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Analysis of Certain Aspects of the Production System and Methods Used by Farmers in Togo to Manage Soya Pests

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ABSTRACT **Original Research Article**

In Togo, there is a lack of data on the soya production system and strategies for the sustainable management of soya pests. The objectives of this study are to analyse certain aspects of the organic and conventional soya production systems and to identify methods for managing pests in three prefectures in Togo. To achieve these objectives, a survey was conducted amongst 233 soya farmers (139 organic and 94 conventional soya producers) using a questionnaire designed for this purpose, combined with a semi-structured interview. The results showed that the average area sown per farmer was 1.96 ± 1.03 hectares for organic soya and 2.86 ± 2.45 hectares for conventional soya. The proportion of soya plots infested by insect pests was 37.67 ± 14.84% for organic farming and 26 ± 12.73% for conventional farming. Average yield losses are estimated at 25 ± 8.19 per cent for organic soya and 16 ± 10.54 per cent for conventional soya. Farmers are familiar with bioinsecticides and believe that pesticides help to increase productivity. These results represent an important contribution to the development of strategies for the sustainable management of soya pests.

Keywords: Surveys, Organic Farming, Conventional Farming, Pest Management.

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Introduction

Soya (*Glycine max* (L.) Merril., 1917) is an annual legume belonging to the Fabaceae family. It is a fast-growing plant with high nutritional value that plays an important role in global food supply (Tidjani et al., 2023). Soya is also a sustainable food source for both humans and animals (Couto et al., 2011; Zongo, 2013; Ollabode et al., 2017). It commands a high price on the world market (Abbasi et al., 2010). Soya can be grown under a wide variety of environmental conditions, which means it has the potential to play a vital role in combating food insecurity globally (Badini, 2017), in the sub-region and at the national level in particular. To alleviate this insecurity, the population is turning to the cultivation of this high-yielding legume. Unfortunately, soya farmers face numerous constraints, particularly those related to insect pests, and so resort to synthetic insecticides. However, these chemical pesticides are toxic and harmful to the farmer, do not promote sustainable agriculture, and are the subject of considerable debate (Samuel and Saint-Laurent, 2001). To avoid these harmful consequences, it is imperative to find alternative means of effective and efficient management of soya pests based on alternative methods. Thus, plant-based bioinsecticides have the advantage of being environmentally friendly, biodegradable and generally less hazardous to human health (Mboussi et al., 2018).

The objective of this study is to contribute to our understanding of the soya production system in Togo. Specifically, the aim is to: (i) analyse certain aspects of the organic and conventional soya production systems; and (ii) determine the methods used to manage pests in soya cultivation across three prefectures in Togo.

Materials and Methods

Survey Areas

Three prefectures in different regions – Dankpen Prefecture (Kara Region), Tchamba Prefecture (Central Region) and East Mono Prefecture (Plateaux Region) (Figure 1) – were the subject of the surveys. Thus, two ecological zones were covered by this survey. Dankpen Prefecture falls within Ecological Zone I, which has a semi-humid climate with a single dry season, whilst Tchamba and East - Mono prefectures fall within Ecological Zone III, which has a Sudano-Guinean tropical climate. The municipalities, cantons and villages within the surveyed prefectures were selected on the basis of the total annual soya bean production in Togo. The survey instrument consisted of a questionnaire administered to the various stakeholders involved in soya production. Based on the literature review, a catalogue of pests was compiled and presented to each producer surveyed to obtain their views on whether or not the different pests were present.

