	15-84	20-91	15-100	-
Growing experience (Years)								
Average	3.00c	6.77bc	8.34bc	17.55ab	12.10bc	25.91a	14,06	***

Variables	Savanes (n=3)	Kara (n=44)	Centrale (n=111)	Plateaux-ouest(n= 242)	Plateaux-est (n= 450)	Maritime (n=87)	Overall (n=937)	Significance Level
Range	2-4	1-30	1-55	1-76	1-65	2-76	1-76	-
Household size								
Average	9.00a	6.36a	6.19a	5.95a	6.56a	7.75a	6.45a	ns
Range	7-12	2-16	2-14	2-28	1-25	2-88	1-88	-

Uses of *Phaseolus* bean in Togo

The usage analysis reveals that the production of *Phaseolus* beans in Togo is primarily intended for home consumption across all regions, accounting for 60.81% to 100% of uses, with particularly high values in the Savanes (100%) and Centrale (90.98%). Commercialization follows as the second main usage, especially notable in Plateaux-Est (28.24%) and Plateaux-Ouest (23.26%), with lower proportions in the Maritime (18.18%), Centrale (7.38%), and Kara (3.92%), while absent in the Savanes. Soil fertilization use is rare, appearing only in Kara (3.92%), Centrale (0.82%), and Plateaux-Est (0.27%). Medicinal use is more common in Kara (9.80%) and Plateaux-Ouest (8.82%), with lower frequencies in Plateaux-Est (6.62%) and the Maritime (2.73%), and is absent in Centrale and the Savanes. Animal feed use is extremely limited, noted only in the Centrale region (0.82%), while traditional potash production is primarily practiced in Plateaux-Est (4.05%) and Plateaux-Ouest (3.21%). Overall, consumption and commercialization dominate the usages, whereas other applications are region-specific and less frequent table 2.

Table 2: Uses categories of *Phaseolus* genus been across the region

Uses categories	Centrale		Kara		Maritime		Plateaux-Ouest		Plateaux-Est		Savanes Region	
	N=111		N=44		N=87		N=242		N=450		N=3	
	F	FL (%)	F	FL (%)	F	FL (%)			F	FL (%)	F	FL (%)
Consumption	111	90.98	44	86.27	87	79.09	242	64.71	450	60.81	3	100
Commercialization	9	7.38	2	3.92	20	18.18	87	23.26	209	28.24	-	0
Soil Fertilization	1	0.82	2	3.92	-	-	-	-	2	0.27	-	0
Medicinal	-	-	5	9.80	3	2.73	33	8.82	49	6.62	-	0
Animals food	1	0.82	-	-	-	-	-	-	-	-	-	0
Traditional Potash production	-	-	-	-	-	-	12	3.21	30	4.05	-	0
ΣF	122		53		110		374		740		3	

N= number of respondents, FL= fidelity level in percentage, F =number of respondents for a modality of use or reason that motivates the culture, ΣF= sum of the number of respondents for all modalities of use or reason

Beans of the genus *Phaseolus* are not only used for family consumption but also serve various other purposes, notably therapeutic uses. They are involved in the treatment of conditions such as madness, malaria, epilepsy, skin diseases, abscesses, ringworm, earache, and felons. Young leaves are primarily used for these medicinal purposes. The nature of the ailments treated varies among ethnic

groups. For instance, the Losso ethnic group use seeds from certain local varieties for treating madness and young leaves in the fight against malaria. The Ahlon, Ewe, Adja, and Kabyè utilize young leaves to treat ringworm. The Ifè use these beans to treat epilepsy and issues related to bewitchment. Additionally, the Watchi, Adja, and Ewe also use young leaves for treating abscesses. Finally, the Adja treat ringworm by combining the leaves of these beans with red oil (palm oil) (Table 3).

Table 3 Medicinal uses of *Phaseolus* genus been: form of preparation and application in Togo's local areas

Diseases	Plant Part Used	Instructions for use	Villages	Ethnic Group
Madness	Seeds	Take three calabashes, put three seeds in each calabash, and pour water over them. After three days, make the patient drink one calabash per day.	Niamtougou-copé (Anié)	Losso
Malaria	Young leaves	Prepare the leaf, extract the water, and mix it with powdered milk to give to the person.	Wia (Doufelgou)	Losso
Epilepsy	Young leaves	Crush the fresh leaves in water and administer during the crisis.	Iko-Akpa, (Ogou)	Ifè
Tinea	Young leaves	Crush the young leaves and apply regularly to the skin.	Ayihoé (Ogou)	Adja
Abscess	Young leaves	Crush the young leaves, mix with a bit of red oil, and then wrap the abscess with the mixture.	Mome-Hagoumé (Vo) ; Dossouhoé et Djéyikopé, (Yoto) ; Azovou et Ayihoé (Ogou) et Kakpa (Danyi)	Watchi, Adja, Ewé
Ringworm	Young leaves	Crush the young leaves and apply after scraping the ringworm.	Dénou, Kakpa, N'digbé, (Danyi) ; Avegamé 1 (Kpélé) ; Féléma et Komlan-copé, (Anié) ; Tométi-Kondji et Dossouhoé (Yoto) ; Gbétan, Azovou et Ayihoé (Ogou)	Ahlon, Ewé, Adja, Kabyè
Earaches	Young leaves	Crush the young leaves and put a drop of the liquid obtained into the infected ear.	Kakpa (Danyi)	Ewé
Whitlow	Young leaves	Crush the young leaves, mix with a bit of red oil, and then apply to cover the whitlow.	Mome-Hagoumé (Vo)	Watchi

The reasons for cultivating *Phaseolus* beans in Togo also vary according to socio-demographic categories. All socio-demographic groups grow *Phaseolus* beans for household consumption. A small portion of both men and women of all ages allocate part of their harvest for commercialization. Commercialization is mainly carried out by the ADJA (98), EWE (65), IFE (53), FON (39), KABYE (23), and AKPOSSO (21) ethnic groups. Only men (5), predominantly from the elderly (5) and adult (2) age groups, engage in the cultivation of these beans for soil fertilization. This practice is particularly observed among the FOULANI (2) and KABYE (3) communities, specifically in the Kara (2), Central (1), and Plateaux-East (2) regions.

