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Assessment of health hazards and risk perceptions of market garden producers towards the effects of pesticides in Western Region Cameroon

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The increased health effect of pesticides on the agrarian population in Africa, particularly in Cameroon is a challenging concern. Therefore, this study aims to assess the health risks and risk perceptions of market garden producers towards the effects of pesticides in Cameroon. Using a multi-stage sampling technique, a sample of 560 producers in the Noun Division, Western Region of Cameroon was obtained and an ordered Logit model was adopted to perform the analyses. The results show that 63.93 and 74.62% of producers testify that insecticides and herbicides are among the extremely hazardous products, while 43.25 and 65.36% consider fungicides and nematicides as strongly hazardous for their health. Meanwhile, some socioeconomic characteristics including education, age, health effects, training on pesticides, knowledge and awareness are the main indicators of risk perception. Consequently, overuse of pesticides and their negative effects on the health of farmers may be aggravated, if there is no support by the integration of social norms. Furthermore, training program from agricultural extension services should place emphasis on imparting basic precautionary knowledge for limited producers.

Key words: Cameroon, Market garden producers, symptoms of poisoning, Ordered Logit model, agrochemical products effects, risk awareness.

INTRODUCTION

The spraying of chemicals pesticides in modern agriculture is a major component with evident benefits on yields and product quality (Cooper and Dobson, 2007).

According to Mehmood et al. (2021) and Alavanja (2009), over 3 billion tons of hazardous chemicals pesticides are used yearly to control weeds, pests and plants diseases

by at least 1.5 billion people worldwide involved in agriculture-related activities. Similar to developing countries of sub-Saharan Africa, Cameroon's agricultural sector consumes massively agrochemicals pesticides (INS, 2015).

Over the past 10 years, with the growing population, the demand for market garden products and other food crops has increased in the country (Galani et al., 2018). Thus, to guarantee the crop protection and then reduce the supply and demand gap, heavy amounts of pesticides have been used across the country (Sonchieu et al., 2019, 2018). Pouokam et al. (2017) attested that over 600 pesticide products have been registered in Cameroon since 2015, dominated by insecticides (33.93%), herbicides (26.55%), and fungicides (24.26%). Further, in 2018 more than 1.373 tons of pesticides were being sprayed (INS, 2015). Although very clear instructions about the judicious use of chemicals pesticides are available in Cameroon's pesticide management legislation, and specifically on the labels of the recommended products, the regulation of their residues on food and nonfood crops has not been meticulous at all (Galani et al., 2018). Usually, Cameroonian producers do not fully conform to the standard pesticides practices in monitoring harmful pests and diseases (Pouokam et al., 2017). As consequences, the overuse of chemicals pesticides has been highly associated with health hazards and acute pesticide poisonings which tragically claim many lives worldwide each year. Popp et al. (2013) and Thundiyil et al. (2008) estimate that acute pesticide poisonings affect nearly 3 million people and cause more than 20.000 accidental deaths annually, generating some high economic costs in developing countries such as Cameroon (Nkontcheu et al., 2017; Reganold and Wachter, 2016; Bertolote et al., 2006).

Considering the above stylized facts, the producers' perception about overuse of pesticides and their effects is very critical; the effects of pesticides on human health and the environment is an important issue. In the literature, the risk assessment of pesticides use focuses mainly on the pesticide itself; studies of Poisson et al. (2021) and Philippe et al. (2021) focus on the toxicological effects of pesticides, and the development of formulations to reduce pesticides doses and exposure; while Son et al. (2018) focus on contamination routes for the producers. But the studies on producers' risk perception of pesticides and the influence of this perception on their behavior are insufficiently known. Nevertheless, some studies indicate that the use of pesticides by producers and their perception are sometimes related to one another. Indeed, Endsley (1995) observed early that perception affects peoples' behavior and their careful management of a risk. So as an example, Afroz et al. (2015) and Ahmed and Shafique (2019) examined the relationship between risk perception and households' knowledge regarding water pollution and

its potential effect on human health. Also, Abdollahzadeh et al. (2015), Philippe et al. (2021) and Parveen et al. (2003) concluded that perception is fundamentally influenced by a producer's education.