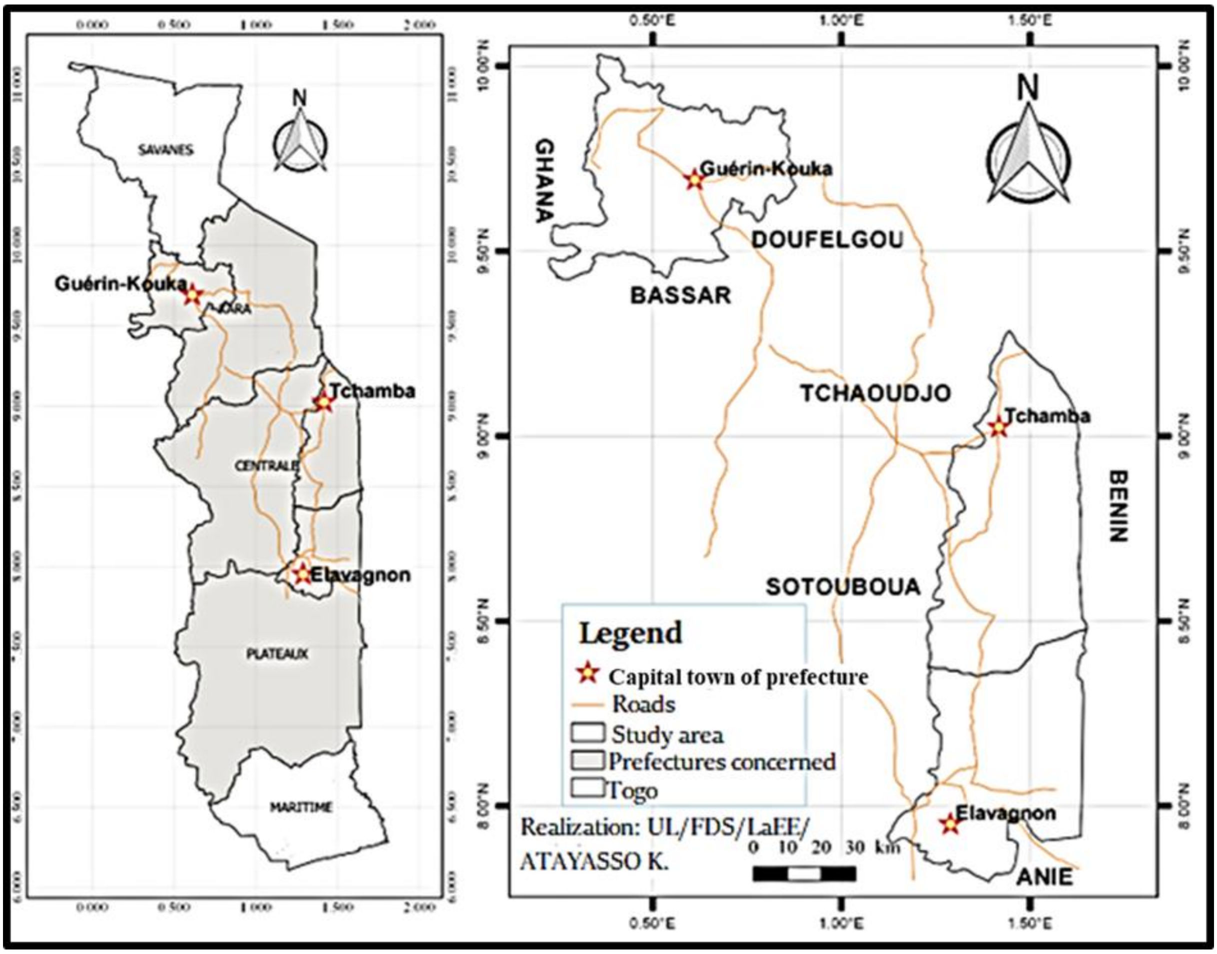

Figure 1 : Data collection sites in Togo

Conduct of the Survey

In the study area, the survey was carried out from July 2024 to January 2025. This period coincides with the soya production and soya bean harvesting seasons. The data collected during the survey focused on the socio-demographic characteristics of soya farmers, the area under cultivation, constraints related to soya production, damage caused by insect pests, yields, pesticides used for pest control, and farmers' perceptions of the use of bioinsecticides, with a view to establishing a strategy for the integrated management of soya pests in Togo. Each farmer was interviewed individually.

Data Analysis

The data collected were entered into Excel and then analysed using PAST version 4.0. The various parameters studied were analysed after cross-tables had been generated using Excel.

