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Factors Influencing the Production, Marketing and Consumption of Fruit-Vegetables in Six Agroecological Zones of Côte d'Ivoire

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Abstract

In Côte d'Ivoire, fruit vegetables such as okra, aubergine, chilli and tomato play a strategic role in food security, nutrition and household livelihoods. However, the factors influencing their production, marketing and consumption remain insufficiently documented across the country's various agroecological zones. This study aims to analyse the factors influencing these practices in order to generate knowledge useful for the sustainable improvement of market gardening systems and to guide plant breeding programmes. A mixed-methods approach, combining quantitative and qualitative surveys, was implemented in seven departments representative of the main agroecological zones of Côte d'Ivoire. Data were collected from 380 producers (approximately 54 per department) and 455 consumers (65 per location, including 40 in urban areas and 25 in rural areas) using structured questionnaires and focus group discussions, and were subsequently analysed using the R software package. The results reveal a high degree of diversity in production systems, characterised by spatial specialisation of crops, variability in fertilisation practices, differing performance of varieties, and marketing channels specific to each species. The organisation of cropping systems is mainly influenced by seasonal constraints, agroecological conditions and territorial dynamics. Furthermore, consumption preferences vary according to gender, educational attainment, marital status and region of residence, influencing the choice of varieties and how they are used. These results highlight the need to promote market gardening development strategies adapted to local agroecological and socio-economic realities in order to enhance the sustainability of fruit and vegetable supply chains in Côte d'Ivoire.

Keywords

Fruit and Vegetables, Production Practices, Marketing, Consumption, Market Gardening Systems, Côte d'Ivoire

1. Introduction

African cities are experiencing strong population growth, which is expected to accelerate over the coming decades [1] [2]. Faced with this demographic trend, Côte d'Ivoire must tackle the major challenges of food security, combating poverty among urban and rural populations, and employment. In Côte d'Ivoire, vegetable crops such as chillies, okra, aubergines, tomatoes, etc., have not been given sufficient consideration in agricultural policies, despite their role in food and nutritional security and as a source of income for vulnerable populations [3]. According to [4], these fruit and vegetable crops are an essential source of vitamins, minerals and fiber for people in Africa, thereby helping to prevent chronic diseases.

Whilst the importance of these fruit vegetables in the Ivorian diet is undeniable, the practices involved in their production are subject to a variety of influences. Climate change and socio-economic changes—notably demographic shifts, changing lifestyles and the globalisation of food markets—have a significant impact on farming systems [5] [6]. In this context, how do these challenges affect agricultural practices, and what strategies could be adopted to enhance their contribution to food security and sustainable development?

The overall objective of this study is to understand the production, marketing and consumption practices relating to okra, aubergine, chilli and tomato in Côte d'Ivoire.

More specifically, the study will characterise the cropping systems based on these fruit vegetables (okra, eggplant, chilli and tomato) in seven (07) different agroecological zones in Côte d'Ivoire.

2. Materials and Methods

2.1. Characteristics of the Study Sites

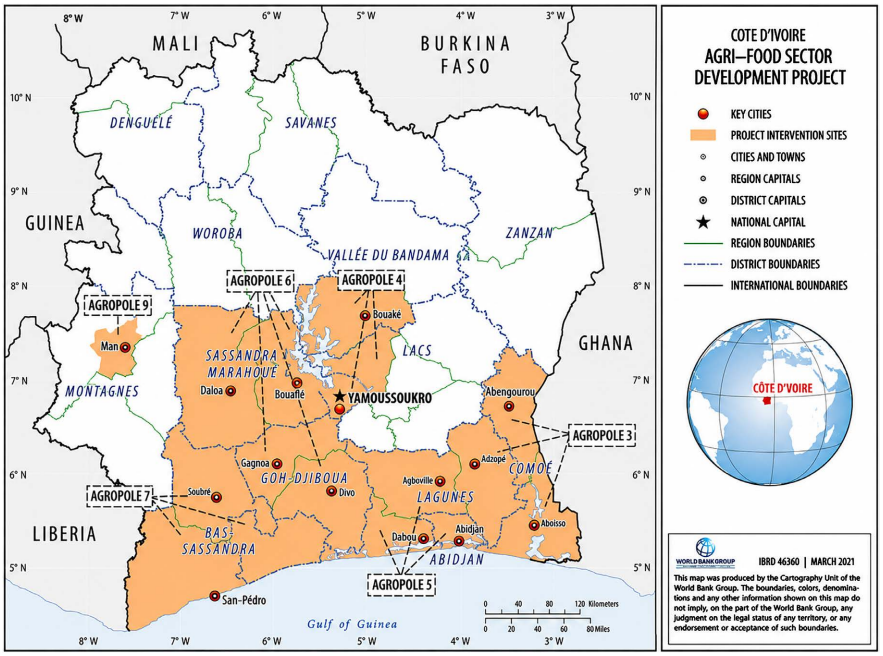
The study was conducted across six agroecological zones of Côte d'Ivoire, represented by six agricultural development poles (Agropoles). Within these Agropoles, seven departments (Abengourou, Bouaké, Dabou, Daloa, Bouaflé, Soubré and Man) were selected as representative study sites according to the implementation framework of the PDC2V project (**Figure 1**).

2.2. Sampling and Data Collection

2.2.1. Sampling

The determination of the sample size was guided by the specific objectives of the study, logistical constraints (human, material and financial resources), and the

need to cover the diversity of stakeholders involved in the fruit and vegetable value chains. The survey was conducted from 05th March to 06th May 2024. The study covered six agricultural development poles (Agropoles), corresponding to six agroecological zones of Côte d'Ivoire. Seven departments were purposively selected according to the implementation framework of the PDC2V project to represent the country's main fruit and vegetable production systems. Within each department, two villages were selected in collaboration with local ANADER extension officers based on the importance of vegetable production, the concentration of producers, accessibility and logistical constraints.



Source: World Bank (2021).

Figure 1. Project study area.

For producers, a sampling frame was first established in each selected village through a complete census of all households engaged in the production of at least one of the four target vegetables (okra, aubergine, chilli and tomato), with the support of ANADER [7]. The final sample size of 380 producers was determined according to the study objectives, project budget and logistical constraints. To ensure proportional representation across the study area, the number of producers selected from each village was allocated proportionally to the size of its sampling frame. Producers were then randomly selected from each village list using the random function in Microsoft Excel, resulting in 380 households with an approximate average of 54 producers per agropole with an additional 10% reserve list prepared to compensate for possible non-responses or unavailable respondents.

For consumers, systematic random sampling was applied using an implicit household listing [8]. A random starting point was selected, after which one

household was surveyed for every three households visited. To capture differences in consumption patterns between urban and rural settings, 65 consumers were interviewed per locality, including 40 urban and 25 rural respondents. Only adults who regularly consumed at least one of the target vegetables and agreed to participate in the survey were included. Particular attention was given to achieving a balanced representation of respondents according to sex, age and socio-economic status.

2.2.2. Data Collection

Data collection followed a mixed qualitative and quantitative approach, carried out in two phases to fully understand production dynamics. Following the literature review phase, primary data collection was conducted through focus group discussions, individual surveys of fruit and vegetable producers and consumers, and direct field observations. With regard to the focus group discussions, meetings were held with farmers on the one hand and traders on the other, in collaboration with extension workers. As for the individual surveys, data were collected using tablets with the KoboToolbox app.