The medicinal use of the plant spans all age groups and genders but is most prominent among adults (37) and the elderly (47), with women (53) being the primary users. The EWE (30), AKPOSSO (26),

NAOUDA (12), and KABYE (9) ethnic groups make the most use of the leaves or seeds for medicinal purposes. These groups are predominantly found in the Plateaux-East (49) and Plateaux-West (33) regions. An adult man from the KABYE Ethnic group in the Central region uses the leaves of the bean plant to feed livestock (goats and sheep).

The use of *Phaseolus* bean pods for traditional potash production is practiced exclusively by women (42), with the majority being elderly (27) from the Plateaux region (West (12) and East (30)). These women primarily belong to the FON (21), ADJA (11), and EWE (9) ethnic groups (Table 4).

Table 4 *Phaseolus* beans use across socio-demographic factors

Socio-demographic factors	Categories	Consumption	Commercialization	Soil Fertilization	Medicinal	Animals food	Traditional Potash production	P-value
Age Categories	Youth	308	104	-	9	-	2	P < 0.001
	Adult	500	147	2	37	1	13	
	Old	129	76	3	44	-	27	
Gender	Male	415	124	5	37	1	-	P < 0.001
	Female	522	203	-	53	-	42	
Ethnic groups	Achanti	1	-	-	-	-	-	P < 0.001
	Adele	36	-	-	-	-	-	
	Adja	162	98	-	1	-	11	
	Agnanga	6	-	-	-	-	-	
	Agouna	1	-	-	-	-	-	
	Ahlon	17	3	-	-	-	-	
	Akebou	1	-	-	-	-	-	
	Akposso	58	21	-	26	-	-	
	Ana	3	1	-	-	-	-	
	Anago	1	1	-	-	-	-	
	Anii	1	-	-	-	-	-	
	Bassar	6	-	-	-	-	-	
	Ewe	186	65	-	30	-	9	
	Fon	64	39	-	-	-	21	
	Foulani	1	-	2	-	-	-	
	Gain	1	-	-	-	-	-	
	Gangam	2	2	-	-	-	-	
	Ife	126	53	-	-	-	-	
	Kaboli	1	-	-	-	-	-	
	Kabye	115	23	3	9	1	1	
	Konkomba	8	-	-	-	-	-	
	Kotokoli	4	4	-	-	-	-	
	Kpessi	8	-	-	-	-	-	
	Lamba	32	6	-	8	-	-	
	Logba	8	-	-	-	-	-	
	Losso	22	4	-	4	-	-	
	Lougba	1	-	-	-	-	-	
	Mina	2	-	-	-	-	-	
	Moba	7	-	-	-	-	-	
	Mossi	3	-	-	-	-	-	
	Naouda	10	2	-	12	-	-	
	Nawda	2	-	-	-	-	-	
	Tchamba	3	1	-	-	-	-	
	Watchi	14	3	-	-	-	-	
	Woudou	2	1	-	-	-	-	
	Yaka	4	-	-	-	-	-	

Socio-demographic factors	Categories	Consumption	Commercialization	Soil Fertilization	Medicinal	Animals food	Traditional Potash production	P-value
Regions	Yourba	18	-	-	-	-	-	P < 0.001
	Maritime	87	20	-	3	-	-	
	Plateaux-Ouest	242	87	-	33	-	12	
	Plateaux-Est	450	209	2	49	-	30	
	Centrale	111	9	1	-	1	-	
	Kara	42	2	2	5	-	-	
	Savanes	3	-	-	-	-	-	

The overall ethnobotanical use values (VUET) of *Phaseolus* beans were calculated for all socio-demographic groups. Statistical analysis of these values showed no significant difference between ethnic groups (P=0.4699). However, the highest overall ethnobotanical use value was observed among the Gangam ethnic group (VUET=2.00). Similarly, no significant difference was found across age groups (P=0.3679), with the highest value recorded among the elderly (VUET=1.36). The same trends were observed regarding gender, where the highest value was noted among men (VUET=1.38) (P=0.3173) (Table 5).

Table 5: Overall uses value of the species across ethnic groups and social categories of *Phaseolus* genus been

Social groups	Modalities	VUET	Kruskal-Wallis Test
Ethnic groups	Achanti	1.00	P=0.4699
	Adele	1.00	
	Adja	1.62	
	Agnanga	1.00	
	Agouna	1.00	
	Ahlon	1.18	
	Akebou	1.00	
	Akposso	1.16	
	Ana	1.33	
	Anago	1.00	
	Anii	1.00	
	Bassar	1.00	
	Ewe	1.35	
	Fon	1.61	
	Foulani	1.00	
	Gain	1.00	
	Gangam	2.00	
	Ife	1.40	
	Kaboli	1.00	
	Kabye	1.23	
	Konkomba	1.00	
	Kotokoli	1.50	
	Kpessi	1.00	
	Lamba	1.24	
	Logba	1.00	