Results

Soya Production System

Socio-Demographic Characteristics of Soya Farmers

The data collected from soya farmers on their socio-demographic characteristics, soya production and their understanding of pesticide use enabled an analysis of the production system.

In total, a sample of 233 soya producers, comprising 94 conventional soya producers and 139 organic soya producers, was surveyed.

Tables 1 and 2 show the distribution of producers by age and gender. The respondents' ages ranged from 17 to 70 years, and men were in the majority (over 85%). Among organic soya farmers, those aged between 31 and 40 years were the largest group, accounting for 44.6% of the sample surveyed (Table 1). They were followed by those aged between 17 and 30, 41 and 50, 51 and 60, and 61 and over, accounting for 22.3%, 20.86%, 8.63% and 3.6% of the total sample respectively.

Table 1: Breakdown of organic soya producers by age and gender

Age group	**Men**	**Women**	**Total**	**Percentage (%)**
17 to 30 years	29	2	31	22.3
31 to 40 years	52	10	62	44.6
41 to 50 years	25	4	29	20.86
51 to 60 years	9	3	12	8.63
61 to 70 years	5	0	5	3.6
Total	**120**	**19**	**139**	**100**
(%)	**86.33**	**13.67**	**100**	

Among conventional soya producers, those aged between 41 and 50 were the largest group, accounting for 30.26% of the sample surveyed (Table 2). This age group was followed by those aged between 31 and 40, those under 30, those aged between 51 and 60, and those aged 61 and over, accounting for 27.63%, 21.05%, 14.47% and 6.58% of the sample surveyed, respectively.

Table 2: Breakdown of conventional soya producers by age and gender

Age group	**Men**	**Women**	**Total**	**Percentage (%)**
17 to 30 years	19	0	19	21.05
31 to 40 years	18	8	26	27.63
41 to 50 years	25	4	28	30.26
51 to 60 years	12	3	15	14.47
61 to 70 years	6	0	6	6.58
Total	**80**	**14**	**94**	**100**
(%)	**85.11**	**14.89**	**100**	

The level of education amongst the soya farmers surveyed is very low (Tables 3 and 4). Among organic soya farmers, the highest level of education is secondary school (38.13%), followed by primary school (29.50%), illiterate individuals (19.42%), university level (7.19%) and those who are literate (5.76%) (Table 3). Sixty-eight per cent (68%) of women have an educational level at or below primary school, whilst 47% of men have an educational level at or above secondary school.

Table 3: Breakdown of organic soya producers by educational level

Educational attainment						**Total**
Gender	**Illiterate**	**Literate**	**Primary**	**Secondary**	**University**	
	Number (%)	**Number (%)**	**Number (%)**	**Number (%)**	**Number (%)**	**Number (%)**
Female	3 (15.79)	3 (15.79)	7 (36.84)	6 (31.58)	0 (0)	19 (100)
Male	24 (20)	5 (4.17)	34 (28.33)	47 (39.17)	10 (8.33)	120 (100)
Total	**27 (19.42)**	**8 (5.76)**	**41 (29.50)**	**53 (38.13)**	**10 (7.19)**	**139 (100)**

Table 4: Breakdown of conventional soya producers by level of education

Educational attainment						**Total**
Gender	**Illiterate**	**Literate**	**Primary**	**Secondary**	**University**	
	Number (%)	**Number (%)**	**Number (%)**	**Number (%)**	**Number (%)**	**Effectif (%)**
Female	1 (6.67)	5 (33.33)	5 (33.33)	4 (26.67)	0 (0)	15 (100)
Male	13 (16.46)	5 (6.33)	25 (31.65)	31 (39.24)	5 (6.33)	79 (100)
Total	**14 (14.89)**	**10 (10.84)**	**30 (31.91)**	**35 (37.23)**	**5 (5.32)**	**94 (100)**

Among conventional soya producers, 14.89% were illiterate, 10.84% were literate, 31.91% had completed primary education, 37.23% had completed secondary education and 5.32% had a university education. Seventy-three per cent (73%) of women in the sample of conventional soya producers have an educational level of or below primary school, whilst 43% of men have an educational level of or above secondary school (Table 4).