2.2.3. Data Analysis

Data analysis followed a mixed-methods approach, combining quantitative statistical methods with qualitative data analysis, following rigorously structured steps to ensure the reliability and validity of the results, including the export of data from KoboToolbox to Excel and data cleaning. Because producers could cultivate more than one of the four target vegetables (okra, aubergine, chilli and tomato) and report several varieties simultaneously, crop-specific analyses were performed using only the respondents concerned by each crop. Consequently, percentages were calculated using the number of valid responses for each crop or variable as the denominator rather than the overall sample size. Therefore, the sample size (n) varies among analyses according to the number of respondents who provided information for the variable under consideration. For descriptive statistics of the quantitative data (frequencies, means, standard deviations and percentages), statistical tests (chi-square, ANOVA/Kruskal-Wallis) and post hoc tests (Tukey's or SNK tests), R software (v4.4.3) was used. With regard to qualitative data, the transcripts of the Focus Group Discussions (FGDs) were analysed using thematic analysis [9], enabling the identification of recurring themes such as perceptions of varieties and phytosanitary constraints.

3. Results

3.1. Socio-Economic Profiles of Respondents

3.1.1. Socio-Economic Profiles of the Producers Surveyed

The socioeconomic characteristics of the producers surveyed are presented in **Table 1**. Overall, the sample consisted mainly of men (79.84%), with most respondents aged 35 to 54. The majority were married (87.35%), and the overall level of formal education was relatively low, with more than two-thirds of the farmers

having received no schooling or only a primary school education. Regarding farm characteristics, one-third of the producers cultivated more than 5 ha, while vegetable farming was the primary agricultural activity for nearly 90% of those surveyed. More than half of the producers combined vegetable farming with at least one other agricultural activity, while only 27.72% reported engaging in a non-agricultural activity. Finally, vegetable production was primarily market-oriented, with 73.91% of producers growing vegetables mainly for sale at local markets (Table 1).

Table 1. Socio-economic profiles of the producers surveyed.

Variable	Category	Sample size (n)	Total respondents	Percentage (%)
Gender	Male	202	253	79.84%
	Female	51	253	20.16%
Age group	45 - 54 years	86	253	33.99%
	35 - 44 years	78	253	30.83%
	25 - 34 years	59	253	23.32%
	55 - 64 years	15	253	5.93%
	Under 25	13	253	5.14%
Marital status	Married	221	253	87.35%
	Single	25	253	9.88%
	Widowed	4	253	1.58%
	Divorced	3	253	1.19%
Level of education	No schooling	87	253	34.39%
	Primary	86	253	33.99%
	Secondary	59	253	23.32%
	Higher education	13	253	5.14%
	Literacy	8	253	3.16%
Household size	5 to 6	50	202	24.75%
	7 to 8	41	202	20.30%
	Over 10	41	202	20.30%
	1 to 4	35	202	17.33%
	9 to 10	35	202	17.33%
Area under cultivation	>5 ha	84	253	33.20%
	0.5 - 1 ha	51	253	20.16%
	0.25 - 0.5 ha	42	253	16.60%
	1 - 2 ha	33	253	13.04%
	<0.25 ha	31	253	12.25%

Continued

Main agricultural activity	Market gardening	181	202	89.60%
	Perennial crops	13	202	6.44%
	Rice cultivation	6	202	2.97%
	Other (please specify)	2	202	0.99%
Secondary agricultural activity	Food crops	75	135	55.56%
	Perennial crops	35	135	25.93%
	Rice cultivation	15	135	11.11%
	Vegetable growing	10	135	7.41%
Non-agricultural activity	Yes	56	202	27.72%
	No	146	202	72.28%
Combined classification of producers' activities	Main agricultural activity + secondary agricultural activity	105	202	51.98%
	Main agricultural activity only	41	202	20.30%
	Main agricultural activity + secondary agricultural activity + non-agricultural activity	38	202	18.81%
	Primary agricultural activity + non-agricultural activity	18	202	8.91%
Main purpose of market gardening	Sale at the local market	187	253	73.91%
	Sale and own consumption	61	253	24.11%
	Self-consumption	4	253	1.58%
	Export	1	253	0.40%

3.1.2. Socio-Economic Profiles of the Consumers Surveyed

This section presents the socio-economic characteristics of the respondents, namely gender, age group, educational attainment, marital status and place of residence (Table 2). For each variable, the numbers and percentages have been calculated on the basis of the total number of respondents to the corresponding question. Age groups were constructed from the continuous "age" variable using standardised intervals.

$$Formula: Percentage(\%) = (Number\ of\ respondents / Total\ number\ of\ respondents) \times 100$$

3.2. Geographical Specialization According to the Four Fruit and Vegetable Crops

The analysis highlights a highly significant spatial differentiation in the cultivation of okra, aubergine, chilli and tomato across the departments studied ($p < 0.0001$). The results reveal marked patterns of regional specialisation: okra dominates in Dabou and Bouaflé; chillies are predominantly grown in Dabou; aubergines are concentrated in Soubré and Man; whilst tomatoes are more concentrated in Abengourou, Bouaké and Daloa. These contrasts reflect the existence of distinct agro-territorial profiles shaped by local production contexts (Figure 2).

Table 2. Socio-economic profiles of the consumers surveyed.

Variable	Category	Number of respondents (n)	Total respondents	Percentage (%)
Gender	Female	464	485	95.7
	Male	21	485	4.3
Age group	<20	12	485	2.5
	20 - 29	144	485	29.6
	30 - 39	173	485	35.5
	40 - 49	102	485	20.9
	50 - 59	43	485	8.8
	60+	11	485	2.3
Level of education	Literacy	8	485	1.6
	Not in education (cannot read or write)	130	485	26.8
	Primary	133	485	27.4
	Secondary	165	485	34.0
	Higher education	49	485	10.1
Marital status	Single	129	485	26.6
	Divorced	3	485	0.6
	Married	336	485	69.3
	Widowed	17	485	3.5
Place of residence	Rural	187	485	38.6
	Urban	298	485	61.4

