

Understanding the determinants of pepper production (*Capsicum annuum* L.) in Niger: Insights into local agricultural dynamics

Halimatou Ousseini Maiga^{1,2}, Oumarou Souleymane^{*1}, Illiassou Mossi Maiga¹, Adam Toudou²

¹National Institute of Agronomic Research of Niger, Niamey, Niger

²Faculty of Agronomy, Abdou Moumouni University of Niamey, Niger

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Corresponding author:

Oumarou Souleymane

Email: umarsou@gmail.com



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ABSTRACT

A study on the determinants of bell pepper production was carried out in Niger, based on surveys of 338 producers in 6 regions of the country. The aim was to identify and understand the factors influencing production of this crop. Farmer's family sizes ranged from 1 to 52, with an average of 12 people. The producers average age of 43 years. Average plot size varies between 0.0015 ha and 8 ha. Almost all farmers are men, and a large proportion of producers in rural areas have no access to formal education. Three cropping systems (monoculture, intercropping and rotation) are practiced. Community seeds are the main source of this input at 67.66%. Soil preparation is rudimentary (81.01%), with two types of seeding preponderated: broadcast (50.15%) and row (49.85%). Furrow irrigation is the most widely traditional technique used at 89.91%. Most bell pepper growers combine mineral and organic fertilization. Harvests are mainly done by hand (98%) and are intended by 48.7% for fresh sale and 51.3% for drying.

Key words: Pepper, Production factors, Niger, Agricultural dynamics, Production system

INTRODUCTION

Bell pepper is a source of potassium, phosphorus, calcium, vitamins A, C, E, B1, polyphenols, carotenoids, sugar, and has a high content of antioxidants such as capsaicin and capsanthin (Lozano-Fernández *et al.*, 2018). Belonging to the Solanaceae family and native to South and Central America (Janaki *et al.*, 2016), bell pepper was introduced to Europe by Christopher Columbus in the 15th century, and then spread to Africa through the spice trade routes. Owing, no doubt, to a long history of cultivation, selection, and to the popularity of this crop, significant genetic variability and crop management practices have developed (Nahak *et al.*, 2018). In Niger, bell pepper is among the most widely grown vegetable crops due to its profitability (Souleymane, 2023). The crop is cultivated in all regions. As in most developing countries, the agricultural sector employs a significant share of the rural workforce in this Sahelian country (Ali *et al.*, 2016), where various factors may influence agricultural production. These determinants play an important role in local agricultural dynamics (Ibitola *et al.*, 2019; Kakar *et al.*, 2016). Thus, bell pepper production in Niger takes place under irrigated agriculture within an environment characterized by major climatic constraints. This crop, now rooted in the country's agricultural tradition, is shaped by local determinants and agricultural dynamics that ensure its sustainability and profitability. It is therefore essential to identify the factors influencing bell pepper production, particularly in a context marked by poverty and scarce production resources (Sanouna *et al.*, 2020). Identifying and understanding the determinants of bell pepper production could support the implementation or adaptation of appropriate policies that can increase crop productivity as well as local, and even national, economic development. The objective of this study is to identify and understand the determinants of bell pepper production in Niger.

MATERIALS AND METHODS

An agroecological zoning exercise was carried out to identify the country regions exhibiting a diversity of bell pepper varieties or accessions. A survey was then conducted in the six regions, namely: Diffa, Zinder, Maradi, Tahoua, Dosso, and Tillabéri (Fig. 1). In each

region, department (within region), and commune (within department), interviews were held with local authorities in order to identify the main bell pepper production sites. To determine the number of villages and producers to be surveyed, a systematic sampling (SS) approach was implemented. This method consisted of randomly selecting a first village or production site and then, after consulting with local officials, choosing every k -th village or site according to a sampling interval defined by the formula $k = N/n$, where N represents the total population (number of producers per village and commune) and n the sample size. A random number r between 1 and k was selected, and the final sample was constructed following the sequence $\{r, r+k, r+2k, \dots, r+nk\}$. A participatory approach was also adopted to gather knowledge on local bell pepper varieties.