	Losso	1.15	
	Lougba	1.00	
	Mina	1.00	
	Moba	1.00	
	Mossi	1.00	
	Naouda	1.25	
	Tchamba	1.00	
	Watchi	1.19	
	Woudou	1.33	
	Yaka	1.00	
	Yourba	1.00	
	Youth	1.31	
Age Categories	Adult	1.35	P=0.3679
	Old	1.36	
Gender	Male	1.38	P=0.3173
	Female	1.28	

Landraces richness and distribution

At the national level, the differentiation of local varieties is based on various seed-related criteria. The main criterion is the combination of seed coat color and seed shape, which is used by 31.22% of the surveyed villages. Additionally, a combination involving seed coat color, seed shape, and the presence of spots on the seeds is employed by 21.95% of the surveyed villages, although this criterion is used less frequently than the color-shape combination. Other criteria, such as growth cycle duration, seed size, the presence of striations on the seed coat, spots around the hilum, cooking time, and taste, are also considered, but with a lower frequency, for distinguishing local varieties. At the regional level, similar trends are observed, particularly in the Central region, where the "Color; Shape; Spots" combination is the most commonly used (50% of the surveyed villages), in the Maritime region, where the "Color; Shape" combination is predominant (44% of the surveyed villages), and in the Eastern and Western Plateaus regions, where the "Color; Shape" association is common, representing 28.41% and 32.20% of the surveyed villages, respectively. (Figure 2)

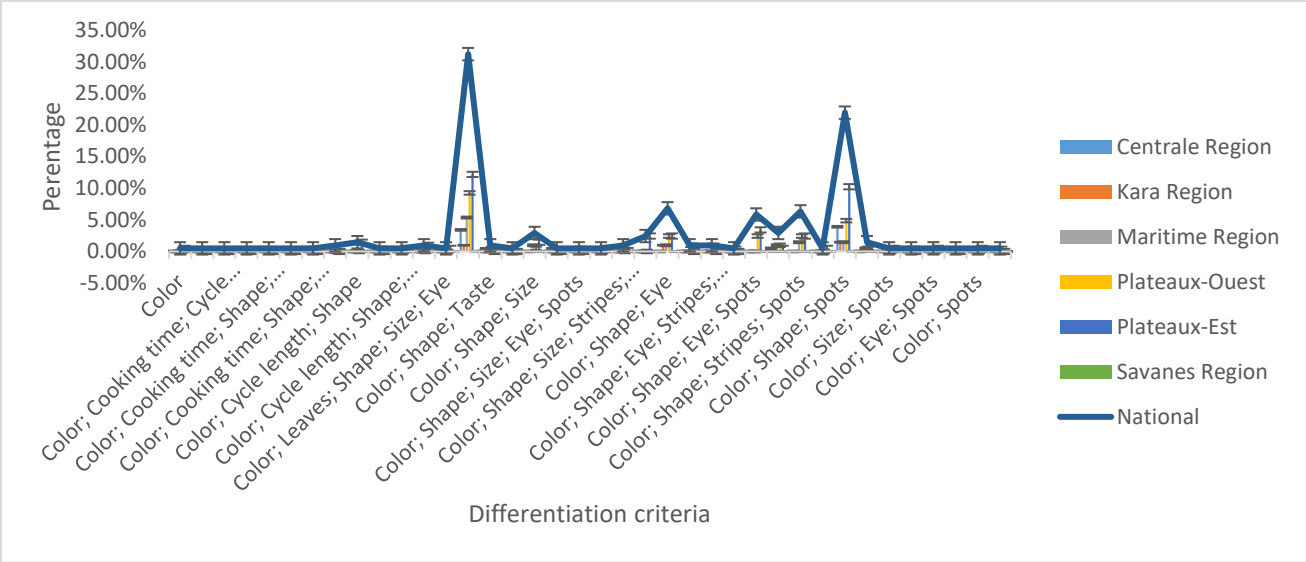
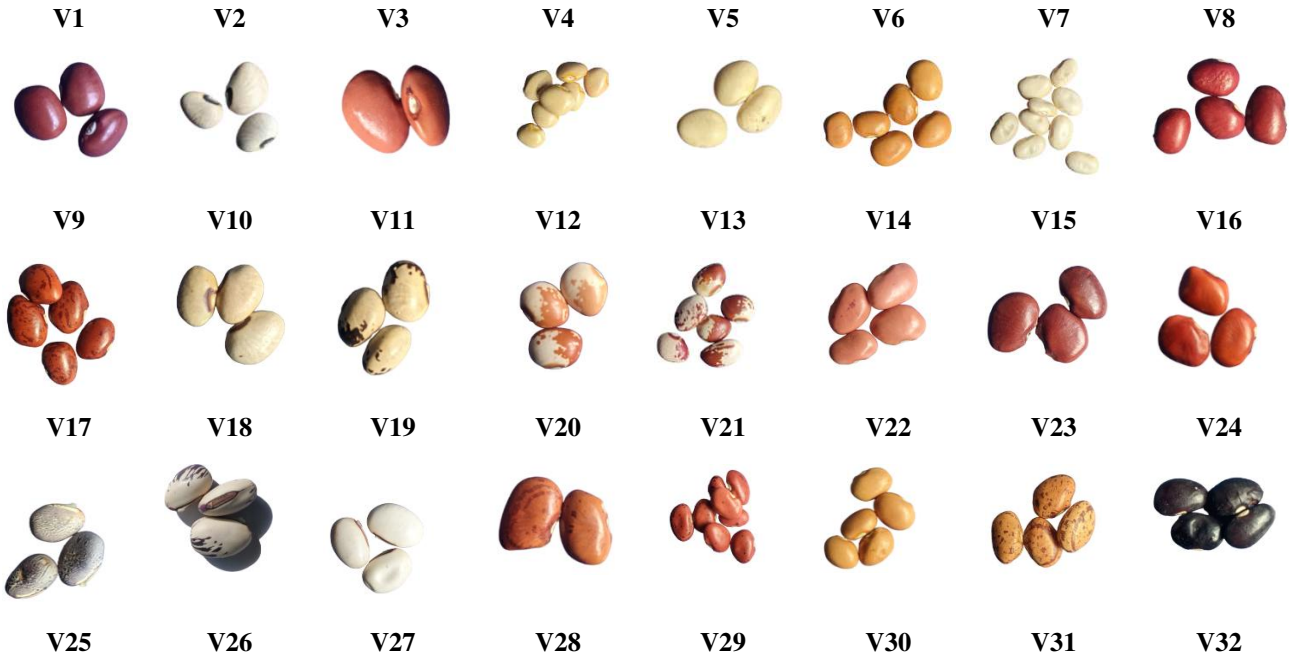


