Original Research Article

Farmers' perceptions of pesticide and chemical fertilizer use in market gardening in the Comoé river watershed in Burkina Faso

ABSTRACT

Aims: analyzing farmers' perceptions of the use of pesticides and chemical fertilizers in market gardening in the Comoé Province of Burkina Faso.
Place and Duration of Study: The present study was carried out in the watershed of the Comoé River located in Burkina Faso in the western part of Africa. The study covered the period from March 12 to May 25, 2019.
Methodology: An individual survey of a sample of 204 market gardeners using chemicals was conducted. It was supplemented by field observations. A survey form was designed and the questionnaire was integrated into an application (mWater) for data collection. The data collected was summarized by descriptive statistics.
Results: Study showed that vegetable producers almost unanimously say it is necessary to use fertilizers and pesticides on their production sites. Some producers (18.87%) well appreciate the use of fertilizers and pesticides on the sites. Nearly 94% also believe that the use of fertilizers improves soil fertility and helps to increase crop yields.
As for the precautions taken by producers in the use of pesticides, it emerges from the interviews with them that 96.57% of them do not use any protective equipment when applying pesticides. In general, after treating their farms with pesticides, vegetable growers wash themselves at water points and clean their equipment in the field. Of all the producers interviewed, nearly 58% wash themselves at water points while 41% do so in the field. Furthermore, almost all the market gardeners (96%) refer to the nearest medical centre in case of symptoms related to the use of pesticides.
Conclusion: with a view to the rational use of phytosanitary products and the safeguarding of the ecosystem, awareness-raising actions aimed at producers must be implemented.

Keywords: Pesticides, Farmer's perceptions, Environmental risk, Burkina Faso

1. INTRODUCTION

The abusive and irrational use of agricultural chemical inputs can have adverse effects on the environment and on human health according to annual statistical data published in developing countries. According to the [1] WHO (1991), nearly 1.5 million cases of pesticide poisoning, causing the death of several thousands of farm workers in sub-Saharan countries are reported.
Pest pressure was identified as being the major constraint on account of crop losses in market gardening [2,3]. As a result, in order to improve yields and meet the ever-increasing

market demand, producers use synthetic pesticides almost systematically ([3]. But yet, their harmful effects on humans and the environment were demonstrated [4,5,6]. It is observed that market gardeners use inappropriate insecticides and also that the methods of use, the lack of appropriate protective equipment for users and the storage conditions constitute aggravating risk factors for farmers and consumers [7]). Pesticides, by protecting market garden crops, make it possible to reduce losses of agricultural production, but their use presents serious risks for both humans and the environment [8].
The Comoé River Watershed (BVC) is an agrosystem where vegetable, sugarcane, cereal and cotton crops are expanding rapidly due to increased activities in the area. This raises a reflection on the management of fertilizers and pesticides to better promote a sustainable development that would permit the long term management and exploitation of the environment while maintaining and even improving the natural resources. Hence, the interest in conducting such an investigation in order to better understand farmers' perceptions of the use of pesticides and fertilizers in market gardening. The present study is aimed at analyzing farmers' perceptions of the use of pesticides and fertilizers in market gardening in the Comoé Province of Burkina Faso.

2. MATERIAL AND METHODS

2.1. Study area

The Comoé River basin is in the western part of Africa between longitudes 2°45 and 5°58 West and latitudes 5°10 and 10°29 North. It is drained by a 1160 km - long river that rises in the region of Banfora at an altitude of 420 m in Burkina Faso. It covers an area of about 78,000 km^2 and extends over the south-western region of Burkina Faso, the south-eastern parts of Mali and eastern part of Ghana, the northern, central and southern regions of Côte d'Ivoire.
The Burkina Faso portion of the Comoé River Basin has an area of 17,590 km^2, covering all or a part of the Comoé, Léraba, Kénédougou, Houet and Poni provinces. It is framed by latitudes 9°35' N and 11° 05' N and longitudes 3°30' W and 5°30' W. It comprises five (05) main sub-basins: the Comoé, the Léraba, the Kodoun, the Baoué and the Iroungou.