For field data collection, ethnobotanical surveys were carried out to document traditional knowledge on bell pepper varieties. In total, 338 producers were individually interviewed using questionnaires, and 18 focus group discussions were organized across the country. Responses were recorded using KoboToolbox, while data analysis was performed with R software version 4.4.1.

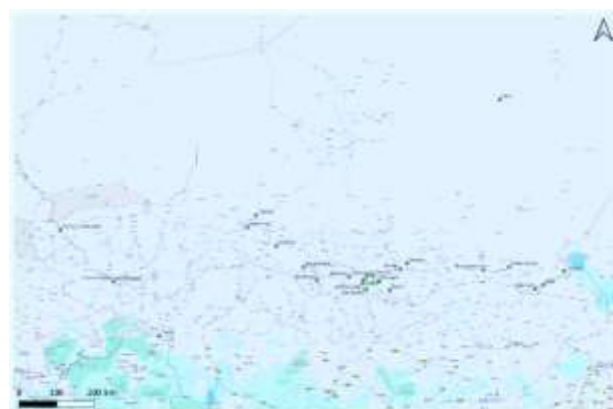


Fig. 1. Communities surveyed and data collected on pepper cultivation in Niger

RESULTS

Characteristics of bell pepper farms

The age of bell pepper producers ranges from 18 to 75 years, with an average of 43 years and a standard deviation of 11. Sixty-six percent (66%) of producers are between 32 and 54 years old. Ninety-five percent (95%)

of producers fall within the age range of 21 to 65 years (Table 1), and 40% are under 40 years old. Thus, only 2.5% of producers are under 21 years old and 2.5% are over 65 years old. Twenty-two percent (22%) of farmers are young (18 to 35 years), and 65% are between 18 and 45 years old. Producers aged up to 55 years represent an overwhelming majority (85.67%). Forty-two percent (42.69%) of producers are between 35 and 45 years old.

The number of people supported by each bell pepper farmer ranges from 1 to 52, with an average of 12 people and a standard deviation of 6. Thus, 66% of farms support between 6 and 18 people, while 17% support fewer than 6 people. Likewise, in 17% of farms, the number of dependents exceeds 18 people. However, the average plot size remains small, ranging from 0.0015 ha (around the Goudoumaria depressions) to 8 ha per farmer.

Table 1. Characteristics of agricultural holdings

Characteristics of operators	Mean	Standard deviation	Max	Min	
Age	42,73	11,18	75	18	
Household sizes	11,91	6,17	52	1	
Plot size (ha)	1,105	1,03	8	0,0015	
Age range	Bellow 35	35-45 years	46-55years	56-65 years	66-75 years
Number	74	143	70	36	12
Frequencies (%)	22,09	42,69	20,90	10,75	3,58
Cumulative frequencies (%)	22,09	64,78	85,67	96,42	100

Table 2. Characteristics of pepper farmers

Population characteristics	Number	Percentage (%)
Gender		
Male	330	97,6
Female	8	2,4
Marital status		
Single	3	0,9
Divorced	2	0,6
Widowed	2	0,6
Married	331	97,9
Level of education		
None	28	8,3
Quranic	184	54,4
Quranic + Primary/Secondary	71	21,0
Primary	18	5,3
Secondary	23	6,8
Higher	2	0,6
Primary occupation		
Farmer	338	100
Secondary occupation		
Commerce	58	17,2
Livestock farming	50	14,8
Fishing	4	1,2
Agrodealer	3	0,9
Transporters	3	0,9
Entertainer	2	0,6
Laborer	1	0,3

The overwhelming majority of bell pepper farmers are men, accounting for 97.6% of the population, compared with only 2.4% women. Among them, 97.9% are married, while single, divorced, and widowed individuals represent 2%. A large proportion of producers in the rural areas covered by this study do not have access to formal education. Indeed, only 8.3% are literate, and 54.40% have received exclusively Quranic education (Table 2). However, a small minority of farmers have completed higher education (0.6%). All producers have agriculture as their main activity. In addition to agriculture, 35.90% have a

secondary activity, of whom 17.2% engage in trade, 14.8% in livestock rearing, and 1.2% in fishing.