Other authors such as Luís et al. (2020), Barraza et al. (2020) and Boissonot (2014) defined risk perception as a subjective assessment of the probability of a specific type of accident occurring and the extent to which the individual concerned values the consequences. According to Mehmood et al. (2021), people receive signals and stimuli from their surroundings and use these to develop their perceptions. Hence, when producers observe adverse pesticide effects, they may be aware of these effects because of possible health issues. Even if the perception of risk goes beyond the individual, it is a social and cultural construct that reflects the symbols, values, history and ideology of a society.

In line with this, we therefore postulate in this paper that the more producers perceive the effects of pesticides as risks to their health, the more vigilant they will be with their handling. The main objective is thus to quantify the perceptions of market garden producers of Western Region in Cameroon about the risk of pesticides and their adverse effects on human health. Results from this research are expected to serve as a decision-making tool for agricultural and health policy makers to design more effective policies for sustainable agriculture.

Analysis of socio-economic factors underlying producers' perception: A Ajzen's theory of planned behavior (TPB)

As previously stated, most Cameroonian market garden producers are not informed and trained enough on the recommended measures against the effects of pesticides and their toxicity. This problem has thus become an important question that has driven researchers to develop theoretical model on the basis of existing studies in the literature. Based on Mehmood et al. (2021)'s observations, this model is especially supported by the Theory of Planned Behavior (TPB), an improvement of the early theory of reasoned action which has its foundation in psychology. A pioneer of this theory is the American psychologist Ajzen, who in the early 1990s established a link between some convictions and an individual's behaviors (Ajzen, 1991).

Over the past decade, Ajzen's theory has then been recognized in various fields of research and implemented to understand a wide diversity of human behavior (Wang et al., 2019, 2017; Ru et al., 2018). The earlier study of Boissonnot (2014) on producers' perception of pesticides, that of Gao et al. (2017) and Ataei et al. (2021) on producers' perception about pesticides effects and the research of Bagheri et al. (2019) are among the recent studies that have applied this theory. The relevance of this theory's approach to studies of producers'
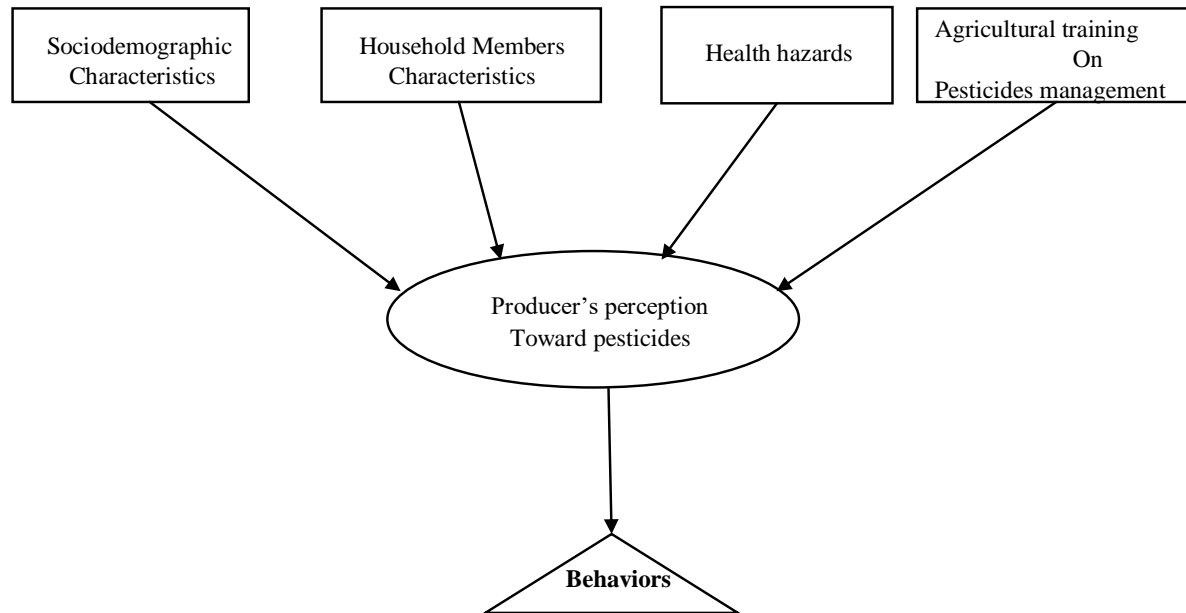
Figure 1. Theoretical framework of factors affecting producers' perception toward pesticide effects.
Source: Authors' Construction (2021)

perceptions of pesticides stems from the fact that producers' pesticide use behavior is not only influenced by institutional factors like pesticide prices, distribution chains, access to market information, but also unobservable emotional factors such as motivating forces on a single decision maker (Mehmood et al., 2021).