2.2 Sampling of producers

In the absence of a sampling frame of vegetable growers operating in the Comoé Basin, an empirical sampling method was used, namely the quota sampling. Nevertheless, random sampling techniques were combined with the quota method. The sample size was determined using the proportion of growers using chemical inputs in market gardening in the study area. This information was obtained from the officers of the ZAT of Banfora. According to them, nearly 85% of market gardeners in the area use chemical inputs. The sample size was therefore determined using formula [9]: $n = \frac{z^2 p(1-p)}{e^2}$ where n=sample size; Z=margin rate deduced from the desired confidence level z=1.96; P(1-P) the variance of the variable; e margin of error (e=5%=0.05).
This formula determines the number of people n to be interviewed according to the margin of error e that can be tolerated on a proportion of responses p.
This gives a size of 196 market gardeners. Assuming that the response rate in these types of surveys is 95% in the place, then the size was adjusted to 206 market gardeners.
In total 204 market gardeners were surveyed, giving a response rate of 99%.

2.3. Data collection and analysis

Data collection was based on the following tools:

An individual interview was conducted using a questionnaire to the sample of gardeners. The questionnaire was integrated into an application (mWater) that not only allows the survey to be conducted without paper but also allows to geo-locate the respondents.
A questionnaire sheet was designed to provide information on the identity of the respondent, the origins of fertilizers and pesticides, and the impacts of fertilizers and pesticides on the natural environment. It also provides information on agricultural production, on the health of the population and on market gardeners' behaviour in water resources use, as well as on pesticides and fertilizers.
An interview guide enabled us to discuss with the people in charge of the technical services and the training personnel in the locality.
These were supplemented by direct field observations in the various vegetable growing sites in the study area.
The whole data collected was processed and summarized through descriptive statistics.

3. RESULTS

3.1. Knowledge on good phytosanitary practices

The knowledge level of market gardeners on good phytosanitary practices is presented in Table 1. It indicates that 44.66% of the market gardeners interviewed have already received training on appropriate practices in pesticide use. This is about the choice of the appropriate formulation, the use of personal protective equipment, the treatment period, the instructions exploitation, etc.

Table 1. Distribution of market gardners according to whether they have received training or not.

Variable / Organisation	No		Yes	
	Number	%	Number	%
State			33	16,02
MCA			25	12,13
PAFASP			3	1,45
SAPHYTO			12	5,83
SOFITEX			19	9,23
Total (n=206)	112	55,34	92	44,66

3.2. *Impact of chemical fertilizers and pesticides on crops*

The results of the impact of chemical inputs on crops are presented in Table 2. Vegetable producers almost unanimously say it is necessary to use fertilizers and pesticides on their production sites. Some producers (18.87%) well appreciate the use of fertilisers and pesticides on the sites. Nearly 94% also believe that the use of fertilisers improves soil fertility and helps to increase crop yields.

Table 2. Distribution of market gardeners according to their apprehensions about the effect of chemical inputs on the soil and on market garden crops

Response	Nbr	%

Question			
What do you think about the use of pesticides and fertilisers on your site?	Good	178	87,25
	Bad	26	12,75
Do fertilisers improve soil fertility?	Yes	191	93,63
	No	12	6,37

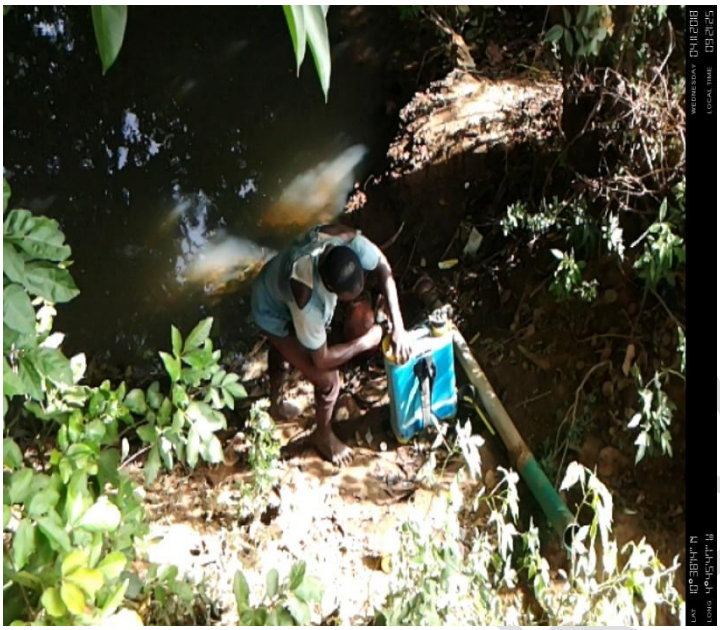
3.3. Knowledge of pesticide hazards and precautions