Bell pepper cropping systems

Three cropping systems are practiced by farmers in the bell pepper production zone in Niger. These include monocropping, intercropping, and crop rotation. Monocropping is a common practice in bell pepper production areas in Niger. It consists of growing the same crop exclusively on the same plot for several years, seasons, or cycles. It is practiced by 88.43% of bell pepper producers (Table 3).

Table 3. Pepper cultivation systems in the areas surveyed in Niger

		Number	Frequencies (%)
Cultivation system	Monoculture	298	88,43
	Intercropping	32	9,50
	Rotation	7	2,08
Seeds	Community	228	67,66
	Formal system	9	2,67
Soil preparation	By hand	273	81,01
	Animal-drawn plow	57	16,91
	Tractor	7	2,08
Sowing method	In rows	168	49,85
	Broadcast	169	50,15

Table 4. Peasant irrigation methods

		Number	Frequencies (%)
Irrigation system	Irrigated	162	48,21
	Receding water	164	48,81
	Both	10	2,98
Irrigation water source	Surface water	85	25,22
	Groundwater	227	67,36
	Both	25	7,42
Water availability	Insufficient	144	42,73
	Sufficient	191	56,68
Irrigation equipment	Motor pump	320	94,96
	Bucket and rope	12	3,56
Irrigation water application method	Surface	11	3,26
	Furrow	303	89,91
	Sprinkler	21	6,23

In addition to monocropping, 9.50% of farmers intercrop bell pepper with other crops. This practice involves cultivating bell pepper together with other species on the same plot to maximize the use of available resources, reduce certain risks, and improve soil fertility. Only 2.08% of producers practice crop rotation. These farmers alternate bell pepper with other crops on the same plot (rotation), generally over a few cycles or seasons.

Community seed systems, used by 67.66% of farmers, constitute the main source of seed supply. The formal seed system is represented by only 2% of producers. Soil preparation remains rudimentary and is carried out manually by 81.01% of farmers, compared with 16.91% who use animal-drawn plows. Two sowing methods predominate: broadcasting (50.15%) and line sowing (49.85%)

Farmers' irrigation practices

Two water supply systems coexist in bell pepper cultivation: the irrigated system and the recession-based system. These two systems are practiced in nearly equal proportions by producers. In regions of the country where surface water is insufficient or seasonal, the use of

groundwater for bell pepper irrigation proves to be an important alternative. Surface water (ponds, marshes, reservoirs, rivers, lakes, the Niger River) is used by 25.22% of farmers (Table 4). In contrast, 67.36% of producers rely on groundwater.

In a context of water scarcity and climatic variability in Niger, some bell pepper producers (7%) have opted for the combined use of surface water and groundwater for irrigation in order to optimize water resources. However, the water needs of bell pepper crops are not always met for 42.73% of farmers, who consider the available irrigation water insufficient, compared with 56.68% who are able to access and use enough irrigation water throughout the crop's growing cycle.

Irrigation of bell pepper using a motor pump is a widely used method across all regions of the country, practiced by 94.96% of farmers. This technique is particularly useful for extracting water from wells, rivers, or reservoirs for agricultural use. Furrow irrigation is the most widely used traditional technique for bell pepper cultivation, with 89.91% of producers using this method, compared with 6.23% who use sprinkler irrigation.