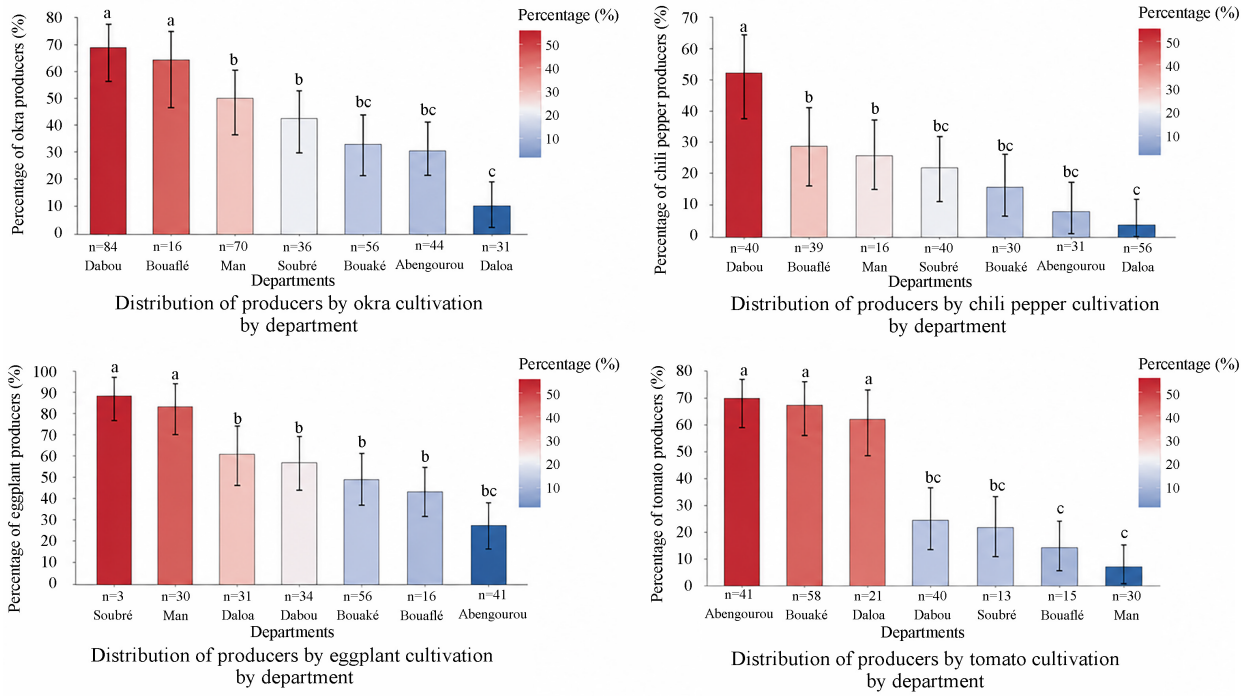


Figure 2. Distribution of producers by crop, by department.

3.3. Analysis of the Intensity of Perceived Seasonal Constraints by Department

The constraints encountered during the various agricultural seasons (main season, short season and off-season) vary significantly across departments. The heat map reveals a higher concentration of perceived constraints during the off-season, particularly in Bouaké and Dabou. It highlights the varying vulnerability of vegetable-growing areas to climatic and structural risks, calling for localised adaptation strategies (Figure 3).

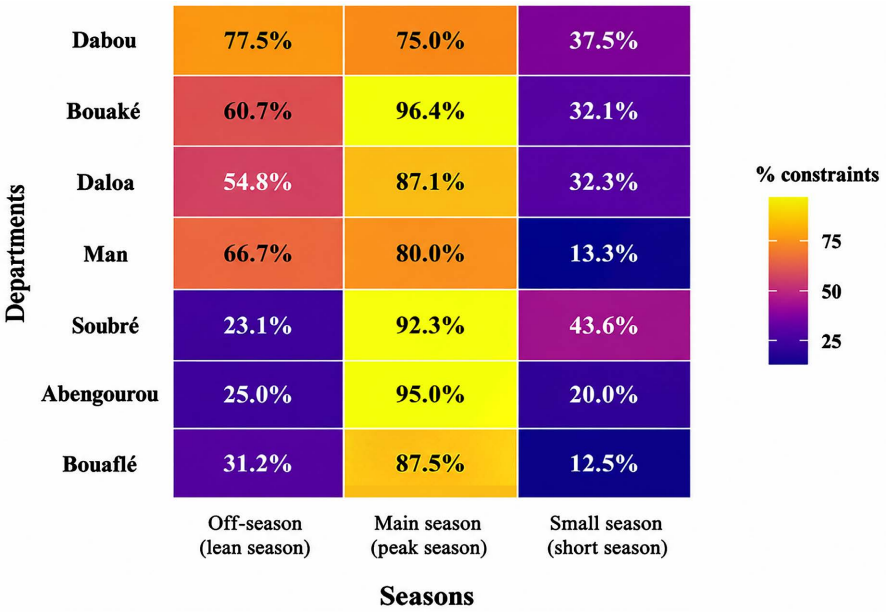


Figure 3. Heat map of constraints encountered by department and season.

Seasonal constraints vary significantly across departments (χ^2 = 18.616; p = 0.00486). The highest levels of vulnerability are observed in Dabou, Bouaké and Daloa, particularly during the off-season when water stress, pest pressure and difficulties in accessing inputs are more pronounced. Conversely, Bouaflé appears to be relatively less exposed. Taken together, these findings highlight a strong interaction between production specialisation and the intensity of agroecological constraints, confirming the territorial differentiation of the market gardening systems studied (Figure 4).

3.4. Fertility Management Practices in Market Gardening Systems

Fertility management in the systems studied relies mainly on the use of mineral fertilisers, adopted by 78.4% of growers, particularly in the form of NPK and urea. However, the joint integration of organic soil improvers remains limited, as only 45.1% of growers combine mineral and organic fertilisation, reflecting a partial adoption of sustainable soil management approaches. We can see it into Table 3.

Mineral fertilisation practices are largely dominated by the NPK (15-15-15) and urea combination, used by 85 per cent of growers using synthetic fertilisers, whilst single-component formulations remain marginal (Table 4). The rates applied remain generally moderate, mostly ranging between 50 and 150 kg of NPK per growing season (Table 5). At the same time, 52.9% of growers report using organic soil improvers (Table 3), mainly poultry manure, either on its own or combined with industrial organic fertilisers (Table 6). However, the quantities applied vary considerably, ranging from low inputs to over 10,000 kg/ha, although the majority of applications are concentrated around 1 to 2 kg/m^2 (Table 7).

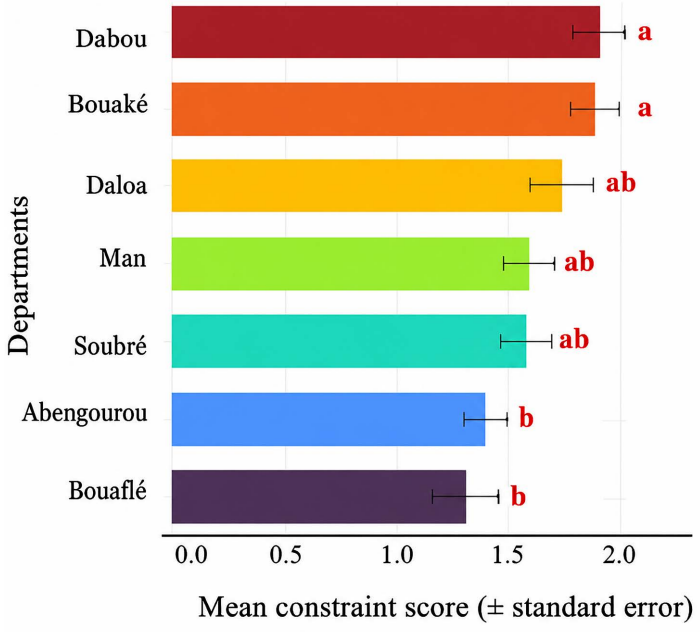


Figure 4. Average constraint score by department with Kruskal-Wallis test and post-hoc comparison letters.

Table 3. Organic and/or mineral fertilisation of soils in vegetable crops.

Type of fertiliser used	Yes (n, %)	No (n, %)	Total (n)
Mineral fertilisers	40 (78.4)	11 (21.6)	51
Organic fertilisers	27 (52.9)	24 (47.1)	51
Combined use	23 (45.1)	—	—

NB: 23 growers use both mineral and organic fertilisers.