The marital status of the soya producers in the sample surveyed (Table 5) showed a high proportion of married producers (85.61% for organic soya producers and 88.30% for conventional soya producers). The single producers accounted for 12.95% in organic farming and 9.67% in conventional farming. In this sample, widowers and widows accounted for 1.44% of organic soya farmers and 1.06% of conventional soya farmers. Divorced farmers made up 1.06% of conventional soya farmers and 0% of organic soya farmers (Table 5).

Table 5: Breakdown of surveyed organic and conventional soya producers by marital status

Marital status of the producers surveyed	Organic soya		Conventional soya	
	Number	(%)	Number	(%)
Single	18	12.95	9	9.67
Divorced	0	0	1	1.06
Married	119	85.61	83	88.3
Widowed	2	1.44	1	1.06
Total	**139**	100	**94**	100

Soya Production in the Prefectures Covered by the Study

Soya growers have gained extensive experience in this sector. The percentage of organic soya producers who have been in the business for less than 5 years is 16%, whilst those with 5 years' experience or more account for 84% (Table 6). The average number of years' experience in organic soya production among respondents was 23.17 ± 18.44 years. In contrast, the percentage of conventional soya producers who have been in this line of work for less than 5 years is 11%, whilst those with 5 years' experience or more account for 89% (Table 6). The average number of years' experience among the sample surveyed was 15.67 ± 13.99 years. The average area of soya cultivated by the sample surveyed was 1.96 ± 1.03 hectares for organic soya fields and 2.86 ± 2.45 hectares for conventional soya fields (Table 7).

Table 6: Farmers' experience in soya production

Number of years' experience	Organic soya producers		Conventional soya farmers	
	Number	%	Number	%
0 - 4 years	21	16	9	11
5 - 9 years	53	41	41	44
10 - 14 years	33	26	17	18
15 - 19 years	23	18	19	20
20 - 24 years	7	5	6	6
25 - 29 years	2	2	2	2
Total	**129**	**100**	**94**	**100**
Average	**23.17**		**15.67**	
Standard deviation	**18.44**		**13.99**	

With regard to proportions, Table 7 shows that 100% of organic soya farmers and 82% of conventional soya farmers report that pests are a major constraint in their various fields. The percentage of plots infested by pests is 37.67 ± 14.84% for the organic farmers surveyed and 26 ± 12.73% for the conventional farmers surveyed.

As for losses, the average yield losses suffered by organic soya producers are estimated at 25 ± 8.19%; by contrast, for those producing conventional soya, they stand at 16 ± 10.54% (Table 7). Organic soya producers suffer greater yield losses than their counterparts practising conventional farming.

Table 7: Area under soya cultivation by farming type and proportions

Types of farming	Number of producers surveyed	Average field area (ha)	Proportion (%) of producers who cited pests as their main constraint	Average proportion of infested fields (%)	Average yield loss in the field (%)
Organic soya	139	1.96 ± 1.03	100	37.67 ± 14.84	25 ± 8.19
Conventional soya	94	2.86 ± 2.45	82	26 ± 12.73	16 ± 10.54

The main pests observed on the crop were predominantly insects (Table 8). These included locusts, caterpillars, bugs, ladybirds, leafhoppers and the larvae of certain beetles. Nematodes (roundworms), molluscs (snails) and fungi were also observed on the soya crop (Table 8). These pests attack the crop and cause various types of damage to different organs or parts of the plant, depending on the species of pest.

The survey of farmers identified the synthetic pesticides used to reduce damage or eliminate pests on the plant. The pesticides used by farmers are mainly insecticides and nematicides. Growers do not use any pesticides to control fungal infestations of the plant (Table 8). The insecticides used by the growers surveyed are: Sniper ddvp 1000 g/l EC (dichlorvos), Kilambda-cyhalothrin (lambda-cyhalothrin 25 g/l), Lion Power 315 EC (profenofos 300 g/l + lambda-cyhalothrin 300 g/l), and Lakter 25 EC (lambda-cyhalothrin 25 g/l). However, the nematicide, Nabohu (1, 3-dichloropropene), is the only one used by the respondents.