Technically, Ajzen's theory describes how an individual shapes his perception by taking into account attitude, subjective norms and perceived behavioral control. In the present study, producers' perceptions about pesticides are influenced by socio-demographic characteristics like age, educational level, farm income, rural cooperative membership, land ownership, agricultural knowledge and experience, and by family members' characteristics (family size and family labor, marital status, health diseases effects, etc; Figure 1). According to Mehmood et al. (2021), the subjective criteria that influence producers to adopt a particular behavior can be associated with the level of consumption of agricultural products.

From an empirical point of view, Ru et al. (2018) concluded that the significant influence of a related subjective norm can improve the perception and probability of executing a particular behavior. Ataei et al. (2021) and Bakker et al. (2021) also discussed the individual's practice and obstacles that may inhibit the perceived behavioral control and then influence farmers' perception of pesticides' toxicity. The authors identified seven main determinants treated as antecedents to producers' risk perception. Due to the complexity of the health diseases occurrence, our understanding of the relationship between individual's factors such as

producers' age, level of education, agricultural income and producers' perceptions could thus be improved by analyzing these characteristics.

The empirical evidence of Doran et al. (2020) considered producers' age as an important factor in differentiating exposure to pesticide toxicity. Similarly, the studies of Mergia et al. (2021) and Wang et al. (2019) indicated that there is a significant and positive correlation between level of education, knowledge and producers' perception of quantity of pesticides to be sprayed. Fundamentally, knowledge refers to a set of information acquired through education. In fact, knowledge of pesticide effects can familiarize patients with health issues and help them take preventive measures in a timely method. Therefore, awareness of pesticides effects is considered as the attention and sensitivity of an individual to health issues. In the rural setting of Cameroon, market garden producers obtain awareness through the rural community, agricultural field officers, health agents, and some suppliers in the rural markets.

MATERIALS AND METHODS

Study area

This study was carried out in the Noun Division, West Region of Cameroon (Figure 2). It is located roughly at 5° N by 10° 30 E. The River Noun separates two main plateaus, one of which is 1,200 m high and the other, 1,500 m high. The local population is grouped around the seven main localities (Magba, Djinoun, Koutaba, Foumban, Kouoptamo, Foumbot, and Massagam) (Table 1).

These seven localities of Noun were the scene of a survey
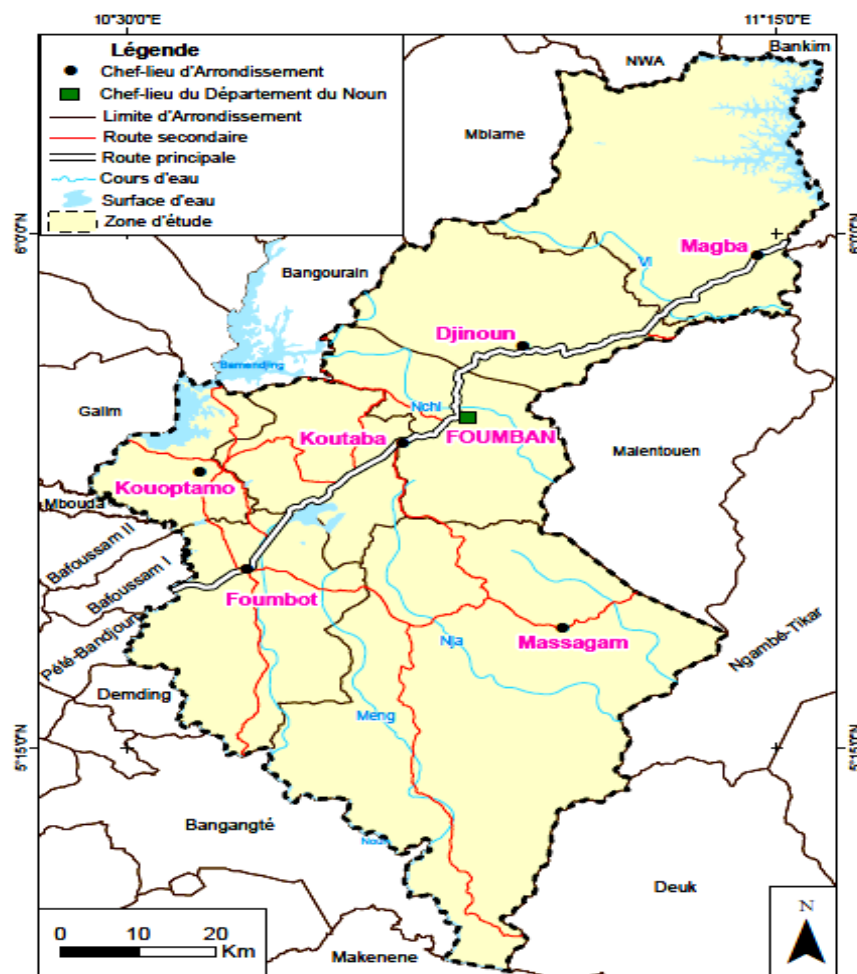
Figure 2. Study area.
Source: Authors' Construction (2021).

