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Farmers' Perceptions of Pesticide and Chemical Fertilizer use in Market Gardening in the Comoé River Watershed in Burkina Faso

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: Analyzing farmers' perceptions of the use of synthetic 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 12th to May 25th, 2019.
Methodology: An individual survey of a sample of 204 market gardeners using synthetic 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 of the producers (18.87%) well? appreciate the use of fertilizers and synthetic 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 the gardeners while using synthetic pesticides, results of interviews showed that 96.57% of them do not use any protective equipment. In general, after treating their

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farms with synthetic 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 synthetic pesticides.
Conclusion: with a view to the rational use of phytosanitary products and the safeguarding of the ecosystem, it is important to initiate and implement awareness campaigns among the gardeners.

Keywords: Synthetic pesticides; farmer's perceptions; environmental risk, Burkina Faso.

1. INTRODUCTION

For several decades, most modern crop management methods have involved use of agrochemical products.

Faced with increased variability in precipitation and temperature due to climate change and seeking to combat the proliferation of weeds, insects and other pests, and plant diseases, systematic use of chemical pesticides is a widespread practice among farmers, including in Burkina Faso [1,2,3].

Commonly practiced during the dry season in Burkina Faso, market gardening of vegetables relies heavily on use of chemical inputs (pesticides and fertilizer) with a goal of increasing crop yields and productivity [4,5].

According to the Burkinabè Ministry of Agricultural and Aquatic Resources (MAAH), herbicides represented more than 60% of the total of 3,000 tons of pesticides imported legally into Burkina Faso during the year 2018 [2].

These pesticides are without a doubt considered to be one of the key enabling factors for agricultural development in a context of agricultural intensification which is necessitated by both rural population growth and economic needs among the population [6].

Pesticide use enables farmers to reduce or even eliminate the negative impacts of various crop pests and diseases on plant growth and yield. However, misuse of these products can lead to problems, including: toxic effects among those who come in contact with these products on the farm, especially those directly applying the chemical products to the field; toxicities among consumers tied to the presence of toxic residues on farm produce; and several types of environmental pollution, including water, air, and soil pollution as well as toxicities in non-targeted organisms [7-12].

Additionally, results of statistical analyses conducted in various developing countries consistently reveal that unmeasured and excessive usage of agrochemical inputs can result in negative impacts both on the natural environment as well as on human health. To illustrate this point, a study conducted by the World Health Organization (WHO) of the United Nations (UN) revealed that over 1.5 million cases of pesticide poisoning have been reported throughout Sub-Saharan Africa in recent years, leading to the untimely deaths of several thousand farmers and agricultural laborers [13].

Environmental and health problems tied to use of pesticides and fertilizer have been documented throughout the world, including on the African continent [14,7,15,8,16,6,4,11].

Burkina Faso, the degree of ecological and health problems tied to pesticide use can be estimated through numerous studies [17,1,3,9,10,12,18]

Faced with this situation, Burkinabè government agencies, NGOs, and agrochemical companies have employed various strategies to educate farmers on the effects of excessive or uncontrolled pesticide use [2,18].

Despite these efforts, cases of poisoning and/or environmental pollution continue to occur in a context of increased agricultural production and monitoring the implementation of good agricultural practices (GAPs). As such, pesticide management has become a key concern for the Burkinabè government, given that the GAPs dealing with pesticide applications are not being followed in large part by Burkinabè farmers [2].

The Comoé River Watershed (CRW) is an agroecosystem in which market gardening, sugarcane production, cereal crops, and cotton production are all growing in both magnitude and geographic extent as agricultural intensification is being increasingly practiced throughout the watershed [12].

These conditions merit a reflection on fertilizer and pesticide management in order to better promote sustainable development in the region. This will enable sustainable usage of the environment by the agricultural sector in the long term while simultaneously protecting and even improving the condition of natural resources throughout the watershed.

