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Perception of Peasant Management Methods for Chilli Pepper (*Capsicum spp.*) Production in Burkina Faso

WAONGO Lucienne (Corresponding Author)
Laboratoire Biosciences, Unité de Formation et de Recherche en Sciences de la Vie et de la Terre, Université Joseph KI-ZERBO, 03 BP 7021 Ouagadougou 03, Burkina Faso
Email: waongolucienne@yahoo.fr

KIEBRE Mariam
Laboratoire Biosciences, Unité de Formation et de Recherche en Sciences de la Vie et de la Terre, Université Joseph KI-ZERBO, 03 BP 7021 Ouagadougou 03, Burkina Faso

OUEDRAOGO Jacques
Equipe Génétique et Amelioration des Plantes, Laboratoire Biosciences, École Doctorale des Sciences et Technologies, Université Joseph KIZERBO, 03 BP 7021 Ouagadougou 03, Burkina Faso

SAKANDE Boureima
Equipe Génétique et Amelioration des Plantes, Laboratoire Biosciences, École Doctorale des Sciences et Technologies, Université Joseph KIZERBO, 03 BP 7021 Ouagadougou 03, Burkina Faso

BELEM Mahamadi
Equipe Génétique et Amelioration des Plantes, Laboratoire Biosciences, École Doctorale des Sciences et Technologies, Université Joseph KIZERBO, 03 BP 7021 Ouagadougou 03, Burkina Faso

BATIONO/KANDO Pauline
Equipe Génétique et Amelioration des Plantes, Laboratoire Biosciences, École Doctorale des Sciences et Technologies, Université Joseph KIZERBO, 03 BP 7021 Ouagadougou 03, Burkina Faso

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Abstract

In Burkina Faso, pepper is increasingly cultivated and is one of the vegetable crops with a high market value. However, knowledge about farmers' management practices that could help in research questions on this crop are less available. The aim of this study is to understand farmers' practices in chilli cultivation in Burkina Faso. A survey on chilli cultivation practices involving 384 growers was carried out in 20 of the country's provinces, divided in three phytogeographical sectors. The collected data were subjected to descriptive and statistical analysis using EXCEL 2016 spreadsheet and R 4.1.2 software with the Rcmdr Package. The results showed that predominantly male growers (92.19%) practice monoculture of chilli (87.24%) over two seasons (winter and dry). The seeds were obtained through a selection at field level (80.91%) at least over two production seasons, and by purchase (55.18%). For 87.24% of the respondents, the crop is produced in small area (less than a quarter of a hectare). The main constraints in chilli production are the faint accessibility to chemical fertilizers and micro-credits, the attacks due to bio-aggressors, etc. These constraints limit the sector's performance and deserve to be analyzed in order to find solutions to boost the production.

Keywords: Pepper; *Capsicum sp;* cropping system; Seed conservation; Burkina faso.

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1. Introduction

Vegetable crops are important sources of nutrients that meet the dietary needs of populations [1]. Among these crops, chilli (Capsicum sp.) occupies an important place [2] with an annual global production of 36.29 million tons on an estimated area of 2,055 hectares in 2021 and average yields of 17.56 tons per hectare (Faostat, 2023). Global chilli production has increased by over 30% within a period of ten years [3]. China (49.53%), Mexico (9.19%), Indonesia (6.95%), Turkey (6.91%, and Spain (3.47%) are the five main chilli-producing countries in the world, followed by Egypt, Nigeria, Algeria and Ghana in Africa [4].

In Africa, however, for a long time, it was considered as a neglected crop, but in recent years certain African varieties have become highly prized on local and sub-regional markets, and are exported to international markets [5]. In Africa, about 3.47 million tons of chilli grains, harvested from an estimated 331,064 hectares and corresponding to an average yield of 10.49 tons/hectare [4] are commercialized, but remains below the world global production average.