The results are shown in Table 3. The figure shows that vegetable producers are less aware of the dangers of pesticide use on nature, the consumer and other living beings. According to the producers, only the applicator can be at risk when using pesticides. In fact, 79.41% of the producers interviewed were aware of the dangers of pesticide use for the applicator. This situation reflects the lack of knowledge of the real dangers of chemical products used in agriculture on other actors, particularly the consumer, the rest of the biocenosis and the environment in general.
As for the precautions taken by producers in the use of pesticides, it emerges from the interviews with them that 96.57% of them do not use any protective equipment when applying pesticides.

Table 3. **Market gardeners' perceptions of the target impacted by phytosanitary treatments and precautions**.

Question \ Response		Nbr	%
Which target do you think the use of pesticides is dangerous for?	Applicator	162	79,41
	Nature	3	1,50
	Consumer	11	5,4
	Others	28	17,72
Do you take any special precautions before carrying out your plant protection treatments?	Yes	7	3,43
	No	197	96,57

Market gardeners do not take any precautions during pesticide application despite the fact that most of them are relatively aware of the danger of pesticides on the applicator (Picture 1).



Picture 1. Pesticide applicator without protective equipment

3.4. Post-treatment precautions and knowledge of the easement area

Analysis of the data in Table 4 shows that, in general, after treating their farms with pesticides, vegetable growers wash themselves at water points and clean their equipment in the field. Of all the producers interviewed, nearly 58% wash themselves at water points while 41% do so in the field. On the other hand, 88% wash their equipment in the field after application of pesticides.
Furthermore, the results of our field interviews indicate that 76% of respondents were unaware of the existence of the easement area.

Table 4. Distribution of producers according to risk behaviour for the ecosystem

	Washing of equipment after application		**Bath after applying pesticides**	
	Number	**%**	**Number**	%
Water point	19	9,31	118	57,84
In the field	180	88,23	84	41,17
Others	5	2,46	2	0,99
Total	204	100	204	100

3.5. Harmfulness of pesticides and prevention of pollution of watercourses

Almost all the market gardeners (96%) know that there are diseases related to the use of pesticides in the Comoé river watershed (Table 5). This information shows that the issue of diseases related to the use of fertilizers and pesticides is not unknown to market gardeners, even if some of them are still unaware of it.

Furthermore, almost all the market gardeners (96%) refer to the nearest medical centre in case of symptoms related to the use of pesticides. Nevertheless, some of them continue to see traditional therapists to treat these diseases.

Table 5. **Distribution of market gardeners according to appreciation of the danger of pesticides by market gardeners.**

	Extremely dangerous	Quite dangerous	Not very dangerous	Not dangerous	Total
Number	171	12	13	8	204
%	83,82	5,88	6,37	3,93	100

As a means of preventing pollution of watercourses, the vegetable producers propose:

- Avoid bathing or washing equipment around or in watercourses after pesticide application,
- Avoid throwing pesticide packaging near or into water points,
- Avoid cultivating near watercourses,
- Avoid preparing pesticide slurries near watercourses.

4. Discussion

The investigations conducted during this study aimed to analyze farmers' perceptions of the use of pesticides and fertilizers in market gardening in this area.

The survey indicates that 79% of the farmers were aware of the dangers of pesticide use on the applicator. Only 1.47% think that the use of pesticides can have a negative impact on the environment. This situation reflects the lack of awareness of the dangers of chemical products used in agriculture on other actors, particularly the consumer, the rest of the biocenosis and the environment in general. This result contradicts that of [7] in Benin, in Togo [10] who showed that all farmers recognize that pesticides are likely to cause harm to humans and the environment.