Figure 2: *Differentiation criteria for local varieties of Phaseolus beans cultivated in Togo*

Based on the aforementioned criteria, 94 local varieties were identified, and using the seed shape criterion, two groups were distinguished. Those with a rounded shape are designated by the letter "V," while those with a flat or kidney shape are designated by the letter "L" (Figure 3). The eastern Plateaux region (81 local varieties) recorded the highest number of local varieties, followed by the western Plateaux region (55 local varieties), the Central region (33 local varieties), the Maritime region (29 local varieties), the Kara region (14 local varieties), and the Savanes region (5 local varieties).




V33
V34
V35
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V47
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L40



Figure 3: *Local varieties of Phaseolus beans with an ovoid shape cultivated in Togo.*

Among these local varieties, the most commonly cited at the national level are L3 (37.67% of producers), V13 (20.28% of producers), L13 (18.57% of producers), V10 (9.93% of producers), V2 (9.71% of producers), L22 (9.39% of producers), L2 (8.96% of producers), L9 (8.22% of producers), and V30 (7.15% of producers) (Figure 4)

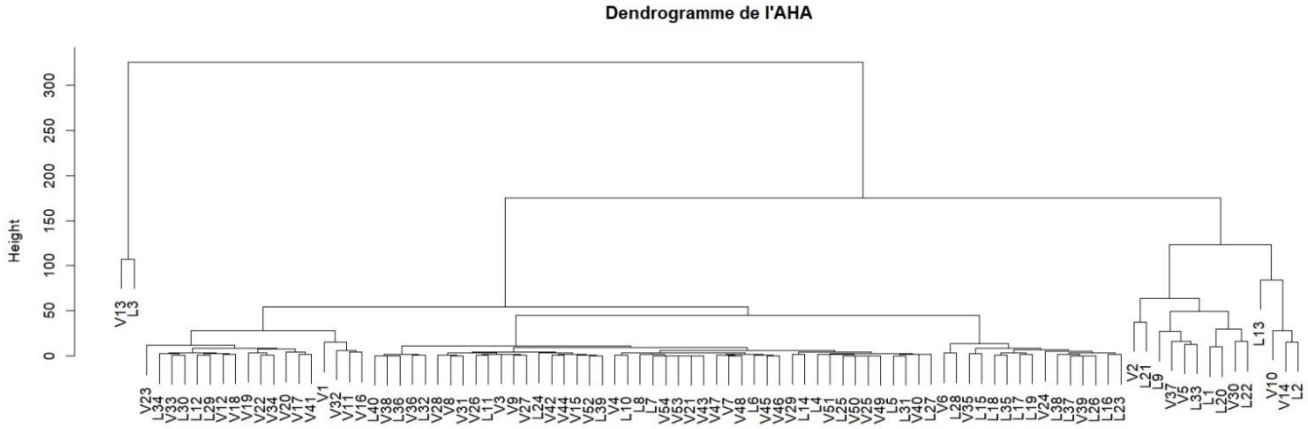


Figure 4*: Number of citations for different local varieties*

The number of local varieties held by households in different regions reveals a significant variation (P=0.00). In the Centrale and Kara regions, there is a strong reliance on unique local varieties, with over 67% of households using only a single local variety. In contrast, regions such as Maritime and Plateaux-Ouest demonstrate greater diversity, with households using multiple varieties. (Table 6).

Table 6: Proportion of the Number of Local Varieties per Household by Region

Local variety per household	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Centrale	67.57	18.92	9.91	3.60						
Kara	84.09	11.36	0.00	4.55						
Maritime	21.84	28.74	33.33	13.79	2.30					
Plataeux-Ouest	37.60	27.27	16.53	8.26	6.20	2.07	2.07			
Plataux-Est	41.11	23.78	13.78	7.33	6.22	3.78	1.78	1.56	0.44	0.22
Savanes	66.67	33.33								

The statistical analysis of the correlation between the number of varieties held by each household, the age of respondents, the number of years of experience in production, and household size reveals a strong correlation between the number of varieties per household and years of experience in production

(P=0.00, R=0.19). In contrast, there is no correlation between the number of varieties per household and the age of respondents (P=0.16, R=0.04) or household size (P=0.15, R=-0.04) (Table 7).