In Burkina Faso, the crop is grown in all the country's provinces, with an increase in production area and yield [6]. Thus, with a production of 8200 tons on 1800 hectares in 2013 (i.e. 4.55T/Ha), this production has risen to

22456 tons on 3373 hectares in 2022 (i.e. 8.58 T/Ha) [6]. Its socio-economic importance is huge. The imported grains are estimated at 166.82 tons in 2020, for a foreign exchange outflow of 43.36 million [4]. Unfortunately, the lack of information on production practices used by chilli growers' means that it would be difficult to implement an effective strategy to improve seasonal production of chilli, and hence the living conditions of those involved in the industry. The aim of this study is to find out how chilli cultivation is managed on farm, with a view to finding innovative solutions to boost the production.

2. Methodology

2.1. Survey on Chilli Growers

An ethnobotanical survey was carried out from September to October 2021 in 29 rural communes and 109 villages from 20 provinces in three phytogeographical sectors of the country (Figure 1). The support of agents from the Technical Animation Zones (ZAT) of the Ministry of Agriculture of Burkina Faso enabled the identification of areas of high pepper production, and the communication with the respondents during the survey was facilitated by an interpreter. Data were collected through individual and semi-structured interviews with people who had been growing chillies for at least one season. For this purpose, a survey form was drawn up and administered. It included information on the identity of the people surveyed, the management of chilli plots and fruit and seed conservation techniques, production constraints, the interest of the crop and the needs of producers. In addition to this information, direct observations were made in the growers' fields to describe the management methods used to grow chillies. The geographical coordinates of each location were taken using a GPS device, and a camera was used to capture the images.

2.2. Data Analysis

The data collected was entered, processed and analyzed using Excel 2016 spreadsheet software. ArcGIS 10.8 software was used to map the areas of data collection, based on geographical coordinates recorded in the field. R software with the Rcmdr package was used to calculate frequencies and to produce graphs.

3. Results

3.1. Socio-Demographic Profile of the Survey

A total of 384 producers were surveyed, including 119 in the Southern Sudan sector, 182 in the Northern Sudan sector and 83 in the Sub-Sahelian sector. The majority of these producers (92.19%) were men, compared with 7.81% of women. These respondents belong to 15 ethnic groups, the majority of which are Mossi (59.89%), followed by Gourounsi (12.24%), Dagara (10.67%), Bwaba (4.69%), Karaboro (4.43%), Goin (2.6%), Sambla (1.56%) and Bobo (1.04%). The other ethnic groups represented a minority (less than 1% of respondents): Sénoufo, Birifor, Samo, Toussian, Dafing, Lobi and Peulh.

The producers were aged from 17 to 77, with an average of 41 years old. The ages were divided into three groups: adult age group (35 < age < 60) (60.68%), whose 57.55% of men and 3.13% of women, young people (17 < age < 35) that represented 34.11% of the producers surveyed and comprising 30.47% of men and 3.64% of women. The least represented age group (5.21% of growers, including 4.95% of men and 0.26% of women) was the elderly (age > 60) (Figure 2). As for their experience in chilli production, the majority (71.27%) have less than 10 years' experience. The most numerous are those with less than five years (37.08%), followed by those with between six and 10 years' experience (34.19%) (Figure 3). Among the respondents, the oldest pepper producer has 42 years' experience, while the youngest has one (01) year experience. The overall average number of years of experience in chilli production is 9.01 years.

3.2. Local Pepper Nomenclature and Naming Criteria for Pepper Cultivars

Chillies are known by various names in the study area (Table 1). In Gourounsi, it is known as "Nandjoua", in Moré as "Tiparé or Kiparé", in Dagara as "Samane or simane", in Peulh as "Kam-biguè" and in Samo as "kirimou or Kirimon". All the growers surveyed (100%) mainly use morphological fruit characteristics such as color, size, flavor and fragrance to differentiate their cultivars. The most commonly used characteristics are fruit size (53%) and flavor (41% of respondents) (Table 1). In addition to these criteria, plant height and seed origin are also used by a minority of respondents (0.21%) in the Mossi and Gourounsis ethnic groups. These include the names *piment de Tambolo* (a locality in the Nahouri province) and Kiparinwobgo, which means "*elephant pepper*" in the Moré language.