Table 5. Irrigation frequencies and equipment used

		Once a week	Twice a week	Thrice a week	4 times/ week	5 times/ week	7 times/ week
Total	Frequency (%)	29	35	23	6	1	6
	Cumulative frequencies (%)	29	64	87	93	94	100
Motor pump	Frequency (%)	28,4	34,4	21,8	5,1	1	5,7
	Cumulative frequencies (%)	28,4	62,8	84,6	89,7	90,7	96,4
Rope + bucket of water	Frequency (%)	0,6	0,6	1,2	0,9	0,0	0,3
	Cumulative frequencies (%)	0,6	1,2	2,4	3,3	3,3	3,6

Table 6. Type of fertilization practiced by producers

	Type of fertilizer/Application time	Number	Frequencies
Nursery	Organic fertilizer	337	100
	Organic-mineral fertilizer	170	50,4
Transplanting	Mineral fertilizer	225	66,8
	Both	107	31,8
Time application	At transplanting	18	5,3
	One week after transplanting	47	13,9
	Two weeks after transplanting	142	42,1
	Three weeks after transplanting	15	4,5
	Four weeks after transplanting	9	2,7
	Flowering-fruiting	42	12,5
Amount of mineral fertilizer used (kg)	Average		417
	Standard deviation		397,5
	Max		2500
	Min		50

Irrigation frequency and equipment used

Thirty-five percent (35%) of producers irrigate twice per week, while 29% irrigate once per week. On average, 23% of farmers irrigate three times per week. Only 11% of producers water their plants more than three times per week, and 64% irrigate fewer than three times per week.

On average, 96.4% of farmers use motor pumps for irrigation, whereas 3.6% use buckets for water lifting and irrigation. Among those who use motor pumps, 62.8% irrigate fewer than three times per week, 21.8% irrigate three times per week, and 15.4% irrigate more than three times per week.

Farmers' fertilization practices for bell pepper: type, quantity, and timing of application.

Bell pepper fertilization by farmers in Niger relies, on the one hand, on the use of organic matter (100% in the nursery, 50.4% after transplanting) derived from local and natural resources to enrich the soil and improve yields while reducing costs, and, on the other hand, on mineral fertilization (66.8% after transplanting). In

addition to these two types of fertilization, a combined approach that integrates organic matter and mineral fertilizers is also practiced (31.8% after transplanting). Thus, in the nursery, 100% of producers use only organic matter.

The application of manure after transplanting is carried out directly at transplanting (5.3%), one week after transplanting (13.9% of producers), two weeks after transplanting (42.1% of producers), three weeks after transplanting (4.5% of producers), four weeks after transplanting (2.7% of producers), and at flowering-fruiting (12.5%) (Table 6).

The average quantity of mineral fertilizer per farmer ranges from 50 kg to 2,500 kg, with a standard deviation of 397.5. Thus, 66% of producers use between 50 kg and 750 kg of fertilizer.

Bell pepper harvesting methods

Bell pepper harvesting in farming communities is carried out mainly by hand, practiced by 98.2% of producers (Table 7), and done in a staggered manner by 100% of farmers. The

number of harvests ranges from 3 to 30 times per production cycle or per year. About 16.3% of producers harvest 3 to 4 times per year; 27.0% harvest 5 to 6 times per cycle; 14.5% harvest 7 to 8 times per year; 18.4% harvest 9 to 10 times; 7.1% harvest 11 to 12 times; and 13.4% harvest

more than 12 times. The average number of harvests is 8, with a standard deviation of 4. Thus, 66% of producers harvest between 4 and 12 times per year. Seventeen percent (17%) harvest more than 12 times, and another 17% harvest fewer than 4 times per year.