***Table 7**: Correlation between Sociodemographic variables and the number of local varieties Held at the Household Level*

		Age of Respondent	***Phaseolus* genus experience (years)**	**Household size**
Correlation test	**Number of Landraces**	P=0.16 R=0.04	P=0.00 R= 0.19	P= 0.15 R= -0.04

The data show that the majority of both men and women cultivate only one or two varieties (313 men versus 315 women). Women are slightly more likely to grow multiple varieties, particularly between 3 and 5. However, very few individuals cultivate more than 6 varieties (Figure 5).

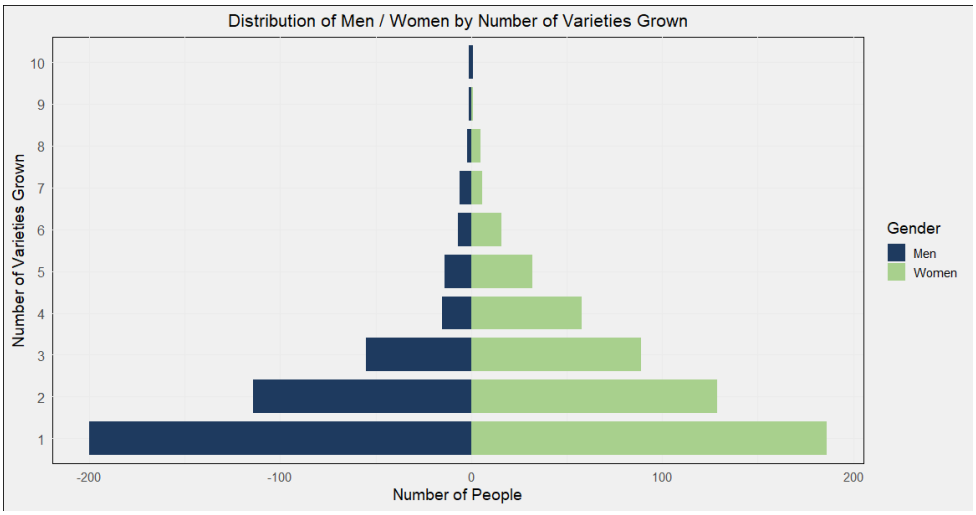


***Figure 5**: Correlation between the number of variety held and gender*

Folk Taxonomy

In total, forty-one (41) names have been recorded across the entire territory. The local name given to these beans is closely related to ethnicity. Thus, beans of the genus *Phaseolus* are known as Kpanku or Kplankplaku among the Adja, Akplanè among the Akposso, Agake, Agbéyi, Gbagbayi, Gbakou, and Gbangbalakou among the Ewé, Ewarègui and Gbangbalakou among the Ifè, and Kpakpalaku among the Watchi. However, the region of residence can influence the naming. For instance, the Kabyè people from the village of Pallakoko in the eastern Plateaux region refer to them as Akpakou or Tib Tira, while the Kabyè from the village of Ounabè in the western Plateaux region recognize these beans by the name Akplanè, which is specific to the Akposso people. Similarly, the Kabyè from the village of Pagala-Gare in the centrael region use the local name Apatchè, a name specific to the Agnanga and Adélé ethnic groups (Table 8).

***Table 8**: Local names given to Phaseolus beans and meaning in the different ethnic group*

Appellation	CENTRALE	KARA	MARITIME	PLATAEUX-OUEST	PLATAUX-EST	z/Z(%)
Agake	NA	NA	NA	PMPS	NA	17
Agbeyi	NA	NA	PMPS	NA	NA	0
Akayagba	NA	NA	NA	PMPS et BMPS	NA	10
Akpakou	NA	NA	NA	NA	PMPS et BMPS	92
Akpalakou	NA	NA	NA	NA	PMPS	0
Akpan-Ten	NA	PMPS	NA	NA	PMPS	0
Akplanè	NA	NA	NA	BMPS	PMPS	24
Alloumagbo	NA	NA	NA	NA	PMPS	0
Apatchè	BMPS	NA	NA	NA	NA	8
Bienkiss	NA	NA	NA	NA	PMPS	0
Chendre	NA	PMPS	NA	NA	NA	0
Core Sona	NA	NA	NA	NA	PMPS	0
Elè	NA	NA	NA	NA	PMPS	0
Ewarègui	NA	NA	NA	NA	PMPS et BMPS	64
Gake	NA	NA	NA	BMPS	NA	50
Gbagbayi	NA	NA	PMPS	PMPS et BMPS	NA	0
Gbakou	NA	NA	NA	PMPS et BMPS	NA	44
Gbangbalaki	PMPS	NA	NA	NA	NA	10
Gbangbalakou	NA	NA	NA	PMPS	PMPS et BMPS	50
Haricot	BMPS	NA	NA	NA	NA	0
Kelinguè	NA	NA	NA	PMPS	NA	0
Kpakpalaku	NA	NA	NA	NA	PMPS	NA
Kpanku	PMPS	NA	BMPS	NA	PMPS et BMPS	45
Kpatkpaken	NA	NA	NA	NA	PMPS	0
Kpayi Kpayi	NA	NA	NA	NA	BMPS	75
Kplankplanku	NA	NA	BMPS	PMPS	PMPS	61
Kpondoyém	NA	NA	NA	NA	PMPS	0
N'kawala	NA	NA	NA	PMPS	NA	0
Odoumolou	NA	NA	NA	PMPS	NA	100
Sans Nom	NA	PMPS	NA	NA	NA	0
Simtèyi	PMPS et BMPS	BMPS	NA	PMPS	PMPS	0
Tchawa	NA	NA	NA	PMPS	PMPS	0
Tib Tira	NA	PMPS	NA	NA	PMPS	44
Tir Sona	NA	PMPS	NA	NA	NA	0
Tougoussoundin	NA	NA	NA	NA	PMPS	0
Tour Sona	PMPS	BMPS	NA	NA	PMPS	0