3.3. Cultural Practices and Management of Chilli Pepper (Capsicum sp.) Cultivation

3.3.1. Chilli Pepper Seed Production Methods

During the surveys, three methods of obtaining seeds were identified: self-production by direct selection in the field, purchase and donation. Self-production by massal selection at farm level is the main method practiced by chilli pepper growers in all the provinces covered by the study (80.91% of respondents). From this method, seeds are harvested from all production rows. Selection of seeds starts during the vegetative stage of plants development (at mid-production) through an identification of plants on which harvest will be done (49.79%), during the first harvest (23.04%), or at the end of production (22.63%) or at any time during production (4.53%).

Most of the growers (81.13%) harvest seeds from vigorous and apparently healthy plants. Others use seeds that have fallen onto tarpaulins during drying or when fruit is displayed for sale at the market (19.87%). For 55.18% of the respondents, seeds are purchased either at markets or seed stores, or from other growers. Thus, according to the respondents, the varieties named *Sassé* and *Oraba* are from Ghana origin, and the varieties *Sent bon, jaune* of Burkina and *Piment rouge* or *piment de Tambolo* are from local companies' varieties (Nankosem, Boutapa Sarl, Sigri semences etc.). The acquisition of seed by donation (0.78% of respondents) is only practiced in two provinces, Yatenga and Sanmatenga. Seeds are either donated in the form of dry seeds or as nursery plants. Most of the time, growers (36.20%) combine self-production and purchase when renewing their seed.

3.3.2. Chilli Pepper Cropping Systems and Production Periods

Ethnobotanical surveys revealed that chilli is generally produced under rain-fed or irrigated conditions. It is grown on market garden sites or in open fields. More than forty-five percent (45.57%) of the respondents grow chillies during the rainy season, compared with 37.50% in the dry season. Only 16.93% of the respondents grow it at any time of year. Chillies are grown in gardens or open fields, either as a monoculture (87.24% of the respondents) or as a combined crop (12.76% of the respondents). The intercropping is more common in the wet season (46.27%). the crops associated with chilli are tomato, onion, eggplant, cucumber, sorrel, okra, maize, cowpea, papaya, lettuce and moringa. Maize and cowpea are the most frequently combined (22.90%), followed by onion (15%) and sorrel (12%).

3.3.3. Area Farmed and Production Cycle of Chilli Pepper

Data analysis shows that the area planted with chillies varies from 100 m^2 to 2 ha. Most of the growers (92.65%) farm less than half a hectare, and 71.92% on areas of less than a quarter of a hectare. As far as the cultivar cycle is concerned, growers assess it from the transplanting date of seedlings raised in the nursery for one month. Thus, depending on water availability, the chilli production cycle in the study area varies from three to 10 months after sowing. For long-cycle cultivars, the vegetative phase takes place in the rainy season and the reproductive phase in the dry season in irrigated areas.

3.3.4. Chilli Pepper Plot Maintenance Practices by Respondents

According to the growers surveyed, seedlings are sown in nurseries and transplanted between 30 and 60 days after sowing. Plot maintenance is carried out from nursery to harvest, and includes weeding, ridging, fertilization and phytosanitary treatments. In the nursery, 59.75% of growers use organic fertilizer, 75.93%, NPK, and 59.34% both fertilizers. Once the seedlings have been transplanted onto the plot, weeding and ridging are carried out as required. As fertilizers, in addition to organic fertilizer and NPK, urea is used by 68.05% of growers at average doses of 1.03 tons per hectare (T/Ha) at the seedling and flowering stage, applied at two weeks interval. NPK is generally applied two weeks after transplanting and repeated every two weeks until the end of harvest, at an average dose of 1.83 T/Ha. For pest attacks management, 84.29% of the growers use chemical products of all kinds, against a minority (8.41% of growers) who use organic products. On the other hand, 7.3% of respondents claim not using any treatments. As biological control, 85.71% of the surveyed people use Neem (*Azadirachta indica*) extracts and 14.29% use ash. As for chemical control, the main molecules and formulations used during phytosanitary treatments are listed in Table 2. These molecules include products not registered by the Sahelian Pesticides Committee (CSP).