This objective leads us to ask the following questions. First, what is the degree of knowledge of good agrochemical practices among market gardeners in the Comoé River Watershed? Second, what is the perception of market gardeners regarding the level of danger and risk accompanying usage of agrochemical pesticide and fertilizer products?

The objective of this study is to answer the above questions, with a goal of reaching a deeper understanding of the perceptions of farmers regarding pesticide and fertilizer use in market gardening.

2. MATERIALS 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 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 (5) main sub-basins: the Comoé, the Léraba, the Kodoun, the Baoué and the Iroungou.

2.2 Sample Collection

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 synthetic pesticides in market gardening in the study area. This information was obtained from the officers of ZAT in Banfora. According to them, nearly 85% of market gardeners in the area use synthetic pesticides. The sample size was determined using the formula [19]: $n = \frac{z^2 p(1-p)}{e^2}$ 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 response 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 Type of Study and Methods of Evaluating Perception

The comprehensive method was used for this study [6]. This method consists of understanding the mechanisms through which environmental consciousness related to use of chemical products and fertilizers in agriculture develops and spreads throughout a population or community. This method enabled the researchers to understand the perceptions of the population in regard to these products, to evaluate their knowledge of pesticides and chemical products, and to comprehend their motives for participating in risky behaviors. To conduct this analysis, data were collected through individual interviews with variables and questions adapted to the specific respondent category. Through analyzing the content of the interviews, the researchers were able to evaluate the perceptions, thoughts, knowledge, and attitudes of the study population as well as environmental and health risks. Findings from this study were then synthesized with other results from the literature to put them in context.

2.4 Data Collection and Analysis

Data collection was based on the following tools: An individual interview was conducted using a questionnaire for the sampling of gardeners. The questionnaire was integrated into

an application (mWater) that not only allows the survey to be conducted without paper but also allows for geo-location of the respondents.

A questionnaire was designed to provide information on the identity of the respondent, the origin of fertilizer and synthetic pesticides, and their impact on the natural environment. It also provides information on agricultural production, health of the population and market gardeners' behavior in the use of water resources, as well as on synthetic pesticide and fertilizer usage.

An interview guide enabled us to discuss with the people in charge of the technical services and the training of personnel in the locality.

These were supplemented by direct field observations in the various vegetable growing sites in the study area.

The 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 regarding pesticide use. This is about the choice of the appropriate formulation, the use of personal protective equipment, the treatment period, the instructions, exploitation, etc.

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 fertilizers and pesticides on the sites. Nearly 94% also believe that the use of fertilizers improves soil fertility and helps to increase crop yields.

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.

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

Table 1. Distribution of market gardeners 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

Key: MCA: Millennium Challenge Account; PAFASP: National Support Project for Agro-Sylvo-Pastoral Sectors; SAPHYTO: African Society of Phytosanitary Products; SOFITEX: National Society of Fibers and Textiles

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

Question \ Response		Nbr	%
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

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

Picture 1. Pesticide application or user without protective equipment

3.4 Post-treatment Precautions and Knowledge of the Protected Riparian Buffer zone

Analysis of 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 gardeners 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 protected riparian buffer zone.

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 synthetic 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, though some of them are 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.

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

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

4. DISCUSSION

This study has enabled the researchers to develop a more nuanced understanding of farmer perceptions on usage of chemical pesticides and fertilizer in the Comoé River Watershed.

The results of this research show that the majority of market gardeners (55.3%) have not received capacity-building on best practices for agrochemical usage. This significant lack of extension training on chemical usage could potentially have negative effects on both human and ecosystem health. Additionally, these negative impacts could be further amplified by the low overall education levels among farmers in the watershed. A study conducted by [1] in Dano commune, Burkina Faso underlined the necessity of strengthening knowledge sharing mechanisms in the Burkinabè agencies responsible for rural development in order to more effectively transfer knowledge to agricultural sector actors, given the low overall literacy rate of rural farmers in the country.