Table 4. Types of mineral fertilisers used by growers (n = 40).

Type of mineral fertiliser	Number (n)	Percentage (%)
NPK: 15-15-15 + Urea (46% N)	34	85.0
NPK: 15-15-15 (alone)	5	12.5
Urea (46% N) (on its own)	1	2.5

97.5% of users report having used NPK; 87.5% report having used urea.

Table 5. Quantities of mineral fertilisers used.

Unit	Main application rates (kg)	Distribution (n, %)
kg of NPK: 15-15-15	50 to 150	28 (71.8)
	>150	11 (28.2)

Doses of 50 - 150 kg are the most common.

Table 6. Organic amendments applied.

Type of organic fertiliser	Number (n)	Percentage (%)
Chicken manure (alone)	25	92.6
Industrial organic fertiliser (alone)	1	3.7
Bird droppings + industrial organic fertiliser combined	1	3.7

92.6% of manure users actually applied this type of soil amendment.

Table 7. Quantities of chicken manure applied.

Unit	Rates (kg/ha)	Frequency (n, %)
In kg	≤1000	10 (38.5)
	1001 - 5000	8 (30.8)
	>5000	8 (30.8)

Inputs vary greatly, ranging from small doses to massive amounts (up to 13,500 kg).

3.5. Diversity and Technical Performance of the Four Fruit-Vegetable Varieties and Their Geographical Distribution

3.5.1. Diversity of Okra Varieties Produced and Their Geographical Distribution

Analysis of okra varieties in Table 8 reveals marked diversity, dominated by hybrids. Among hybrid varieties, the Kirikou variety, known to 100 per cent of growers across the seven departments, appears to be the most widely grown, followed by Hiré (87.7 per cent). Conversely, local varieties such as Soundê, Wawa and Monglouiné (30.9 per cent) are less widespread and geographically concentrated.

3.5.2. Diversity and Technical Performance of Eggplant Varieties Produced and Their Geographical Distribution

The study highlights the strong dominance of hybrid varieties, the most significant of which is the Djamba F1 variety, adopted by 70.97 per cent of producers and present in all the departments surveyed (Table 9). Other varieties, such as Kotobi, the purple aubergine or certain local cultivars, show significantly lower adoption rates and a more limited geographical distribution. Varieties such as Anzrohua, Klogbô or other recent introductions remain marginal and localised, reflecting a varietal diversity that is generally concentrated around a few dominant centres, despite the existence of a more discreet local diversity.

Table 8. Okra varieties grown by producers and by department.

Variety	Number of growers (%)	Number of departments (%)	Departments covered
Kirikou	81 (100)	7 (100)	Dabou, Soubré, Bouaflé, Bouaké, Abengourou, Daloa, Man
Hiré	71 (87, 65)	5 (71, 43)	Dabou, Soubré, Bouaké, Abengourou, Man
Yellen	27 (33, 33)	1 (14, 29)	Dabou
Cultivars locaux (Soundê, Wawa, Monglouiné, etc.)	25 (30, 9)	2 (28, 57)	*Soundê* (Bouaké, Abengourou), *Wawa* (Abengourou), *Monglouiné* (Man)

Table 9. Eggplant varieties grown by producers and by department.

Variety	Number of growers (%)	Number of departments (%)	Departments covered
Djamba F1	110 (70, 97)	7 (100)	Abengourou, Bouaflé, Bouaké, Dabou, Daloa, Man, Soubré
Kotobi	17 (10, 97)	3 (42, 9)	Bouaflé, Man, Soubré
Aubergine Violette	13 (8, 39)	3 (42, 9)	Bouaflé, Bouaké, Daloa
Anzrohua	6 (3, 87)	1 (14, 3)	Abengourou
Autres cultivars locaux (N'Drowa, aubergine africaine, etc.)	4 (2, 58)	3 (42, 9)	Abengourou, Bouaké, Soubré
Klogbô (aubergine en grappe)	3 (1, 94)	2 (28, 6)	Bouaké, Soubré
Tropo ou N'Gbokouman	1 (0, 65)	1 (14, 3)	Abengourou
Aub21nb/06	1 (0, 65)	1 (14, 3)	Bouaké

In terms of technical performance, the Djamba F1 hybrid variety accounts for over 70 per cent of yields and confirms its dominant position, consistent with the predominantly positive assessment by growers (nearly 65 per cent of yields rated as good to very good). However, the persistence of average or low performance among around one-third of growers highlights technical disparities that call for targeted support (Figure 5).

3.5.3. Diversity and Technical Performance of Chilli Varieties Grown and Their Geographical Distribution

An analysis of the chilli varieties grown within Table 10 reveals a clear predominance of the "Big Sun" variety, chosen by 63.5 % of producers, making it the most widespread. The "Garba" variety comes second with 25.0 %, followed at some distance by "Bec d'oiseau" (7.7 %), "Safi" (5.8 %) and "Jaune du Burkina" (3.8 %). This distribution indicates a strong preference for "Big Sun", whilst the other varieties remain marginal in the production systems of the producers surveyed.

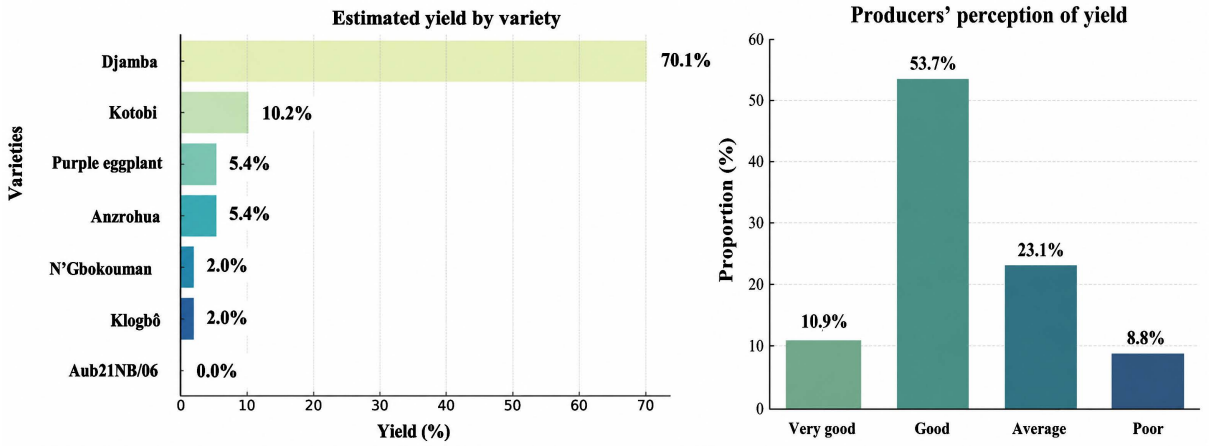


Figure 5. Varietal performance and producers' assessment of yields for eggplant in the study areas.

Table 10. Chilli varieties grown by producers and by department.