3.3.5. Harvest and Post-Harvest Treatments of Chillies

The results of the survey showed that the harvest of chilli starts in the second and fifth month after transplanting for early and late varieties respectively. Harvest operations is generally done by hand, and can last up to 3 to 4 months or more, depending on the availability of water in the field. Thus, 4.56% of respondents harvest their chillies twice a week, 59.75% once a week, 17.84% every ten days, 16.60% every two weeks and 0.83% each three weeks' interval.

After harvesting, chillies are sold fresh or dried. Drying is either traditionally done by exposition of fruits under shade followed by permanent manual tossing (1.47%), either directly exposed to the sun (94.12%), or by blanching (soaking in boiling water) before exposure to the sun (4.41%). The dry chillies obtained are then packed in bags and stored outside the households for conservation and marketing.

3.3.6. Chilli pepper Seed Preservation Technique

After harvesting and drying, the seeds are stored in form of fruit or seed. Seed storage in whole fruit form practiced by 7.15% of the surveyed growers consist of fresh fruit drying under shade before storing in jars, canaries or bags. However, seed storage in form of single grains (81.33% of growers) consist of extracting the seeds from the fruit and packing them in insecticide cans or boxes (30.41%), in bottles (12.24%), boxes (1.53%) or in pieces of loincloth (9.18%), then hanging them on the roof of the house. Plastic bags (40.30%) and other containers (6.14%) are also used for seed conservation (Figure 4).

2.3.7. Constraints to Chilli Pepper Production

Eleven constraints related to chilli cultivation were listed by growers (Figure 5). The most frequently cited were the high cost of inputs (83, 90%), diseases and pests (58.2%), and lack of water during the dry season (36.84%). Soil

low fertility, price fixing by buyers, lack of mastery of the chilli production technical itinerary, and difficult access to micro-credit are as well among the difficulties that hamper chilli production according to the respondents.

3.3.8. Growers' Requirements about Chilli Seed

The expectations of the growers surveyed about chilli's improved seeds varied from a respondent to another (Figure 6). However, the majority of the growers expressed the need of varieties with large fruit (64.71%), disease and pest resistance (61.76%), short cycle (35.29%), very hot taste (38.24%) and with high yield (32.35%).