Our study results reveal that the majority of farmers believe that usage of chemical pesticides and fertilizers in the region is necessary (87.3% of farmers), and that these products contribute to improving soil fertility (93.6% of farmers). In general, these products are seen by farmers as factors which can improve soil fertility and quality of agricultural produce. These observations are in line with those obtained by [6] in Azaguié, Côte d'Ivoire. Additionally, a study conducted by [20] revealed that 93.0% of rice farmers believe that usage of chemical fertilizers improves soil fertility and ensures sufficient harvests in Burkina Faso. Taken together, these observations show that the principal determinants of adoption of chemical fertilizer and pesticides are harvests and quality of agricultural produce.

After applying chemical products to their crops, 81.4% reported washing only their hands, while 16% reported washing their entire body. Other studies have shown that lack of availability of

Table 4. Gardner behaviors that pose risks to ecosystem health

	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

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

personal protective equipment increases the risks of toxicity or poisoning which, although low in magnitude at the outset, can become much more significant over time through the process of bioaccumulation [3,12]. Multiple cases of poisoning and health conditions related to pesticides in market gardening and cotton cultivation have been observed in Burkina Faso [13,9].

Cases of discomfort or other health impacts often reported by market gardeners in the Comoé River Watershed are likely tied to failure to follow hygiene safety practices during and after applying agrochemical products, as was also reported by previous studies [5,21]. Almost all respondents indicated a basic understanding of health risks associated with chemical applications, shown by the high rates of reported use of hygiene practices following applications (handwashing, bathing or showering, etc.).

The study results show that very few farmers believe that pesticide use could have negative impacts on the natural environment (1.5%) or on consumers (5.4%). This situation is a testament to the lack of producer knowledge regarding the dangers agrochemical product usage can pose to others, including consumers, other living organisms, and the environment in a general sense. These observations are well aligned with the results of previous studies [4,5,12]. Notwithstanding, results of the present study diverge from those reported by [22] in Benin and [23] in Togo who found that almost all farmers recognized that pesticide usage poses risks to both humans and the environment on a wide scale.

In our study region, the majority of producers do not use sufficient personal protection when working with agrochemical products. They reported low levels of adherence to hygiene safety rules before, during, and after applying agrochemical products to their gardens, which is similar to results observed by [23] in Togo, by [22] in Benin, by [24] in the Philippines.), and [21] in Benin, Ethiopia, Ghana, and Senegal. On another note, other studies have shown that low levels of personal protective equipment use could be tied to lack of economic means to procure these equipment as well as farmer negligence [17,3].

Furthermore, 96.6% of surveyed producers reported that they do not take particular safety measures before applying agrochemical products to their gardens. This attitude results in both the individual applying the products as well as the surrounding ecosystem being at a higher risk of exposure to possible chemical contamination and pollution. A study conducted by [11] revealed similarly that none of the farmers they interviewed in the Foumbot District of Cameroon reported using personal protective equipment when applying agrochemical products to their crops. Likewise, a study conducted by [5] revealed that more than 70% of market gardeners reported using no adequate protective measures during the process, from preparation of the mixture through application in the field.

Results from this study show that 75% of the market gardeners surveyed in the study area were unaware of or failed to apply the principal of avoiding chemical use in the riparian buffer zone of the Comoé River, risking chemical pollution of the river, which animals and sometimes humans use as a source of drinking water. The proximity of market gardens to surface water sources and the topography of the watershed could also be contributing risk factors. The greatest risk of placing market gardens adjacent to surface water sources is that of chemical contamination. The proximity observed between many garden plots and the banks of the Comoé River aligns with observations from previous studies on other regions [17,3,18]. In effect, crop management practices such as herbicide and insecticide use can severely impact water quality through runoff and drainage [18].

At the conclusion of the study, we observed, in accordance with the observations of [5], that crop management practices of Burkinabè market gardeners are risky and potentially damaging to the health of farmers, consumers, and the environment.

5. CONCLUSION

Market gardening in the Comoé region remains the main activity of farmers during 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 line on 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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