Table 8: Main pests encountered by farmers on conventional soya crops, the damage they cause and the pesticides used to control them

Pests	Plant parts affected	Damage	Pesticides used
Locusts	Leaves and stems	Chewing damage to leaves and stems	Sniper ddvp, Kilambda-cyhalothrin, Lion power, Lakter,
Caterpillars	Leaves, flowers, immature pods	Leaf punctures, shedding of immature pods, loss of leaves and flowers	Sniper ddvp, Lakter, Kilambda-cyhalothrin
Larvae of certain beetles	Leaves, flowers, pods	Holes in leaves and pods; pods falling off	Kilambda-cyhalothrin, Sniper ddvp
Roundworms	Roots	Nodules on roots; wilting and deformation of leaves, pods and roots; stunted growth followed by rotting of the plants	Nabohu
Leafhoppers	Seedlings	Stunted plants, pale spots on leaves, embossed leaves and leaf drop	Sniper ddvp, Lakter, Kilambda-cyhalothrin
Ladybirds	Leaf blades	Defoliation and feeding on leaf blades	Sniper ddvp, Lakter, Kilambda-cyhalothrin
Molluscs	Germinating seeds, young plants	Gnawing on the radicle and hypocotyl, loss of leaves, severing of the seedling at the base leading to its death	Lakter, Kilambda-cyhalothrin
Fungi	Leaves, stems	Wilting, yellowing and rotting of plants	-

Soya Farmers' Perceptions of Pesticide Use

Analysis of Table 9 shows that 77.25% of the farmers surveyed who were familiar with medicinal plant extracts stated that these extracts can be used to spray soya crops for pest control. Only 22.75% of farmers did not state this.

Table 9: Farmers' perceptions of their knowledge of biopesticides

Prefectures of respondents	Farmers' knowledge of the use of biopesticides in soya cultivation				Total number
	Yes		No		
	Numbers	%	Numbers	%	
Dankpen	79	73.14	29	26.85	108
East - Mono	29	72.5	11	27.50	40
Tchamba	72	84.7	13	15.29	85
Total	**180**	**77.25**	**53**	**22.75**	**233**

With regard to the need for using pesticides, 57.08% of farmers in the areas surveyed felt that it was necessary to use chemical pesticides as these enable high productivity (Table 10).

Table 10: Breakdown of farmers according to their perception of whether or not pesticides are necessary

Prefectures	Necessity				Total number
	Yes		No		
	Numbers	%	Numbers	%	
Dankpen	95	87.96	13	12.04	108
East - Mono	26	65	14	35	40
Tchamba	61	71.76	24	28.24	85
Total	**133**	**57.08**	**100**	**42.92**	**233**

Farmers were asked for their views on the integration of biopesticides based on local medicinal plants into future integrated pest management programmes for soya at national and sub-regional levels. Figure 2 shows that 85.61% of organic soya producers and 80.85% of those practising conventional farming believe that biopesticides can contribute to better management of soya pests.