4. Discussion

Chilli cultivation in Burkina Faso is practiced in all the provinces and during both rainy and dry seasons, thanks to its adaptation to a wide range of pedoclimatic conditions [2, 7]. However, as water is a major limiting factor for vegetable crops, chilli is widely grown in the rainy season than in the dry season during which water is only available thanks to dams, boulis and boreholes. Chilli is a crop mainly grown by men to the detriment of women because of its high market value [8], the socio-cultural and socio-economic organization of activities in Africa Komlan, *et al.* [9]. Elsewhere, it low production by women can be attributed to their difficult access to land for crop production and their reduced availability during the harvest period. Growers use seed acquisition methods or practices that are widely known and traditionally established. These practices for seed acquisition are observed for various crops such as *Abelmoschus esculentus* L. (Okra) [10], Amaranthus sp. (Amaranthus) [11] and *Hibiscus Sabdariffa* L. (Guinea sorrel) [10]. In these modes of acquisition, the purchase is more common, and this is linked to the fact that the improved vegetable seeds available are generally hybrids, whose the agronomic performance diminishes after three years of use. Others buy nursery stock because they have not mastered seedling production techniques, or to fill in the delay in starting up. In addition, as the production is done in small area, some growers prefer buying seedlings directly available at any price than seeds, usually expensive, unavailable and packaged in small quantities. In the production process, several operations and agricultural practices are used to guarantee good yields and product quality. The quantities of fertilizers used for chilli plants at field using such as organic manure, NPK and urea fertilizers depend on the purchasing power of the grower (since, according to them, difficult access to credit is a constraint), but also on the availability of water, which lengthens or shortens production season. Thus, the longer the season, the greater the quantities of fertilizers to be used, and the higher the harvest. The absence of a marketing loop leads the fixation of the price by the customer. After harvest, producers experience the constraints of the unsold quantities storage. Unsold products are dried using blanching techniques (soaking using hot water) [7, 12, 13] to speed up the direct sun-drying process. For Weil [14], this process has little impact on pungency, cleans and reduces diseases and insects propagation, major constraint and the crop at phenological stages [15], [16]. That technique also limits enzymatic browning and affects fruits color. Seeds, on the other hand, are sun-dried and stored in various materials such as cans, bottles, sachets, boxes and pieces of cloth, as reported by Ellis, *et al.* [17] Segnou, *et al.* [8] and Kiebré [18]. The use of these instruments is related to the quantity and types of seed (whole fruits or seeds) [19, 20]. According to Fao [21], the choice of the storage material is also linked to storage times; glass materials (jars, bottles) are more suitable for long-term storage than plastics; fabrics being suitable for very short storage times. The producers surveyed use this technique for a storage during a maximum period of six (6) months. However, the seed collected through massal selection at field may contain germs and spread to the plots when the collection is done from infested plants. For cases of plants infestation by pests at field, several families of pesticides are used by the respondents through chemical control, that remains the most effective for market gardeners in the short term. However, the use of these pesticides at the recommended doses, can lead to pest resistance and the appearance of new pests in a context of climate change; in addition, the use of non-approved pesticides for use on market garden crops can affect the quality of the harvested products and reduce its economic value. Botanical pesticides are also an alternative method used by producers to control insects. the efficacy of Neem (*Azadirachta indica*) extracts used by producers has been shown by Lawal, *et al.* [22] in management of Aphids. This inexpensive method could help small producers to minimize production costs and guarantee healthy product to consumers.

5. Conclusion

Peppers are grown by men in irrigated and wet-season conditions, either in monoculture or in association with other crops. Seeds are mostly purchased or renewed by massal selection during three (3) years of use. Growers use different cultural practices to increase yields of productions. Several constraints affect the crop, which need to be addressed for perform chilli production. Therefore, it would be necessary to provide growers with suitable germplasm. Trainings of the growers on the technical aspects of pepper production and their organization in cooperatives is necessary for increasing productions performance and for acquiring credit and prices.

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Figure-1. Location of ethnobotanical survey on pepper in Burkina Faso