Table 1. Distribution of market garden producers by survey location.

Locality	Number of producers [N (%)]
Foumbot	130 (23.21)
Koutaba	80 (14.28)
Djinoun	80 (14.28)
Kouoptamo	70 (12.5)
Massagam	100 (17.85)
Magba	50 (8.92)
Foumban	50 (8.92)
Total	560 (100)

Source: Authors' Construction (2021).

conducted from April 2019 to July 2020. The Noun Division was selected for some reasons: (i) the high production of market garden products which is approximately 30 to 40% of the national production (Pan et al., 2020); (ii) the significant consumption of chemical pesticides in this division (Sonchieu et al., 2019); (iii) the presence and organization of rural cooperatives, the socio-economic importance of agriculture for rural households, the intensity of agricultural activities, and (iv) the soil and climate characteristics favourable to agricultural production.

Survey design and data collection

The multistage sampling technique was applied. In the first step, the stratified random sampling technique was used and Noun Division was geographically divided into three main zones: the North, West and Centre (Figure 3). In the second step, one district was selected from each geographical stratum, followed by the selection of villages per district and finally market garden producers per village (Table 1). In the third stage, a random sample technique was used, and a sample of 560 market garden producers was obtained.

Field survey and face-to-face interviews were conducted from May to July 2020; there was an agreement with the traditional chief and his senior advisers in the respective villages. Therefore, out of 560 producers from 7 villages interviewed, 130 were from the Foumbot village, 100 were from the village of Massagam, and 80 were from Koutaba and Djinoun, respectively.

The main information collected was on households' socio-

Figure 3. Field survey with producer/ sprayer practicing without protective devices.
Source: Author's Field Survey (2021).

demographic characteristics, symptoms of poisoning, and risk perceptions of agrochemicals pesticides effects. After data spring-cleaning, 560 valid observations were finally used for the study. Table 2 presents a descriptive statistics of the selected variables.

Estimation technique and data analysis

In order to determine the degree of correlation and significance of the link between the perception of market gardeners and socio-economic characteristics, Pearson's point biserial correlation tests and Spearman's correlation tests were used. Factors which influence producers' perception of the effects of pesticides are estimated by regressing one dependent variable with eleven independent variables.

This model is a continuation of the binary ordered Logit regression which is used when the dependent variable is in binary or rank form. Based on the approach of Mgale and Yunxian (2021), who estimated risk perception, we also adopt the ordered Logit as an estimation technique. This model can be specified to identify producers' responses that influence the perceived health risks of pesticide use in market garden production such as:

$$P_i^* = \beta' Y_i + \delta_i \qquad (1)$$

With P_i^* the unobserved and continuous measure of health-related risk perception of using pesticides for market garden production, Y_i

is a vector of sociodemographic variables, β' a vector of parameters to be estimated and δ_i is a disturbance term supposed to be normally distributed. Because P_i^* is unobserved, we evaluate the coded discrete responses of the variable P_i as follows:

$$P_i^* = \begin{cases} 1 & \text{if } -\infty \leq P_i^* \leq \lambda_1 \ (\text{not hazardous}) \\ 2 & \text{if } \lambda_1 \leq P_i^* \leq \lambda_2 \ (\text{very hazardous}) \\ 3 & \text{if } \lambda_2 \leq P_i^* \leq \lambda_3 \ (\text{fairly hazardous}) \\ 4 & \text{if } \lambda_3 \leq P_i^* \leq \lambda_4 \ (\text{strongly hazardous}) \\ 5 & \text{if } \lambda_4 \leq P_i^* \leq \lambda_{+\infty} \ (\text{extremely hazardous}) \end{cases} \qquad (2)$$

While considering the maximum likelihood method which provides consistent and asymptotic estimators we can alternatively estimate the vectors of β' parameters and $\lambda's$ thresholds, according to Mehmood et al. (2021). The marginal effects of the dependent variables were estimated using the coefficients of the ordered Logit model. The probabilities associated with the coded risk perception responses of the farmers in the ordered Logit model are given as follows:

Table 2. Distribution of descriptive statistic of socioeconomic variables.