Most farmers do not protect themselves sufficiently. There is little compliance with hygiene rules before, during and after a phytosanitary treatment as already observed by [10] in Togo, in Senegal [11], in Benin [7], in the Philippines [12] and [13] in Benin, Ethiopia, Ghana and Senegal. [14] showed that the non-use of personal protective equipment could be linked to lack of financial means and neglect by farmers.

After treatment, 37% wash only their hands, while 16% wash their whole body. However, it was shown that the lack of body protection equipment increases the risk of poisoning which, although minor at the beginning, can become serious through bioaccumulation [14,15,16]. A number of poisoning and illness cases linked to pesticides in market gardens and cotton growing areas have been reported [17,18,19, 20]. The cases of discomfort often reported by market gardeners in the Comoé region may be due to non-compliance with hygiene rules during and after phytosanitary treatments, as shown by [21] in Ethiopia. Aware of the health risks involved, all of them take some precautions after the treatments: washing their hands, taking a bath, etc.

On the other hand, 13% of the farmers interviewed said that women also participate in the treatment and generally for their farms which are small in size. However, a study conducted in the United States noted an increase in certain categories of congenital malformations, central nervous system anomalies and cleft lip and palate, related to parents' exposure to pesticides or to mother's residence near cultivated fields, without further details on the products used [22].

As for the type of treatment applied, 54% of the vegetable producers used calendar spraying and 40% used threshold spraying. The calendar treatment does not take into account the need for intervention but is automatically started when the day comes. This type of practice

exposes the applicator cyclically and continuously to chronic poisoning as they do not have adequate protective equipment. [23] and [24] considered that the long time exposure of cotton growers to treatments without adequate protective equipment constitutes the major source of risk of poisoning.
The results of our field interviews show that 75% of the market gardening population is unaware of the existence of the easement areas, which prevents pollution of the watercourse where animals and sometimes human's drink. The proximity of the market gardening sites to water points and the topographical situation can be a risk factor. The major risk related to this proximity to water points is contamination.

5. CONCLUSION

Market gardening in the Comoé region remains the main activity of farmers in the dry season, but it is faced with various difficulties. Despite the economic profitability of this activity, it must be recognized that there is a major issue relating to the farmers' perception of the use of pesticides and fertilizers in market gardening in the Comoé Province of Burkina Faso.
In order to preserve the farmers' health, and consequently public health and the environment, measures and actions must be taken. Proposals are made along the same lines around strict control of the quality of fertilizers and pesticides that are used on the various market gardening areas and, more generally, the safe management of chemical inputs in agriculture; sensitization on the dangers of plant care products, which should focus on pollution problems, particularly water pollution and its consequences on human and environmental health.
It would therefore be wise to encourage and promote biological pest control in order to preserve human and animal health and the environment.

REFERENCES

1. World Bank. https://donnees.banquemondiale.org/indicator/NV.AGR.TOTL.ZS (Website consulted on 06/11/2020).

2. Kanda M, Djaneye-Boundjou G, Wala K, Gnandi K, Batawila K, Sannie A, Akpagana K. Application of pesticides in market gardening in Togo. The electronic journal in environmental sciences, 2013. https://journals.openedition.org/vertigo/13456

3. Mondedji AD, Amevoin K, Nyamador SW, Adeoti R. Analysis of some aspects of the vegetable production system and producers' perception of the use of botanical extracts in the management of insect pests in market gardening in southern Togo. International Journal of Biological and Chemical Sciences. 2015 ; 9(1):98-107.

4. Assogba-Komlan F, Anihouvi P, Achigan E, Sikirou R, Boko A, Adje C, Ahle V, Vodouhe R, Assa A. Cultivation practices and content of anti-nutritional elements (nitrates and pesticides) of Solanum macrocarpum in southern Benign. African Journal of Food, Agriculture Nutrition and Development. 2007; 7(4):1-21.