***Legend:** Legend: PMPS = Few households on a small area; BMPS = Many households on a small area; e z = number of landraces threatened to disappear (cultivated by few households on small areas) and Z = total landraces identified in the ecological zone, NA*= not available

Status of production related to the number of households and the area dedicated to production

The results highlight significant differences (P=0.00) in the proportions of villages where *Phaseolus* bean cultivation is practiced by either few or many households on small areas, depending on

the region. At the national level, this cultivation is carried out by a few households on small areas in 72.65% of the surveyed villages. At the regional level, the central region stands out with a higher proportion of villages where many households engage in this cultivation on small areas (55.26%), in contrast to other regions, particularly the Plateaux-ouest region, where this proportion is the lowest (18.64%). However, in the Plateaux-ouest region, the majority of villages (81.36%) fall into the category of "few households on small areas" for this cultivation (Tableau 9).

Table 9: Distribution of Production Status by Region

Production Status	Central	Kara	Maritime	Plateaux-ouest	Plateaux-est	National	P
Many households with small area	55.26% (a)	22.73% (b)	30.77% (b)	18.64% (b)	21.35% (b)	27.35%	0.00
Few households with small area	44.74% (b)	77.27% (a)	69.23% (a)	81.36% (a)	78.65% (a)	72.65%	0.00

Discussion

Socio demographic characteristics of Phaseolus bean producers

For local communities, beans of the *Phaseolus* genus are traditional crops that play an important role in the human diet, especially for households with close births or limited food resources (Milognon et al. 2020). Despite the importance of the *Phaseolus* beans in Togo and the fact that agriculture accounts for around 70% of the country's working population (Adjiwanou 2005), only 937 people have been identified as producers of these beans. In Togo, beans production is mainly carried out by women (56%). This can be to justify by their in-depth knowledge of the value of these beans. In contrary, a similar study in Benin found that beans production is carried out by men (69.29%) (Milognon et al. 2020). Similar results have been obtained by (Fagbédji et al. 2022), (Estelle et al. 2018) and (Loko et al. 2018). Thus, (Fagbédji et al. 2022) obtained 69.19% men against 30.81% women out of 990 people surveyed, while (Estelle et al. 2018) and (Loko et al. 2018) stated that out of 101 producers surveyed, 77.2% were men. Our results are similar to those of (Fagbédji et al. 2022) The results we obtained are similar to those of (Fagbédji et al. 2022) with regard to the number of people surveyed in Benin, although they differ from those of (Loko et al. 2018). Moreover, production is unevenly distributed throughout the country. The Plateaux region, made up of the Eastern and Western Plateaux, is the benchmark area for Phaseolus bean production in Togo, since it is the area with the most producers, and it is also the area where these beans are grown not only for consumption, but also for marketing. In fact, this is the only region in the entire study area where beans are permanently available on local markets throughout the year. This confirms the importance of the crop in this region. Beans of the Phaseolus genus are also voluble species and necessarily need support for their perfect development. The plateau region is a forest zone where trees are easily found in growers' fields, unlike the savannes region where trees are rare in the fields.Production is mainly carried out by adults (51.65%), followed by young people (32.02%) and the elderly (16.33%).. Similar results have been obtained by other authors in other countries [29], (Loko et al. 2018); (Fagbédji et al. 2022). These results show that young farmers attach little importance to Phaseolus beans. This can be

explained by the lack of outlets for the harvested seeds. Thus, the young generation of farmers interviewed says that they are mainly interested in cash crops such as cotton, sorghum and cassava, and especially soybeans, which can bring in a lot of money in a short space of time (Dansi et al. 2012). As a result, the growers interviewed only produce these beans for family consumption. Similar results were obtained by (Milognon et al. 2020), (Akoègninou A., Van der Burg W.J., & Van der Maesen L.J.G 2006).

Our results also reveal that 60.73% of Phaseolus bean growers in Togo have an average of less than 10 years' experience in production. These results are close to those of (Loko et al. 2018) who obtained an average experience of 14.5 years. Contrary to the work of the same authors (Loko et al. 2018), whose oldest grower had 32 years' production experience in Benin, our study reveals that the oldest grower has over 76 years' production experience. This means that Phaseolus beans have been grown in Togo for at least 76 years.

Phaseolus beans uses

Similar to the pigeonpea (Ayenan et al. 2017), the results of this study reveal that beans of the *Phaseolus* genus grown in Togo are primarily intended for consumption, with a variety of local uses depending on the region and ethnic group. This culinary diversity, although mainly oriented towards local consumption, reveals cultural specificities that deserve to be highlighted. For example, the Ayimolou dish, a combination of beans and rice, is widespread, while among the Éwé, Adja, Watchi and Mina, beans are incorporated into specific recipes such as Ayibli (beans with maize) or Blikoloé (roasted beans with maize). These culinary variants testify to the importance of beans not only as a source of protein, but also as a central element of dietary identity. What's more, the use of beans in regional dishes, such as Wohè among the Ifè and Akposso, shows that their role goes beyond simple staple consumption, reinforcing the links between agricultural production and culinary tradition.. Among the Kabyè, Losso, Naouda, Yaka and Lamba peoples, beans are crushed to obtain a flour used to make fritters (gawou in vernacular), African pizza (Kpédigawou) and Tindinè or Bèbèrèbou. (Milognon et al. 2020), found that *Phaseolus* beans can be prepared as boiled beans with cassava flour (gari) and oil, as maize flour grilled (using a closed container or pot) or not, and in association with rice or maize grain (Aboda or ayibli in the vernacular). Most scientific studies carried out on beans have revealed their richness in protein (20 to 30%) and trace elements (Pujolà et al. 2007; Milognon et al. 2020; Baudoin 2001; Ismet B et Firkret Y. 2011; Romero-Arenas et al. 2013). In fact, these beans are a greater source of polyphenolic compounds with numerous beneficial health properties (Ganesan & Xu 2017). They have antioxidant, anti-diabetic, anti-obesity, anti-inflammatory, anti-mutagenic and anti-carcinogenic properties (Ganesan & Xu 2017). They are also an excellent source of important nutrients such as iron, copper, phosphorus, magnesium, zinc, calcium, potassium and vitamins (Mojica & de Mejía 2015). Their consumption could therefore make up for dietary deficiencies in these elements among growers, and help maintain their health.