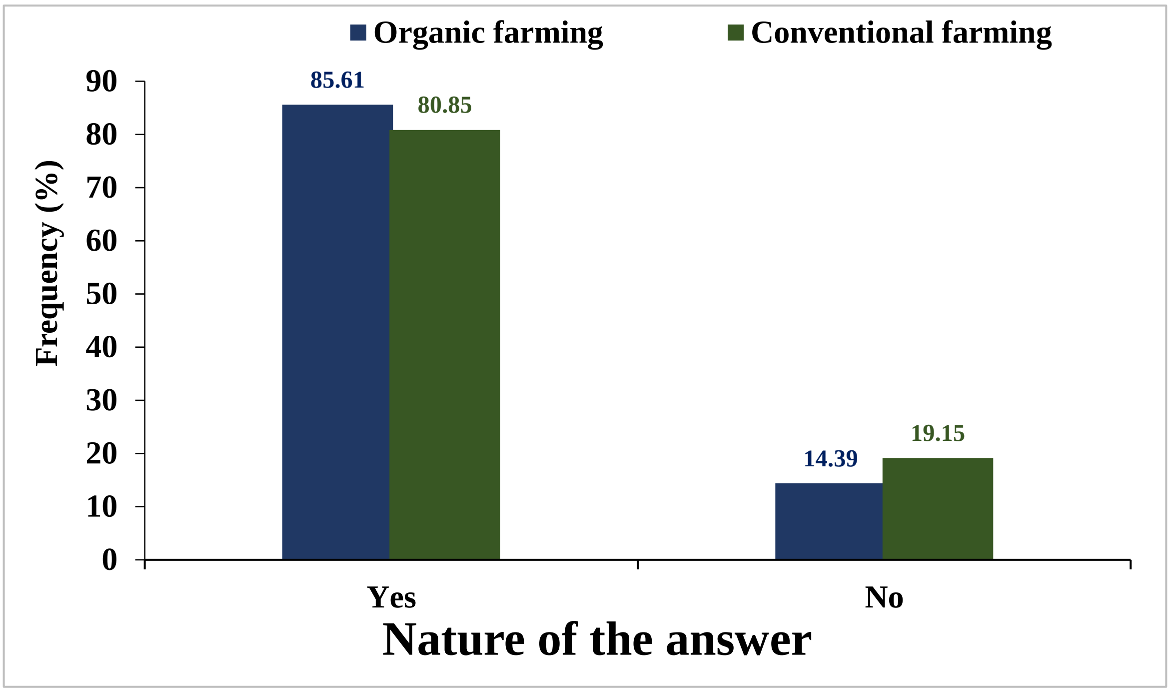

Figure 2: Proportion of producers who believe that soya pests can be controlled using biopesticides

Analysis of Figure 3 reveals that 80.58% of organic soya farmers and 74.47% of conventional soya farmers are willing to adopt the use of biopesticides provided they are effective and available at a reasonable cost.