Varieties	Number of producers (%)	Number of departments (%)	Departments covered
Big Sun	127 (63, 5)	7 (100)	Abengourou, Bouaflé, Bouaké, Dabou, Daloa, Man, Soubré
Piment Garba	50 (25, 0)	5 (71, 4)	Dabou, Bouaké, Bouaflé, Man, Soubré
Bec d'oiseau	15 (7, 7)	3 (42, 9)	Bouaflé, Bouaké, Daloa
Safi	12 (5, 8)	3 (42, 9)	Bouaflé, Man, Soubré
Jaune du Burkina	8 (3, 8)	1 (14, 3)	Bouaké

The Bec d'oiseau variety leads the way with top performance, notably 100% production stability, making it the most reliable variety. "Safi" achieves consistently high scores (65 - 72%), whilst "Big Sun" displays an intermediate and versatile profile. "Jaune du Burkina" stands out for its high productivity (50% of results were very satisfactory) but commercial instability. "Garba", with modest but consistent performance, ranks last. These results reflect varied economic strategies depending on production objectives (Figure 6).

3.5.4. Diversity and Technical Performance of Tomato Varieties Grown and Their Geographical Distribution

Table 11 shows that the hybrid variety Cobra 26F1 is by far the most widely grown, with 72% of growers cultivating it. The other varieties remain marginal, notably UC-82-B (8.4%), PADMA (6.5%) and Cellulaire (3.7%), whilst Rio Grande, Raja F1, Daran F1, Kawa and Lindo are each grown by fewer than 2% of growers.

The radar chart (Figure 7) shows that "Rio Grande" and "Daran F1" achieve 100% favourable yield, with no failure rate. "Cobra 26 F1" and "UC-82-B" also perform well, with cumulative favourable yields of 74% and 77.8% respectively, despite modest failure rates (3.9% and 11.1%). "Raja F1" shows a balance between good and average yields (50% each), whilst "PADMA" combines good, average and very good yields. The Cellulaire variety is dominated by average yields (75%)

but includes 25% very good yields. "Kawa" and "Lindo" record 100% average yields. Overall, levels of underperformance remain low.

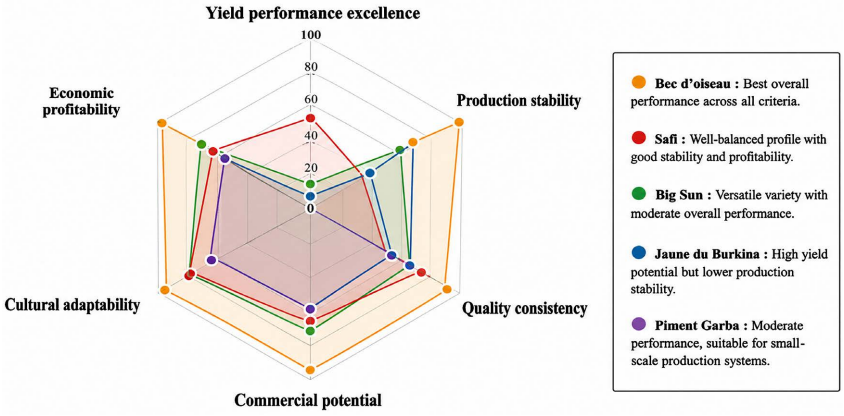


Figure 6. Economic value profile of chilli varieties.

Table 11. Cross-tabulation of chilli varieties by prevalence and associated fertilisation strategies.

Variety	Number of Growers (%)	Number of departments (%)	Departments covered
Cobra 26 F1	144 (72,0)	7 (100)	Abengourou, Bouaflé, Bouaké, Dabou, Daloa, Man, Soubré
Rio Grande	2 (0, 9)	1 (14, 3)	Bouaké
UC-82-B	17 (8, 4)	3 (42, 9)	Bouaflé, Man, Soubré
Raja F1	4 (1, 9)	3 (42, 9)	Abengourou, Bouaké, Soubré
Daran F1	2 (0, 9)	1 (14, 3)	Bouaflé
Cellulaire	7 (3, 7)	3 (42, 9)	Bouaflé, Bouaké, Daloa
Kawa	2 (0, 9)	1 (14, 3)	Abengourou
Lindo	2 (0, 9)	1 (14, 3)	Bouaké
PADMA	13 (6, 5)	3 (42, 9)	Abengourou, Bouaflé, Bouaké

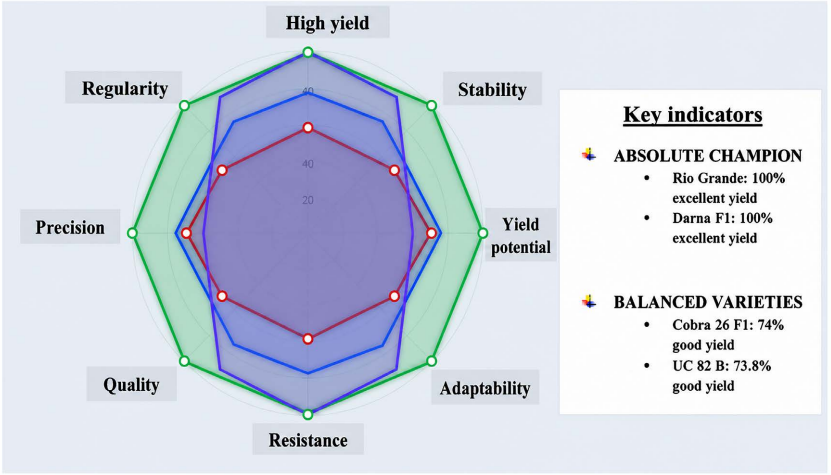


Figure 7. Profil de valorisation économique des variétés de tomate.

3.6. Analysis of Economic Valuation Profiles and Marketing Channels for Fruit Vegetables

3.6.1. Economic Value Profiles and Marketing Channels for Okra

The combined analysis of economic value profiles and marketing channels, presented in Table 12 below, indicates that the Clemson Spineless and Yellen varieties are characterised by exclusive commercial specialisation, with 100 % of their production destined for sale. This approach is reinforced by the continued use of the wholesale distribution channel. Although the Hiré variety is slightly less specialised (82.2 per cent for sale), it exhibits a similar profile. It is marketed exclusively through wholesale channels. In contrast, the Soundê variety is mainly used in hybrid systems, which combine sales and self-consumption. Nevertheless, it is distributed entirely through wholesale channels. As for the Wawa variety, it is more subsistence-oriented, with 25 per cent purely for self-consumption. It is also characterised by a diversification of distribution channels, including a significant proportion of retail sales (25 per cent). These results highlight the importance of improving sales channels for varieties with high commercial value and of improving processing conditions for varieties used for both consumption and food crops, with the aim of increasing their profitability.

Table 12. Summary of economic value profiles and marketing channels for okra varieties.