Variable	Description	Code	Value	S.D
Age	Age of producer (head of farm)	Year	42.587	12.009
Education	Level of education of the producer (head of farm)	0= illiterate 1=Primary 2=Secondary 3=Tertiary	- 1.442	- 0.800
Exp	Producer experience in years of large-scale farm management	Number of Year	15.180	9.877
Membership	Whether the producer is an Agricultural Cooperative member	1=Yes 0=No	0.617	0.486
Area	Size of land operated by farms	hectare	2.683	1.877
Ownership	Land ownership by the producer	1=Yes 0=No	0.941	0.235
Pesti_training	Whether the producer have received a training on pesticides management	1=Yes 0=No	0.216	0.41
Size	The proportion of family labors in the total farm labor force	Number of people in the house	7.235	3.626
Health	Whether the producer has had health problems	1=Yes 0=No	0.748	0.434
Knowledge	Producer has a good knowledge on pesticides effects	1=Yes 0=No	0.423	0.465
Awareness	Whether the producer is aware of the dangers of pesticides	1=Yes 0=No	0. 412	0.457

Source: Authors' Construction (2021).

$$T_1(0) = T_r(P_i = 0) = T_r\left(P_i^* \leq \lambda_1\right) = T_r\left(\beta'Y_i + \delta_i \leq \lambda_1\right)$$
$$= T_r\left(\delta_i \leq \lambda_1 - \beta'Y_i\right) = \varphi\left(\lambda_1 - \beta'Y_i\right)$$
$$T_i(1) = T_r(P_i = 1) = T_r\left(\lambda_1 \leq P_i^* \leq \lambda_2\right) = T_r\left(\delta_i \leq \lambda_2 - \beta'Y_i\right) - T_r\left(\delta_i \leq \lambda_1 - \beta'Y_i\right) = \varphi\left(\lambda_2 - \beta'Y_i\right) - \varphi\left(\lambda_1 - \beta'Y_i\right)$$
$$T_i(k) = T_r(P_i = k) = T_r\left(\lambda_k \leq P_i^* \leq \lambda_{k+1}\right) = T_r\left(\delta_i \leq \lambda_{k+1} - \beta'Y_i\right) - T_r\left(\delta_i \leq \lambda_i - \beta'Y_n\right)$$
$$= \varphi\left(\lambda_{k+1} - \beta'Y_i\right) - \varphi\left(\lambda_k - \beta'Y_i\right)$$
$$T_i(K) = T_r(P_i = K) = T_r\left(\lambda_k \leq P_i^*\right) = 1 - \varphi\left(\lambda_k - \beta'Y_i\right) \tag{3}$$

With k symbolizing a marginal response of the producer, $T_r(P_i = k)$ representing the probability that a market garden producer i gives a response k, $\varphi(.)$ is the cumulative Logit distribution function. Appreciated health hazards theoretical depend on the quantity and quality of pesticides sprayed by each market garden producer. Risk perception is a latent variable as producers had to choose one answer among a set of five possible options. The

positive signs of the parameters β show higher health-related risk towards the use of pesticides, while negative signs indicate the contrary.

RESULTS

Socioeconomic characteristics of the market garden of the study area are shown in Table 2.