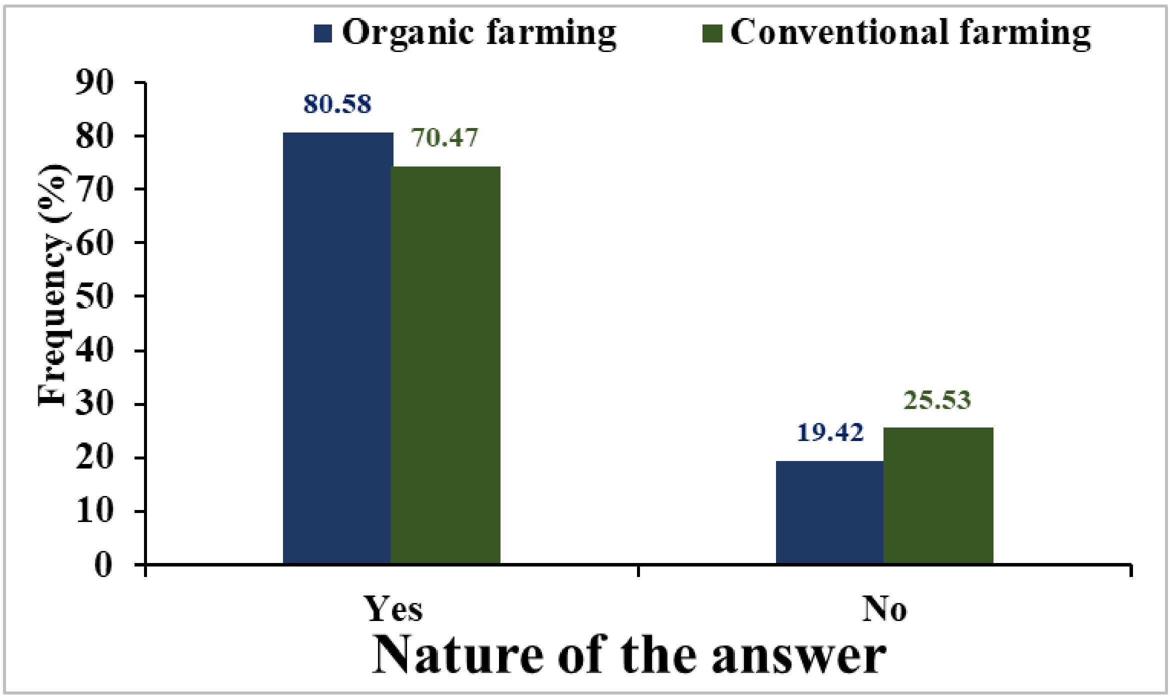

Figure 3: Proportion of producers willing to adopt biopesticides extracted from medicinal plants with insecticidal properties for the control of soya pests.

Discussion

In the various areas where the survey was carried out, soya producers are generally aged between 17 and 70. The survey revealed that the predominant age group among organic soya farmers is between 31 and 40 years, accounting for 44.6% of the sample, whereas those producing conventional soya are aged between 41 and 50 years (30.26%) of the sample surveyed. This suggests that soya producers are young and will continue to cultivate this crop for one, two or three decades (Houngnandan et al., 2015). Similar findings were reported by Dogbe et al. (2013) in Ghana, who concluded that soya production has a promising future if relatively young farmers can be encouraged to remain in the sector. Men predominate, accounting for over 85%. These findings can be explained by the fact that young people are better suited to agricultural work and that men are better equipped for field work than women. This high proportion of men may also be explained by the fact that field work generally requires a great deal of physical effort, which men are better able to exert (Mondedji, 2010). According to Ollabode et al. (2017), in Benin, agricultural work is the preserve of men. Furthermore, Saïdou et al. (2007) also revealed that this could be due to the fact that only men are landowners and can inherit land from their parents

The soya producers surveyed have a low level of education. Support from aggregators (in the form of credit) to the population may encourage farmers to drop out of school to take up farming. This may explain the low literacy rate in the areas studied. It could also reduce the adoption of improved agricultural technologies (Houngnandan et al., 2015). Indeed, Eze et al. (2006), Ofuoku et al. (2008) and Koskei et al. (2013) have indicated that literacy levels determine farmers' adoption of improved production technologies, as literate farmers are able to understand agricultural instructions more quickly than illiterate farmers.

Organic soya farmers have more experience than their conventional counterparts. This is because organic soya cultivation was practised using manual farming techniques (weeding, ploughing, etc.) long before the advent of cheaper inputs (herbicides) and the machinery used by conventional soya farmers. On the other hand, the areas under cultivation are larger in conventional soya fields than in organic ones. The use of agricultural inputs (insecticides, particularly herbicides, etc.) could explain this difference.