Variety	Sales (%)	Self -consumption (%)	Dominant circuit	Type of economic value creation	Comments
Clemson Spineless	100	0	Wholesale	Exclusive commercial	Highly market-oriented variety
Yellen	100	0	Wholesale	Exclusive commercial	Identical profile to Clemson Spineless
Hiré	82.2	17.8	Wholesale	Dominant commercial sector	High market specialisation
Soundê	50	50	Wholesale	Hybrid system	Combination of sale and self-consumption
Wawa	75	25	Wholesale and retail	Self-consumption	Higher proportion of self-consumption and diversification of outlets

3.6.2. Economic Value Profiles and Marketing Channels for Eggplant

Table 13 reveals a marked economic stratification among aubergine varieties, with Djamba F1 emerging as the most economically successful and versatile variety. This variety accounts for 56.5 per cent of production intended for sale and 15 per cent for mixed use, demonstrating its ability to adapt to different value chains. Kotobi, with 10.9 per cent of production destined for commercial sale, occupies a promising intermediate position, indicating considerable but under-exploited economic potential. The analysis shows an almost total preference within the aubergine sector for commercial sales, with home consumption remaining marginal

at just 0.7 per cent for Djamba F1. This trend reflects a market-oriented approach to aubergine cultivation. The varieties Aub21NB/06, Aubergines violettes, Anzrohua, Tropo and Klogbô have very limited economic profiles.

Table 13. Economic value profiles of eggplant varieties.

Variety	Level of economic value	Main characteristics
Djamba F1	Very high	Highest-performing variety; 56.5% of production for sale and 15% for mixed use
Kotobi	Intermediate	10.9% of production for commercial sale; promising economic potential but still under-exploited
Aub21NB/06	Low	Limited economic profile
Purple aubergines	Low	Limited economic profile
Anzrohua	Low	Limited economic profile
Tropo	Low	Limited economic profile
Klogbô	Low	Limited economic profile

3.6.3. Profiles of the Economic Value and Marketing Channels for Chillies

Table 14 reveals a highly contrasting economic value profile across the chilli varieties studied. The "Bec d'oiseau" variety clearly dominates the market with exceptional performance across all criteria, achieving the maximum score for production stability thanks to 100 per cent of growers reporting good yields, making it the most reliable variety from an economic perspective. With scores consistently ranging between 65 per cent and 72 per cent across all criteria, "Safi" stands out as a prime choice. Big Sun has an intermediate profile, combining stable production with average potential for excellence. It is therefore a versatile variety suitable for a range of production environments. The Jaune du Burkina variety stands out for its remarkable productivity, with 50 per cent of results being highly satisfactory. However, its overall commercial value is affected by marked instability. The Garba variety, although it ranks last in this classification with rather modest but consistent performance, appears to be an entry-level option that could be suitable for novice growers or in less-than-optimal growing conditions. All these profiles highlight the variety of possible economic approaches depending on the objectives pursued.

Table 14. Economic value profiles of chilli varieties.

Variety	Level of economic value	Main characteristics
Bird's beak	Very high	Highest-performing variety; maximum production stability with 100 per cent of growers achieving good yields; best economic reliability
Safi	High	High and consistent performance across all criteria (65 - 72 per cent); an excellent production option
Big Sun	Intermediate	Stable yield and average potential for excellence; a versatile variety suited to a range of environments

Continued

Burkina Yellow	Intermediate	Remarkable productivity with 50 per cent highly satisfactory results; economic value limited by high instability
Garba	Low	Modest but consistent performance; suitable for novice growers or less favourable growing conditions

3.6.4. Economic Value Profiles and Marketing Channels for Tomatoes

Table 15 highlights differing economic value profiles across tomato varieties. The Pawa, Cherry Tomato, UC82 and Cobra 26 F1 varieties offer the greatest economic potential due to their sensory qualities and their alignment with consumer preferences. The Rio Grande, Roma and Raja varieties occupy an intermediate position due to their specialisation in certain specific culinary uses. These results suggest that opportunities for the economic value of tomatoes are closely linked to consumer preferences and consumption patterns.

Table 15. Profiles of potential economic value of tomato varieties.

Variety	Level of potential economic value	Main characteristics
Pawa (side-fruiting hybrid)	Very high	Highly prized for fresh consumption; sought-after visual and sensory qualities
Cherry tomato	High	Versatile uses (raw and in sauces); sweet flavour and good shelf life
UC82	High	Highly prized for making fresh sauces; recognised for its flavour
Cobra 26 F1	High	High consumer acceptance; colour, shape and flavour are appreciated
Traditional cellular tomato	Medium to high	Versatile uses; good keeping quality and attractive visual characteristics
Rio Grande	Medium	Mainly intended for making sauces
Roma (elongated)	Intermediate	Valued for its shape, which is suited to certain culinary uses
Raja	Intermediate	Appreciated for its flavour in certain ecological contexts

3.7. Factors Influencing Consumer Preferences for Fruit Vegetables

3.7.1. Social, Geographical and Agroecological Factors Influencing Okra Consumption Preferences

Analysis of Figure 8 shows the influence of several factors on the choice to consume okra. Indeed, amongst the social variables analysed, gender emerges as a significant factor in the preference for traditional Soundê okra ($p = 0.001$). In other words, stronger preferences develop for certain local varieties, particularly due to their texture, taste or cooking time. The other okra varieties do not show a significant association with gender, suggesting a more uniform consumption pattern between men and women. The region variable shows a significant association

with traditional Wawa okra. This relationship indicates a strong regional bias in preferences, likely linked to the local availability of this variety as well as its culinary uses. It also appears that the ecological context significantly influences preferences for traditional Wawa okra ($p = 0.013$) and, to a lesser extent, for traditional Baoulé okra ($p = 0.051$). This suggests that certain varieties are strongly linked to specific agroecological regions, where they demonstrate their greatest potential in terms of yield, resistance or organoleptic quality.

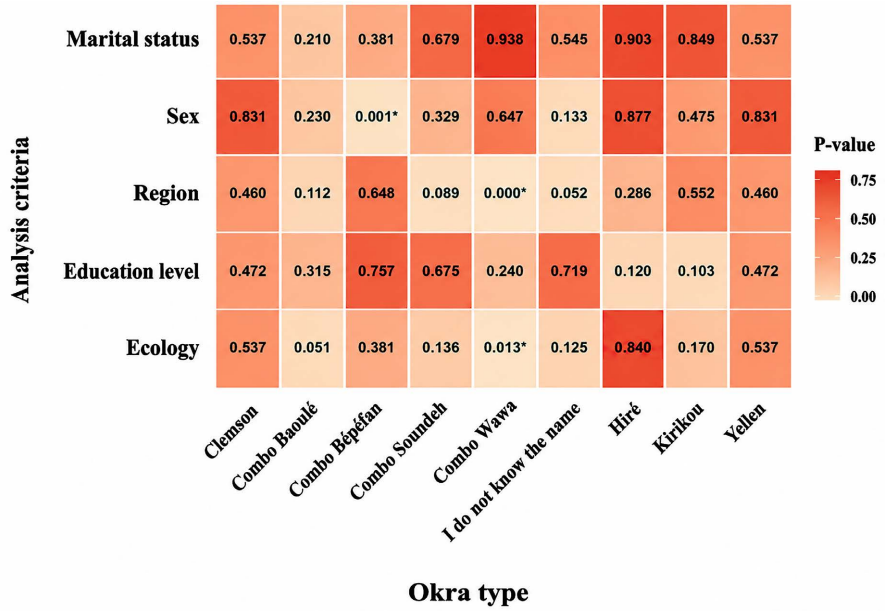


Figure 8. Heatmap illustrating the relationships between social, geographical and ecological factors and consumer preferences for the different types of okra studied.