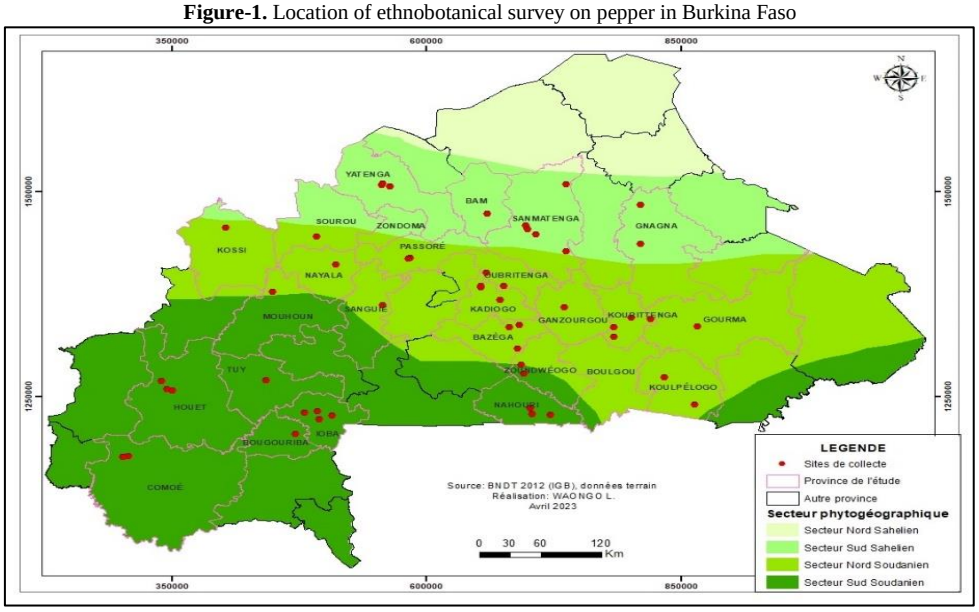


Figure-2. Proportion of respondents by age group and gender

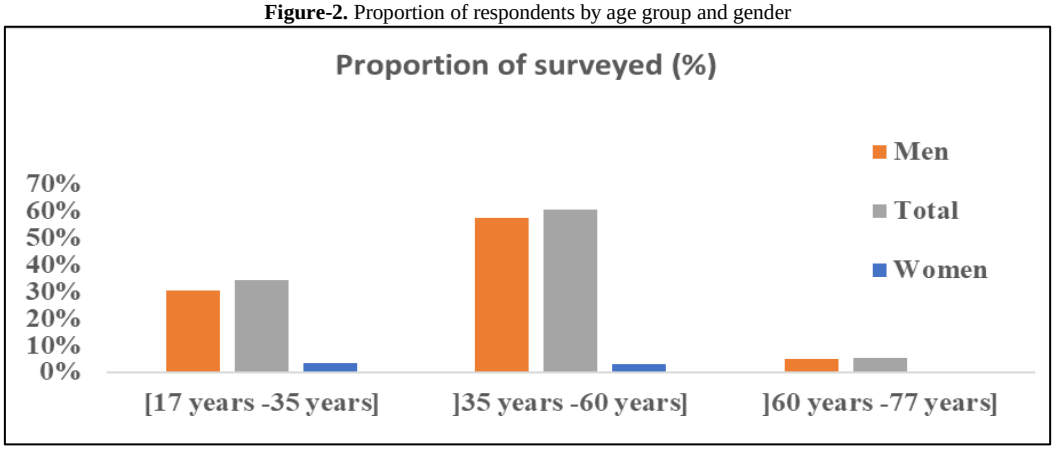


Figure-3. Proportion of respondents by experience of chilli production

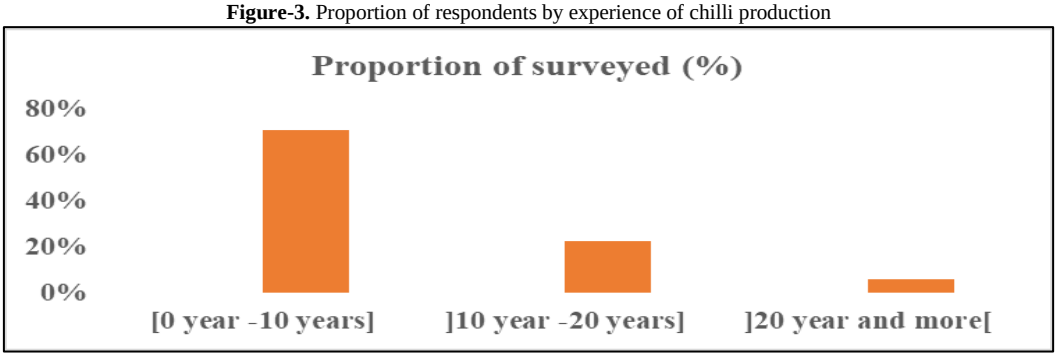


Figure-4. Preserved chilli seeds. (a) in cloth (seed), (b) can (seed), (c) bag (fruit) and (d) sachet (seed)