In all regions, the level of marketing of *Phaseolus* beans is very low, as noted by (Loko et al. 2018), given that production itself is low. Thus, only a small proportion of bean production is destined for marketing. This activity is absent in the Savanes region, very low in the Maritime and Central regions, but average in the Plateaux-Ouest region and very important in the Plateaux-Est region, where more than half of producers devote part of their harvest to sale in order to meet the financial needs of their respective families and this could explain the high

number of growers in this region.. The Ewé, Adja and Ifè ethnic groups are the most active in the bean trade. In fact, the Fon, Ifè and Yourba ethnic groups, who are in fact descendants of the Yorouba people of Nigeria, are traditionally known as traders in their host countries (Fagbédji et al. 2022; Cissé 2015). Marketing is largely carried out by adult women, thus contributing to their financial autonomy. Our results, like those of (Loko et al. 2018), show a significant increase in the commercial use of beans with the age of the producers. However, these results are contrary to those obtained by (Mbitsemunda & Karangwa 2017), who found that age had a significant negative influence on the commercial use of common beans (*Phaseolus vulgaris* L.). Furthermore, (Birachi et al.) point out that young farmers are more inclined to commercialize beans than their older counterparts. This result could be explained by the fact that bean production is mainly carried out by farmers of a certain age, as indicated by (Ngoh SB, Endeley JB, Emmanuel AT, Lytia ME. 2017). They therefore argue that when a farmer produces more beans, it is clear that he is also involved in marketing them. However, the results of our work have also shown that the majority of *Phaseolus* bean growers in Togo are adults. Several studies have shown that women are more involved in the *Phaseolus* bean trade (Loko et al. 2018; Njuki et al. 2011; Kibiego et al. 2003; Broughton et al. 2003). The seeds are marketed either in the pasty stage in fresh pods [16], in the dry state, or as donuts after processing. The dry pods of these beans are burnt and used to make traditional potash, which is then used in a local variety of culinary applications. The ash filtrate from most legumes is used as a traditional cooking additive to reduce legume cooking time and impart a culturally preferred taste (Bergeson 2014).

The mostly young leaves and seeds of the bean are used in folk medicine (Plateaux-West and Plateaux-East), in traditional ceremonies (Plateaux-West) and in the mythical domain (Plateaux-West and Plateaux-East) by the Ewé, Akposso, Kabyè, Nauouda, Lamba, Losso and Adja ethnic groups. The leaves are the most widely used in folk medicine, and are used to treat earaches, abscesses and panaritis (among the Ewe and Adja). The seeds are also used to cure madness by the Losso ethnic group, and as protection against sorcerers by the Akposso people. All age groups use beans in the traditional treatment of illnesses, but the elderly and especially women are the most concerned. This is not surprising, as it is well established that older people have a more in-depth knowledge of useful plant species than younger people (Loko et al. 2018; Beltrán-Rodríguez et al. 2014). In addition, certain male producers from the Kabyè and Foulanie ethnic groups, most of whom are elderly adults in the Kara, Central and Plateaux-East regions, use the dried leaves of these beans to fertilize the soil. In fact, legume leaves are a valuable source of fodder for livestock (Bossuet & Vadez 2013). Compared with other plant species, legumes have the comparative advantage of being able to fix nitrogen from the air independently, as well as absorbing natural phosphorus which is found in non-soluble form in the soil (Bossuet & Vadez 2013) and storing it in their organs such as seeds and leaves.

Landraces richness, folk taxonomy and extent of *Phaseolus* Landraces

Although seed color, shape, and size are used as criteria to differentiate local varieties, similar to (Kinhoégbè et al. 2020) findings on the pigeonpea, no specific nomenclature is assigned to each variety. Indeed, all local varieties are referred to by the same name [14], regardless of the ethnic group. The absence of specific nomenclature for each bean local variety can be attributed to cultural, linguistic and practical factors that favor a simplified and unified approach to the classification of useful plants.