3.7.2. Social, Geographical and Agroecological Factors Influencing Consumer Preferences for Eggplant

According to Figure 9, the consumer's gender is a highly significant factor in determining variety preferences for aubergines. For all the varieties analysed, a significant relationship was observed with gender ($p < 0.0001$). This result indicates that preferences differ markedly between men and women. Similarly, place of residence significantly influences all aubergine consumption preferences ($p < 0.0001$). This pattern of preferences points to a strong local influence on dietary habits. All aubergine varieties show a significant association with the ecological context ($p < 0.0001$). This link demonstrates a strong connection between the agro-ecological conditions of vegetable-growing areas (soil types, humidity, microclimates, altitudes) and the distribution of the varieties grown and consumed.

3.7.3. Social, Geographical and Agroecological Factors Influencing Consumption Preferences for Chillies

Figure 10 shows that, contrary to what was observed for okra above, gender does not appear to be a determining factor in the choice of chilli varieties (Figure 10), with the exception of a marginal trend for the "Option 4" variety ($p = 0.084$). This lack of a statistically significant link suggests that the use of chilli, a key ingredient

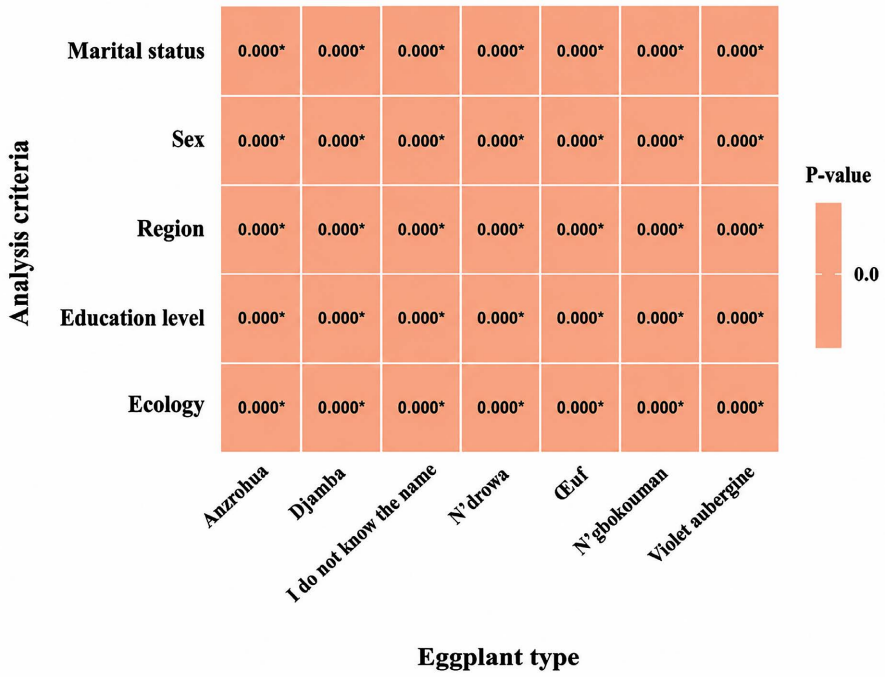


Figure 9. Heatmap showing the statistical relationships between social, geographical and ecological factors and consumption preferences for different types of eggplant.

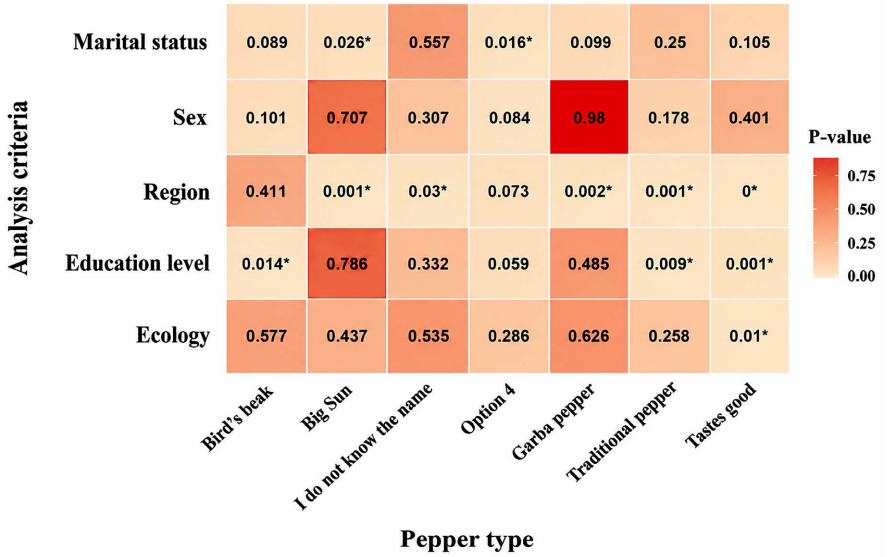


Figure 10. Heatmap showing the statistical relationships between social, geographical and ecological factors and consumption preferences for different types of chilli.

in many dishes, transcends gendered roles in dietary practices. The region variable is one of the most influential factors in shaping consumer preferences for chilli varieties. Highly significant associations were observed for the "Big Sun" ($p = 0.001$), "Piment Garba" ($p = 0.002$) and "Traditional Chilli" ($p = 0.001$) varieties. The ecological context (soil and agroclimatic characteristics) significantly influences the consumption of the "Sent Bon" chilli ($p = 0.010$). This association suggests that this variety is adapted to specific ecological conditions, in which it fully

realises its potential, both agronomically and in terms of sensory qualities. The other chilli varieties show no significant link with this factor, indicating that they could be grown or consumed in more varied or ecologically tolerant environments. Furthermore, consumers' level of education significantly influences preferences for several chilli varieties, notably "Bec d'oiseau" ($p = 0.014$), "Piment traditionnel" ($p = 0.009$) and "Sent bon" ($p = 0.001$). These results suggest that individuals with a higher level of education develop a particular sensitivity to certain varieties. This variable thus appears to play a moderating role in the diversification of dietary choices relating to chillies.

3.7.4. Social, Geographical and Agroecological Factors Influencing Consumption Preferences for Tomato

According to Figure 11, the consumer's gender is a determining factor in tomato variety preferences. The analysis reveals statistically significant associations for the majority of the varieties studied ($p < 0.05$), notably for the Cobra 26 F1, Cœur de bœuf, Dana, Roma (elongated) and traditional French tomato varieties. Only the Fula variety shows a non-significant association ($p = 0.711$). These results indicate that consumption preferences differ markedly between men and women. Consumers' level of education shows varying links depending on their preferences for tomato varieties. A statistically significant association is observed only for the variety "I don't know the name" ($p = 0.008$). For the other types of varieties analysed, the p-values exceed 0.05 (ranging from 0.058 to 0.94), indicating that there is no significant association between educational attainment and consumer preferences. Contrary to the initial hypotheses, the most highly educated individuals do not show any particular preference for the majority of varieties, and differences in educational attainment do not lead to any significant differentiation in tomato consumption patterns. Significant associations are observed for the "Cœur de bœuf" ($p = 0.034$), "UG203" ($p = 0.034$) and "UG203 français + fruits" ($p = 0.034$) varieties. These results indicate that marital status exerts a selective influence on preferences for certain specific varieties.