5. Houndete TA, Hougni A, Aladji S, Dagoudo A, Zoumarou-Wallis N, Thomas-Odjo AA. Behavior of the main bio-aggressors and cotton diseases on tested varieties of cotton (Gossypium hirsutum) under different doses of fertilizers at Angaradebou in Benin. International Journal of Biological and Chemical Sciences. 2015 ; 9(1): 217-224

6. Aboyi LK, Ketoh GK, Martin T, Glitho IA, Tamò M. Pesticide resistance in Plutella xylostella (Lepidoptera: Plutellidae) populations from Togo and Benin. International Journal of Tropical Insect Science. 2016; 36 (4): 204-210.

7. Ahouangninou C, Martin T, Assogba-Komlan F, Cledjo P, Kpenavoun CS, Nouatin G, Boko W, Soumanou MM, Houssou C, Biaou G, Ahanchede A, Boko M, Fayomi B. Production sustainability assessment market gardening in southern Benin. CBRST Notebooks. 2015 ; 2(7):98-126.

8. Toé AM, Coulibaly M. Evaluation of the effects of the 2004 locust control on the health of populations and the environment in Burkina Faso. Sahelian studies and research. 2006; 13:7-9.

9. Dagnelie P. 1998. Theoretical and applied statistics. Brussels: De Boeck, 1998.

10. Kokou E, Madjouma K, Semihinva A, Kperkouma W, Komlan B, Koffi A, 2014. Appearance of an informal trade in phytosanitary products in southwestern Togo. European Scientific Journal. 2014 ; 10(6):271-283

11.Wade CS. The use of pesticides in peri-urban agriculture and its impact on the environment. Pharmacy thesis, Dakar, UCAD, 2013.

12. Snelder DJ, Masipiquena MD, De Snoo GR. Risk assessment of pesticide use by smallholder farmers in the Cagayan valley (Philippines). Crop. Prot. 2008; 27: 747-762.

13. Williamson S, Ball A, Pretty J. Trends in pesticide use and drivers for safer pest management in four African countries, Crop Prot. 2008; 27:1327-1334.

14. Matthews GA. Attitudes and behaviors regarding use of crop protection products - A survey of more than 8500 smallholders in 26 countries. Crop. Prot. 2008; 27: 84604-84614.

15. Kankou MOSO. Vulnerability of waters and soils on the right bank of the Senegal River in Mauritania: Laboratory study of the behavior of two pesticides, Doctoral thesis, University of Limoges, 2004.

16. INRS. Use of phytosanitary products in tropical agriculture. National Institute for Research and Security, Paris. 2007.

17. Gomgnimbou APK, Savadogo PW, Nianogo AJ, Millogo/Rasolodimby J. Use of chemical inputs in a tropical agrosystem: diagnosis of the risk of environmental pollution in the cotton region of eastern Burkina Faso. Biotechnol. Agron. Soc. About. 2009; 13(4):499-507.

18. Ton P, Tovignan S, Vodouhè DS. Poisoning and deaths in Benin by endosulfan. Pesticides and alternatives. 2000; 10: 2-3.

19. Pesticide Action Network. Socio-economic, health and environmental impact study of the use of POPs in Davié in the North of Lomé (Maritime region), Togo, Study report, Lomé, IPEP, PAN Togo, 2005.

20. Benin Organization for the Promotion of Organic Agriculture (OBEPAB). Identification of health and environmental problems related to Pops, Study report. IPEP. Cotonou. 2006

21. Toe AM. Use of chemical pesticides in vegetable and cotton crops in the eastern region of Burkina Faso, Campaign 2005-2006 and 2006-2007, Study report, IRSS, Bobo Dioulasso, Burkina Faso, 2007.

22. Shaw GM, Wasserman CR, O'malley CD, Nelson V, Jackson RI. Maternal pesticide exposure from multiple sources and selected congenital anomalies. Epidemiology. 1999; 10: 60-66.

23. Kumar R. Insect pest control. Agriculture in the tropics. Wageningen, Netherlands: CTA/Karthala Publishing, 1991.

24. Guissou IP, Toe MA, Domo Y, Hema OS. Contribution to agro-food toxicology in Burkina Faso: epidemiology of pesticide poisoning and serum cholinesterase activities among producers in the cotton-growing area of the Mouhoun loop. Study Search 1996 ; 4-5 : 39-48.