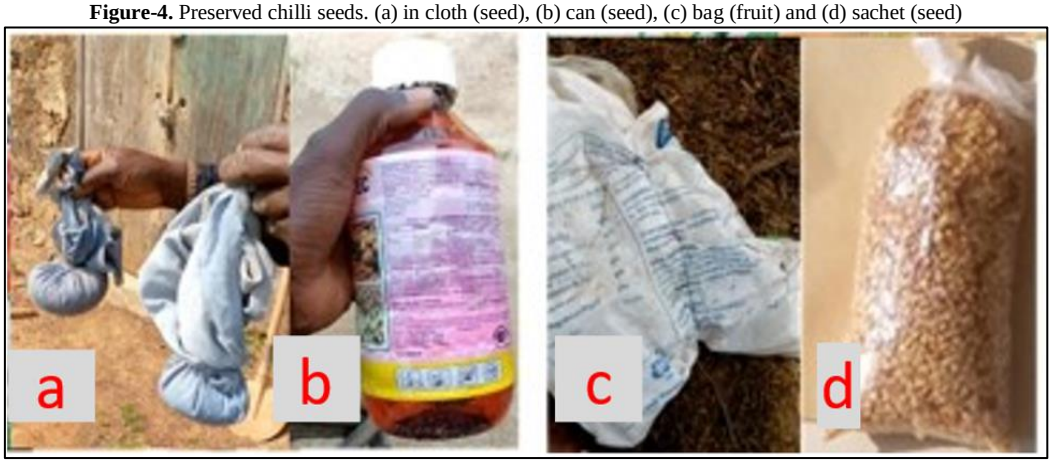


Figure-5. Pepper production constraints according to interviewers

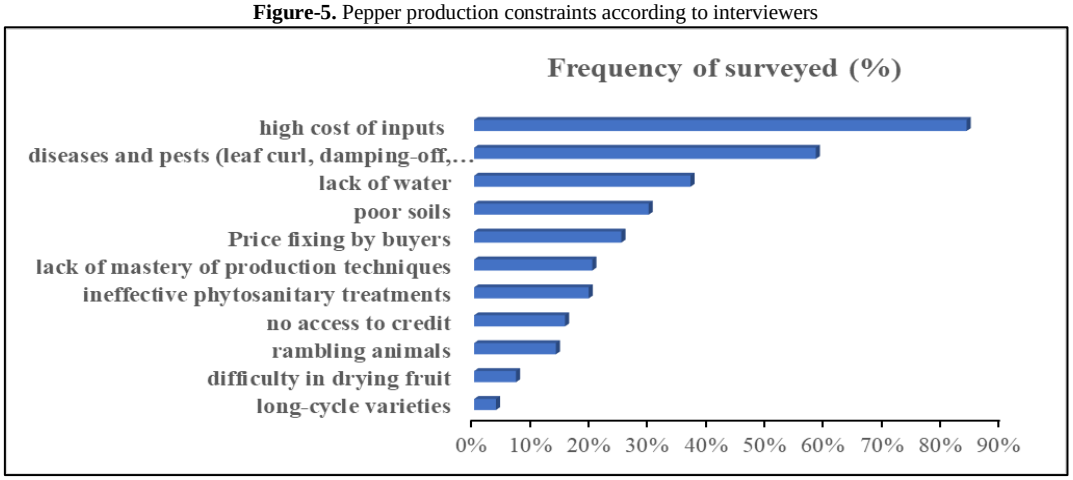
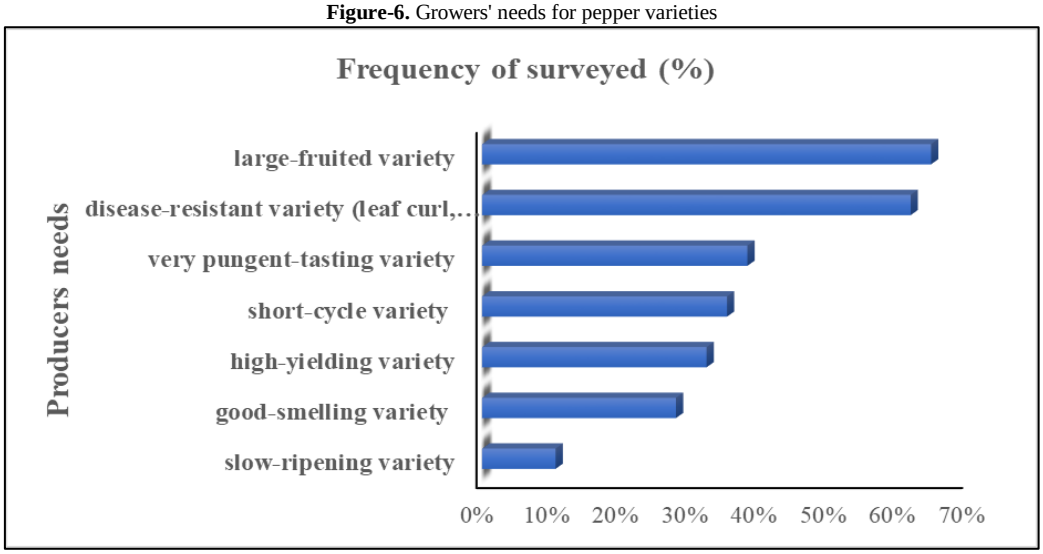