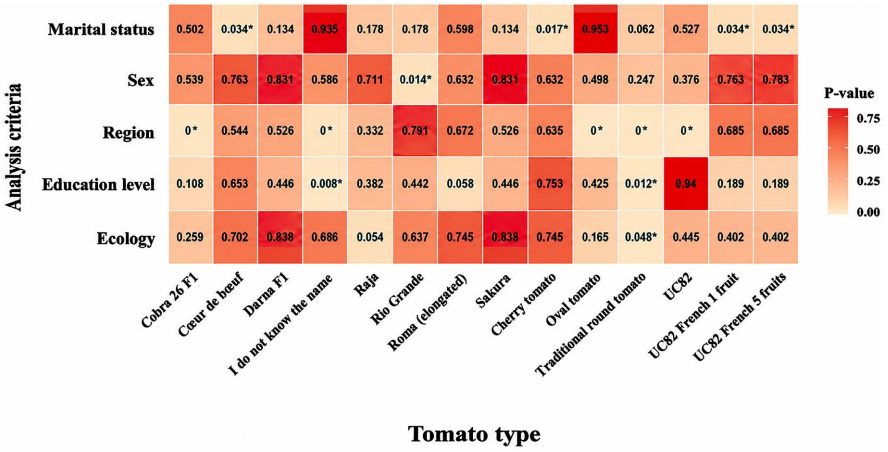


Figure 11. Heatmap showing the statistical relationships between social, geographical and ecological factors and consumption preferences for different types of tomato.

4. Discussion

The results obtained for aubergines, showing a highly significant influence of gender across all varieties, corroborate international observations documenting marked gender differences in dietary choices. Generally, women tend to favour the consumption of vegetables, in line with a healthier diet. Several studies support this observation, confirming that women consume greater quantities of fruit and vegetables than men [10]. This gender-based differentiation is also observed in dietary preferences regarding vegetables, where women's choices are often influenced by specific health-related beliefs [11].

Similarly, our results indicate that gender significantly influenced preferences for several okra varieties, including Soundê, confirming that gender-related differences in varietal preferences are not restricted to introduced vegetables but also extend to traditional African vegetables. These findings suggest that cultural habits, culinary practices and gender-specific food preferences may jointly shape varietal choices. This observation is consistent with previous studies reporting that socio-cultural factors contribute to differences in vegetable consumption patterns between men and women [12], indicating a cultural complexity in tastes that goes beyond traditional gender-based dietary patterns.

For tomatoes, the significant influence of gender on the majority of varieties is consistent with the observations of [13] regarding gender differences in vegetable consumption, which are partially mediated by specific health beliefs. Paradoxically, chillies largely escape this gender differentiation, contradicting the hypothesis of increased female sensitivity to vegetables [14].

The strong territorialisation observed for okra (*Wawa* variety), chilli (five varieties significantly associated with the region) and aubergine ($p < 0.0001$ for all varieties) is consistent with previous research on African food diversity. Information on the production, processing, distribution and marketing of vegetable species specific to sub-Saharan Africa is a key focus [15], confirming the importance of local contexts in shaping preferences. This study highlights the importance of traditional African vegetables in combating food insecurity in this region.

The study, conducted in Kenya, showed that raising awareness of the consumption of these vegetables improves the quality and diversity of the diet, highlighting their potential to enhance nutritional security.

This territorialisation stands in striking contrast to the geographical homogeneity of the tomato, for which preferences transcend regional boundaries. This phenomenon can be attributed to the tomato's status as a "globalised vegetable", which forms part of modern trade networks, unlike traditional vegetables that are deeply rooted in local food systems.

Studies by [16] on gender and generational disparities in local knowledge and appreciation of food trees in Uganda and Kenya offer an illuminating parallel regarding the territorial roots of food knowledge in sub-Saharan Africa.

The significant influence of educational attainment on preferences for chillies (*Bird's Beak* varieties, traditional varieties and *Big Sun or Sent Bon*) and auber-

gines (all varieties, $p < 0.0001$) suggests that education plays a moderating role in the diversification of dietary choices. This observation is consistent with the theories of social food distinction developed by [17], in which education promotes openness to varietal diversity and influences the quality of dietary choices.

However, the lack of a significant correlation for most tomato varieties contradicts this assumption, suggesting that education does not have a uniform influence on all vegetables. This finding differs from the usual conclusions of [18] regarding the impact of education on healthy food choices, calling into question the generalisation of Western models in the African context.

The significant associations observed between the ecological context and varietal preferences (such as the Wawa and Soundê okra, or the Sent Bon and Big Sun chilli varieties) suggest that local environmental conditions may influence farmers' varietal choices. However, these associations should not be interpreted as direct evidence of varietal adaptation, as the present study was based on observational survey data rather than experimental evaluation. Ethno-pedological descriptions nevertheless highlight the remarkable consistency between farmers' knowledge of soils and scientifically recognised soil properties (e.g. pH, organic matter and available phosphorus). These findings are consistent with [15], who emphasised the importance of traditional vegetables for food security while preserving biodiversity adapted to diverse agroecological contexts. Further experimental studies would be required to confirm the mechanisms underlying varietal adaptation and their contribution to resilience under changing environmental conditions [19].

The geographical homogeneity of the tomato suggests its potential for uniform national policies, whilst the high degree of territorialisation of other fruit vegetables requires regionalised approaches. This differentiation addresses the challenges of food insecurity exacerbated by climate change in sub-Saharan Africa, where diversification based on adapted local varieties constitutes a resilience strategy in the face of the challenges identified.

Although several statistically significant associations were identified in this study, these findings should be interpreted as observational relationships rather than direct causal effects. The cross-sectional design does not allow causal inference regarding varietal adaptation, resilience or agronomic performance. Instead, the observed patterns provide a valuable basis for future experimental and longitudinal studies aimed at validating the underlying mechanisms.

5. Conclusions

This study provides new insights into the production practices and consumption preferences for okra, aubergine, chilli and tomato across six agroecological zones of Côte d'Ivoire. By integrating agronomic, socio-demographic and agro-pedological information, it highlights the spatial variability of production systems and varietal preferences within the country's major vegetable-growing areas.

The results revealed significant regional differences in production practices, varietal distribution and consumer preferences. They also showed that socio-demo-

graphic factors, particularly gender, educational level and geographical location, were significantly associated with preferences for several vegetable varieties. These findings suggest that both local environmental conditions and socio-cultural characteristics contribute to shaping production and consumption patterns, although the observational nature of this study does not allow direct causal inferences regarding varietal adaptation or resilience.

The study further suggests that local agro-pedological knowledge remains an important component of farmers' decision-making and may contribute to the organisation of production systems across contrasting agroecological contexts. However, additional experimental and longitudinal studies are required to better understand the mechanisms linking soil characteristics, varietal performance and long-term system resilience.

Overall, these findings provide valuable evidence to support the development of context-specific strategies for vegetable production and consumption in Côte d'Ivoire. They also offer a useful scientific basis for future research and for the design of agricultural policies aimed at promoting sustainable vegetable production while taking into account regional diversity, local knowledge and evolving consumer preferences.

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Author Contributions

G-FRN, MED, DJBE, ALK, NDC and AJM participated in conducting the fieldwork, the design, drafting and formatting of the article, as well as the statistical analysis of the data; DJBE and MED supervised the conduct of the work, the design, development and drafting of the manuscript.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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