All organic soya farmers (100%) and 82% of conventional soya farmers considered pests to be a major constraint on crop output. Furthermore, organic soya farmers suffer greater losses than their conventional counterparts. This indicates that organic soya is more severely affected by pests, which may be due to the fact that no synthetic chemicals were applied. The main pests are insects (locusts, caterpillars, bugs, ladybirds, leafhoppers and the larvae of certain beetles). In Benin, Houngnandan et al. (2015) highlighted that insects are the main pests affecting soya. However, nematodes, molluscs and fungi are also present. These pests attack various crops and cause different types of damage to different parts of the plant, depending on the pest (Mondedji et al., 2015). As regards the control of these pests in conventional soya cultivation, synthetic pesticides are widely used to the detriment of organic pesticides. This is thought to be because the best-known and most widely adopted control method remains treatment with synthetic chemicals (Hoyer et al., 2002). The time required to produce biological pesticides is often considered too long, the number of treatments required too high, and the narrow spectrum of activity of these pesticides are some of the reasons that discourage their use by farmers (Adekambi et al., 2010). In terms of efficacy, the slow onset of their effects, their short residual activity and their very narrow spectrum of activity, compared with that of synthetic products, mean that biological pesticides are often less considered by farmers (Adekambi et al., 2010; Tounou et al., 2011). In Togo, according to the Plant Protection Directorate (DPV, 2022), there are as yet no registered biopesticides for use against soya pests. Only synthetic chemical pesticides are available (Kondow, 2023). The chemical pesticides used against pests of conventional soya include, amongst others, Sniper ddvp 1000 g/l EC (dichlorvos), Kilambda-cyhalothrin (lambda-cyhalothrin 25 g/l), Lion Power 315 EC (profenofos 300 g/l + lambda-cyhalothrin 300 g/l), Lakter 25 EC (lambda-cyhalothrin 25 g/l) and Nabohu (1,3-dichloropropene). These pesticides are not registered by the DPV. Farmers use them because they are affordable, readily available, fast-acting and easily accessible, unlike the authorised products. Producers are well aware that these synthetic pesticides are not recommended. Furthermore, they recognise the harmful effects these toxic chemicals have on their own health and on the environment. Despite this, they continue to use them.

The majority of farmers (77.25%) in the study area are aware of the use of biopesticides in the management of soyabean pests. Owing to the strong insecticidal potential of neem (Mondedji, 2010; Yarou et al., 2017), extracts from this plant are considered to be effective biopesticides that can be used for plant protection treatments in agriculture. Neem-based extracts are less toxic to humans and certain animals. They are effective against more than 200 insect species. Following ingestion by the insect, their active ingredients disturb the hormonal cycle in the organism leading to malformations during the moulting process and preventing its post-embryonic development and growth (Vallet, 2006; Mondédji et al., 2016; Kondow, 2023).

Around 57% of farmers in the surveyed areas considered it necessary to use chemical pesticides as they enable good productivity. The low level of education amongst farmers is thought to hinder a proper understanding of the risks associated with the use of chemical pesticides (Mondedji, 2010). This explains their surprise during the survey when they were informed, for example, that pesticides contaminate the water table (Mondedji et al., 2015).

Over 80% of farmers growing both types of crops in the surveyed areas believe that biopesticides can contribute to better management of soya pests. Indeed, this high level of support is thought to stem from farmers' knowledge of the potential benefits of plant-based biopesticides, such as the accessibility of the natural resource (raw material), their moderate toxicity, and their contribution to maintaining environmental (agrosystems) and human health.

Consequently, the use of plant-based biopesticides could prevent health problems (headaches, nausea, respiratory problems and other forms of severe poisoning) among farmers, consumers and animals, and preserve the environment (Mnif et al., 2011). The use of biopesticides contributes not only to the conservation of animal biodiversity but also to the preservation of soil properties.

Regarding the potential for using biopesticides, the survey results showed a higher proportion of organic soya farmers (80.58%) who approved the use of biopesticides compared with those practising conventional farming (74.47%). This may be explained by the fact that organic soya producers experience low yields or significant losses due to the lack of organic pesticides. Furthermore, Kondow (2023) found similar results regarding pests (leafhoppers) on cocoa trees, stating that a higher proportion of organic cocoa farmers endorsed the use of biopesticides compared to those practising conventional farming. This may be explained by the fact that they are the first to be affected by losses caused by mirid bugs and do not have access to organic products.

Conclusion

This study showed that soya farmers were aged between 17 and 70, with men making up the majority. Organic soya farmers were younger than those growing conventional soya. These farmers' level of education is low. Organic soya farmers had more experience in this agricultural activity than those growing conventional soya.

The main constraint facing farmers is the problem of pests, particularly in organic soya cultivation, leading to huge yield losses. However, some use biopesticides to control harmful insects. Many soya farmers (both organic and conventional) have expressed an interest in using biopesticides extracted from medicinal plants, as these are readily available, accessible, effective, less hazardous and reasonably priced.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Authors' Contributions

All authors contributed to this work. After reviewing this manuscript, all authors approved the final version.

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