Figure-6. Growers' needs for pepper varieties



LIST OF TABLE

Table-1. Local pepper nomenclature

Ethnic groups	Generic nomenclature	Specific nomenclature	Signification
Birfor	Dayirè ou Saman	Bouralé	Goat testicle
Lobiri	Dayira	Dayèlé	Hot pepper
Bobo	Foronto, Foroto		Hot pepper
Dioula		Soubaga foroto	Very hot pepper or witch pepper
Senoufo		Foroto bani,	Hot pepper
		Foroto ba	Big pepper
Bwaba	Kipani	Kpepini	Big pepper
Dafing	kani	Foroto bani	Big pepper
Dagara	Samane, simane	Simane millet	Small pepper
Gourounsi	Gnamoin, Namiguio Nadjoua	Sassé, oraba	Hard-skinned pepper
Mossi	Kiparé or Tiparé,	Kambi,	Small pepper
		kiparinbônogo	Small pepper
		Kiparinpèlega	White pepper
		Kiparinwobgo	Elephant pepper
		Foroto	Big pepper
		Kiparinsablega	Black pepper

Table-2. Phytosanitary products used by growers

Commercial names	Active substances	Number of citations	Frequency (%)
Tihan 175 O-TEQ	Spirotetramate 75g/l+Flubendiamide 100g/l EC	18	4.69
Emacot 050 WG	Emamectine benzoate 50g/Kg WG	154	40.10
Pacha 25 EC	Acétamipride (10 g/l)+Lambda-cyhalothrine (15 g/L°	143	37.24
K-optimal	Acélamipride (20 g/L)+Lambda-cyhalolhrine (15 g/L)	35	28.65
Mancotop 800WP	Mancozeb (800 g/kg)	57	14.84
Emaba	Emamectine benzoate 20g/l+Abamectine 20g/l EC	32	8.33
Bomec 18 EC	Abamectine 18g/l EC	56	14.58
Emapyr	Emamectine benzoate 20g/L+Pyriproxylene 60g/l EC	37	9.64
SAVAHLER	Méthomyl 250g/kg	70	18.23
TARZAN 480 EC	Liquid 60g/l	16	4.17
Attack	Téfluthrine 200g/l	23	5.99
Duel 186 EC	Profenofos 150 g/L+Cypermethrine 36 g/l EC	13	3.39
Manga plus	Macrocebe 800g/kg	16	4 .17
Veto 30 EC	Deltméthrine 10g/l+Acétamipride 20g/l EC	13	3.39
Belt Expert	Flubendiamide 100g/l +Thiacioprid 240g/l SC	11	2.86
Zebra 800 WP	Mancozèbe 800g/Kg WP	10	2.60
Thalis 56 EC	Emamectine benzoate 24g/l + Acétamipride 32 g/l	25	6.51
Caïman B19	Emamectine benzoate EC 19,2g/l	79	20.57
Benji	Acétamipride SP 250g/kg	102	26.56