Table 7. Harvesting and storing peppers in rural areas

	Section	Number	Percentage (%)
Harvesting method	By hand	331	98,2
	With pruning shears	6	1,8
Harvesting procedure	Staggered	337	100
	All at once	0	0
Number of harvests	3 to 4 times	55	16,3
	5 to 6 times	91	27
	7 to 8 times	49	14,5
	9 to 10 times	62	18,4
	11 to 12 times	24	7,1
	More than 12 times	45	13,4
	Average	8,34	
	Standard deviation	4,34	
Color of harvested fruit	Max	30	
	Min	3	
	Green	50	14,8
	Red	265	78,6
Destination of harvest	Green/Red mix	22	6,5
	Sold fresh	164	48,7
	Preserved by drying	173	51,3

Bell peppers are harvested green by 14.8% of producers when the fruits reach their maximum size and are firm. Meanwhile, 78.6% of farmers harvest red peppers when the fruits show their characteristic full-ripe coloration. However, 6.5% of producers harvest a mix of fruits (green and red). The harvested peppers are either sold fresh (48.7% of producers) or conserved through drying (51.3% of farmers)

DISCUSSION

The results showed that 22% of bell pepper farmers are under 35 years old, 40% are under 40, and 65% are between 18 and 45 years old. Thus, 40% of farmers are considered young according to the definition by Aggelopoulos and Arabatzis (2010), which states that a young farmer is a man under 40 years old. Youth plays a major role in bell pepper farming in Niger, as it could ensure the sustainability and development of the sector. However, although family farming is promoted as an approach that supports sustainable development (Sourisseau *et al.*, 2012; Lacombe, 2016), the role of young farmers in this context remains little studied (Amichi *et al.*, 2015). Yet, it is essential to focus on this group in order to better understand the diversity of

family farming models and their medium-term evolution (Desmulier and Gasselin, 2015), as well as to develop public policies adapted to the plurality of agricultural realities (Sabourin *et al.*, 2014). The importance of youth in agriculture is undeniable (Moussa *et al.*, 2022), as they primarily help to renew the agricultural workforce. Indeed, bell pepper cultivation in Niger largely relies on traditional practices and an aging population (60%). In this context, young people would bring new energy and could ensure the generational succession necessary to guarantee the sector's sustainability. Additionally, they are more likely to adopt technological innovations that improve productivity.

The results showed that the overwhelming majority (97.6%) of farmers are men. This proportion is 64% men and 36% women on vegetable farming sites in Mali (Moussa *et al.*, 2022). In Burkina Faso, studies have shown that 97 to 99% of vegetable farmers are men (Ouédraogo *et al.*, 2019). In addition to being farm heads, men play a key role in bell pepper cultivation at multiple levels. They are involved in land preparation and management, as they are generally responsible for preparing the fields, plowing, and developing irrigated

areas. They also handle the construction and maintenance of irrigation systems (wells, motor pumps, canals).

Furthermore, they participate in sowing, crop maintenance, harvesting, and marketing. Indeed, they play a central role in the commercialization of bell peppers in local markets and even for export, particularly to Nigeria.

The study showed that the predominant cropping system is pepper monoculture (88.43%), but it coexists with intercropping and crop rotation. Pepper monoculture in Niger could have several impacts. It allows farmers to acquire in-depth expertise in the crop, thereby optimizing yields. It promotes intensive production and contributes to a steady supply for local and regional markets.

However, monoculture could lead to soil depletion, increased diseases and pests, dependence on chemical inputs, reduced biodiversity, and so on. Intercropping has several agronomic advantages, including a reduction in health-related crop problems (Garba *et al.*, 2015; Malézieux *et al.*, 2009; Perrin and Lefevre, 2019; Ratnadass *et al.*, 2012), improved soil fertility (Duchene *et al.*, 2017; Lithourgidis *et al.*, 2011), and increased and more stable yields (Perrin and Lefevre, 2019). Despite all these benefits, only 9.5% of producers practice this production system.

The survey highlighted that 67.66% of farmers use community seeds, which could provide a collective and sustainable solution for producers facing challenges related to access to quality seeds. These local, traditional initiatives allow farmers to produce, store, and share seeds locally.