Morphological differences such as bean color, shape or pattern may not play a sufficiently relevant role in their everyday use to justify separate designations. Indeed, growers often mix all local varieties whether for sowing, cooking or marketing. However, there is a regional specificity in terms of popular nomenclature for these beans. Although the name attributed to the bean is closely linked to ethnic, as noted by (Gbaguii et al. 2013), (Dansi et al. 2012) and (Ayenan et al. 2017), names vary from one language to another. Similar results have been reported in Benin for cowpea (Gbaguii et al. 2013), fonio (Dansi et al. 2010) and engole weight (Ayenan et al. 2017). Like the work of (Loko et al. 2018), analysis of the meaning of local names given to local bean local varieties in Togo reveals the existence of various scenarios, such as unexplained names, synonyms, local names used by different sociolinguistic groups or even the absence of a name. This phenomenon is also observed in the vernacular nomenclature of many legumes in Benin, such as cowpea (Gbaguii et al. 2013) and engole weight (Assogba et al. 2016). Name similarities are observed between the names Agake and Gake (among the Ewé of the western and eastern plateaux), Akpakou and Akpkalakou (between the Ifè and Fon of the eastern plateau region), Kpakpalakou, Gbangbalakou and Gbangbalaki (between the Balanka of the central region and the Ifè of the eastern plateau region), as well as Kpanku and Kplankplanku (among the Adja in all regions). The most widespread vernacular names in Togo include Kpanku (used in three regions by the Adja and some Ewé), Akplanè (by the Akposso), Agake or Gake (by the Ewé), and Gbangbalakou (by the Ifè and Ewé). The same vernacular nomenclature is found among the Adja of Benin (Pahoukoui (adja), kpakpakouin (mina, ouatchi) (Loko et al. 2018; Fagbédji et al. 2022; Milognon et al. 2020)) and the Adja of Togo (Kpanku or Kplankplanku or Kpankpanku). The same applies to the Fon, Yourba and Ifè peoples of Togo (Akpalakou) and Benin (kpalakoun in the Yourba ethnic group, including the Ifè (Fagbédji et al. 2022)), with a few nuances in the names used. According to producers in the Akposso ethnic group, the Akposso people of Ghana, also known as Akebu or Akebu-Ewé, call *Phaseolus* beans "Akplanu" in the vernacular. This name reflects a linguistic similarity with the name used by the Akposso people of Togo, where the term "Akplanè" is also common. This could be explained by the fact that the cultivation of these beans was probably introduced to Benin from Togo, given that the number of years of accumulated experience in production is higher in Togo (76 years) than in Benin (32 years obtained by (Loko et al. 2018) and (Estelle et al. 2018). It is also possible that the crop was introduced to Togo from Ghana. The vernacular nomenclature Apatram (Baa-Poku & Asante 2020a) in Ghana shows a similarity to the vernacular name Apatchè used by the Adélé ethnic group.Indeed, the Adja, watchi, Ifè and Fon are also found across the border between Togo and Benin, and part of the Akposso is also found in neighboring Ghana. Furthermore, a significant number of growers interviewed in villages bordering Ghana (Anygbé, Akloa, Tchifama...) claimed to have received their first seeds from relatives or friends living in Ghana.

Regarding the bean local varieties, our local varieties have been identified in others countries such as Benin, Côte d'Ivoire and Ghana. In Benin, these include L12, L13, L4, L10, L18, L20, L1, L26, L40, V1, V15, V2, V10, V24, V5, V11, V13, V19, V48, V17 and V46 by (Fagbédji et al. 2022), V37, V10, V42, V7, V8, V29, V19, V37, L32, L40, L29, L12 and L13 by (Missihoun et al. 2017), V41, V42, V13 and L12 from (Loko et al. 2018). In Côte d'Ivoire, these are L1, L2, L3, L5, L14, L17, L23, L32, V1, V11 and V23 (Mobio et al. 2020). In Ghana, local varieties V1 and L21 (Chukwunyere 2022), L3, L15

and L20 (Baa-Poku & Asante 2020b) have also been reported.

The number of local varieties (94) we identified is significantly higher than those reported by previous authors, including 33 local varieties for (Fagbédji et al. 2022), 16 local varieties for (Missihoun et al. 2017), 26 local varieties for (Loko et al. 2018) and (Estelle et al. 2018), although not all local varieties are specific to the *Phaseolus* genus.

Status of production in relation to the number of households and the area dedicated to production

The predominant status of bean production of the *Phaseolus* genus by a few households on small plots in Togo reflects broader trends in smallholder farming systems across West Africa. Such production methods often stem from limited access to resources, including land and capital, forcing farmers to operate on a small scale. Studies have documented that smallholder farmers frequently face resource constraints and market access challenges (Kherallah et al. 2000), which limit their productivity and opportunities to expand cultivation(Gafsi 2007).

This small-scale production not only reveals a lack of economies of scale but also poses significant risks to the genetic diversity of local *Phaseolus* varieties. Smallholder farmers tend to grow a limited number of varieties, often favoring a few high-yielding types, which leads to a reduction in genetic diversity, crucial for crop resilience (Hirsch 2010). The loss of genetic diversity can make crops more vulnerable to environmental stresses such as climate change, pests, and diseases, thereby exacerbating food insecurity (Gonzalez 2011).

Moreover, this trend threatens the traditional knowledge associated with *Phaseolus* cultivation. Many local varieties, developed over generations, have cultural significance and are adapted to local conditions (Ficiciyan et al. 2018). The erosion of these varieties risks not only the genetic base of crops but also the invaluable agricultural practices and knowledge held by local communities.

Conclusion

This study highlights the importance of *Phaseolus* beans in the agricultural and food landscape of Togo. The results reveal that the majority of households cultivate these legumes primarily for family consumption, with a significant portion allocated for marketing, particularly in the Plateaux regions. However, production is largely dominated by small-scale farms, raising concerns about genetic diversity and the sustainability of agricultural practices. The potential erosion of genetic diversity, caused by the concentration on a few dominant varieties, exposes these crops to risks associated with climate change and pests. Traditional practices and medicinal uses of beans underscore their cultural and social value for local communities, reinforcing the need to preserve this biodiversity. It is imperative to develop sustainable management strategies that support smallholders, improve their access to resources, and promote the conservation of local varieties. Raising farmers' awareness of the importance of genetic diversity is essential to ensure the sustainability of this vital crop.

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