Producers using seeds from the formal system must purchase them each season. In contrast, with the other main type of seeds—community seeds—they have the opportunity to produce their own seeds from their harvest. However, this self-production can be a source of inefficiency (Lemarié, 2003). Soil preparation is carried out rudimentarily (by hand) in 81.01% of cases. This soil work plays an essential role in pepper

cultivation by directly influencing plant growth, nutrient availability, and water management.

The frequency of irrigation per week on farms varies from 7 (in cases where farmers irrigate daily) to 1 (where farmers irrigate once a week). Irrigation management is crucial for pepper cultivation. The frequency adopted by farmers should be adapted to the climate, soil, and the plant's stage of development. Furrow irrigation is the most widely used method by farmers (89.91%). It is a traditional, widely practiced method which, although simple and inexpensive, has many shortcomings, including low water-use efficiency, significant losses through deep infiltration at the upstream end and runoff at the downstream end, and uneven water distribution.

Runoff can lead to erosion of the furrows, especially on sloped soils. Close manual monitoring is required to control flows and close the furrows at the right time. Consequently, to improve irrigation water-use efficiency for better productivity, the following measures could be considered: (i) ensuring gentle slopes to allow water flow without causing erosion, (ii) shortening the length of the furrows to reduce infiltration losses and distribute water more evenly, (iii) installing, where possible, valves or pipes instead of long furrows to reduce losses, and (iv) raising farmer awareness about water management, irrigation techniques, and network maintenance.

Most pepper farmers combine mineral and organic fertilization. This has also been observed in other studies (Abdulkadir *et al.*, 2013; Ouédraogo *et al.*, 2019). However, there is a clear predominance of mineral fertilizers, particularly nitrogen.

Harvests, which are carried out almost entirely by hand (98%), are intended 48.7% for sale as fresh produce. This represents the marketing of fresh peppers without processing. This type of sale has several advantages that are important to consider in the context of agricultural or commercial activities related to pepper. Peppers are widely used in Nigerien cuisine, particularly in sauces and traditional dishes.

Consequently, selling fresh allows for rapid product turnover. If well managed, fresh peppers can generate substantial income, especially during periods of scarcity. Moreover, no complex processing or preservation equipment is required, which can reduce the initial investment. Selling fresh peppers can also create local employment, as several people (harvesters, transporters, vendors) can be involved from field to market.

However, this practice also has disadvantages. Some are related to the high perishability of peppers. Fresh peppers are difficult to store without a cold chain, which limits the sales window and increases post-harvest losses. Transportation is also delicate, as shocks and excessive heat must be avoided. Additionally, access to urban markets can be limited if infrastructure is inadequate. Prices of fresh peppers can drop sharply in cases of overproduction. Outside major urban centers, demand for fresh peppers may be lower. To overcome these challenges and maximize their income, 51.3% of producers have opted for diversification by drying and preserving peppers before sale. Some also engage in processing.

REFERENCES

- Abdulkadir A, Leffelaar PA, Agbenin JO, Giller KE.** 2013. Nutrient flows and balances in urban and peri-urban agroecosystems of Kano, Nigeria. *Nutrient Cycling in Agroecosystems* **95**, 231–254.
<https://doi.org/10.1007/s10705-013-9560-2>
- Aggelopoulos S, Arabatzis G.** 2010. European Union young farmers program: a Greek case study. *New Medit* **9**, 50–55.
- Ali D, Bowen D, Deininger K, Duponchel M.** 2016. Investigating the gender gap in agricultural productivity: evidence from Uganda. *World Development* **87**, 152–170.
- Amichi H, Kadiri Z, Bouarfa S, Kuper M.** 2015. Une génération en quête d'opportunités et de reconnaissance: les jeunes ruraux et leurs trajectoires innovantes dans l'agriculture irriguée au Maghreb. *Cahiers Agricultures* **24**, 323–329.
- Desmulier D, Gasselin P.** 2015. La quadrature des agricultures familiales: instruire et dépasser les controverses. *Revue Tiers Monde* **221**, 129–146.
- Duchene O, Vian JF, Celette F.** 2017. Intercropping with legume for agroecological cropping systems: complementarity and facilitation processes and the importance of soil microorganisms: a review. *Agriculture, Ecosystems & Environment* **240**, 148–161.
- Gaba S, Lescourret F, Boudsocq S, Enjalbert J, Hinsinger P, Journet EP, Navas ML, Wery J, Louarn G, Malézieux E, Pelzer E, Prudent M, Ozier-Lafontaine H.** 2015. Multiple cropping systems as drivers for providing multiple ecosystem services: from concepts to design. *Agronomy for Sustainable Development* **35**, 607–623.
- Hernández-Pérez T, Gómez-García MDR, Valverde ME, Paredes-López O.** 2020. *Capsicum annuum* (hot pepper): an ancient Latin-American crop with outstanding bioactive compounds and nutraceutical potential: a review. *Comprehensive Reviews in Food Science and Food Safety* **19**, 2972–2993. <https://doi.org/10.1111/1541-4337.12634>
- Ibitola OR, Fasakin IJ, Popoola OO, Olajide OO.** 2019. Determinants of maize farmers' productivity among smallholder farmers in Oyo State, Nigeria. *Journal of Agricultural Science* **9**, 189–198.
- Janaki M, Naidu LN, Ramana CV, Rao MP.** 2016. Genetic divergence among chilli (*Capsicum annuum* L.) genotypes based on quantitative and qualitative traits. *International Journal of Science and Nature* **7**, 181–189.
- Kakar M, Kiani A, Baig A.** 2016. Determinants of agricultural productivity: empirical evidence from Pakistan's economy. *Global Economics Review* **1**, 1–12.
- Lacombe P.** 2016. L'agriculture familiale: renaine ou nouveauté ? *Natures Sciences Sociétés* **24**, 123–135.
- Lemarié S.** 2003. Évolution des structures industrielles et de la concurrence dans les secteurs des semences et des pesticides. In: INRA (ed.), *Économie rurale. La politique de la concurrence dans l'agroalimentaire*, Didier Aubert, Brandebourg, 167–182.

Lithourgidis AS, Dordas CA, Damalas CA, Vlachostergios D. 2011. Annual intercrops: an alternative pathway for sustainable agriculture. *Australian Journal of Crop Science* **5**, 396–410.

Lozano-Fernández J, Orozco-Orozco LF, Montoya-Munera LF. 2018. Effect of two environments and fertilization recommendations on the development and production of bell pepper (cv. Nathalie). *Acta Agronómica* **67**, 101–108.

Malézieux E, Crozat Y, Dupraz C, Laurans M, Makowski D, Ozier-Lafontaine H, Rapidel B, Tourdonnet S, Valantin-Morison M. 2009. Mixing plant species in cropping systems: concepts, tools and models: a review. *Agronomy for Sustainable Development* **29**, 43–62.

Moussa S, Savio S, Ousmane K. 2022. Rôle du maraichage dans le développement socioéconomique à l'Office du Périmètre Irrigué de Baguineda. *International Journal of Biological and Chemical Sciences* **16**, 213–226.

Nahak SC, Nandi A, Sahu GS, Tripathy P, Das S, Mohanty A, Pradhan SR. 2018. Assessment of genetic diversity in different chilli (*Capsicum annuum* L.) genotypes. *International Journal of Current Microbiology and Applied Sciences* **7**, 634–639.

Ouédraogo RA, Kambiré FC, Kestemont MP, Biélders CL. 2019. Caractériser la diversité des exploitations maraîchères de la région de Bobo-Dioulasso au Burkina Faso pour faciliter leur transition agroécologique. *Cahiers Agricultures* **28**, 1–9.