Based on initial observations, the producers in the area were having a mean age of 42 years, with primary educational level. About 1 to 25 family members worked on the farm, with an average of 7 persons per farm. Majority of producers (94.1%) own an agricultural land, with average size of 2.6 ha, and produce a wide range of vegetables in the region. Further, 74.82% of the producers claimed to have adverse health effects due to pesticide
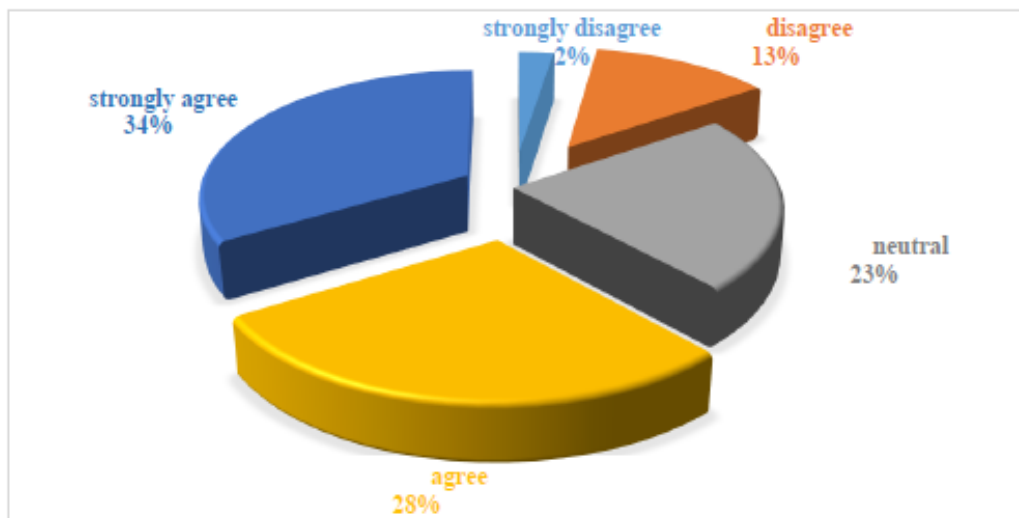
Figure 4. Producers' appreciations of pesticides risk.
Source: Authors' Construction (2021).

Table 3. Health hazards perception of pesticides effects.

Perception by category	Extremely hazardous	Strongly hazardous	Fairly hazardous	Very hazardous	Not hazardous
Insecticides	63.93	33.07	0	0	0
Fungicides	12.32	43.25	40.20	0.18	4.50
Herbicides	74.62	22.41	0.54	0	2.43
Nematicides	0	65.36	34.64	0	0

Source: Authors' Construction (2021).

spraying activity, while 21.67% received pesticides management training. In addition, 42.34 and 41.23% of the producers, respectively, were aware of the effects of pesticides on human health and the environment.

Findings of this study revealed the use of four main pesticide products (herbicides, insecticides, fungicides, nematicides). According to the first stage of the producers' perception analysis, 28% among them agreed that pesticides have a hazardous effect on health, 34% strongly agreed, while only 2% strongly disagreed, as shown in Figure 4. This is in line with the study of Teklu et al. (2021) who observed that there were few producers in Ethiopia who had a good understanding of the health implications.

For the second stage of perception analysis, producers were asked about their awareness of the health hazards of each product (Table 3). About 63.93 and 74.62% of producers testify that insecticides and herbicides are among the extremely hazardous products, while 43.25 and 65.36% consider fungicides and nematicides as strongly hazardous to their health.

Furthermore, only 4.50 and 2.43% of the producers,

respectively consider that fungicides and herbicides were not hazardous to human health. All these results confirm that the producers' perceptions of pesticides effects are worth investigating in order to understand their behavior in managing pesticide products. However, Teklu et al. (2015) believe that most producers lack the training to improve their knowledge, and among African countries, only Ethiopian farmers have good knowledge of the health implications of pesticides application.

Symptoms of intoxication reported by the exposed producers

Previous studies reported that most producers applying pesticides on their farms face numerous health problems (Jaga and Brosius 1999). Therefore, Solomon et al. (2000), compared two producers' groups and indicated that toxic pollutants were found in higher concentrations in blood tests taken from cancer patients compared to controls. Table 4 shows that excessive sweating (61.07%), general tiredness (61.96%), nausea and

Table 4. Diseases symptoms reported by producers suffering pesticide poisoning.

Pictogram	Health symptoms	N (%)
	Dizzy	212 (37.86)
	Headaches	297 (53.04)
	Excessive sweating	342 (61.07)
	Confused and blurry vision	169 (30.18)
	Nausea and vomiting	305 (54.46)
	Tremors of upper limbs	161 (28.75)
	Convulsions	150 (26.79)
	Excessive salivation and loss of appetite	277 (49.46)
	General tiredness	347 (61.96)

Source: Authors' Construction (2021).

vomiting (54.46%), excessive salivation and loss of appetite (49.46%), headaches (53.04%), and dizzy (37.86%) are among the main symptoms of health issues reported. Furthermore, confused and blurry vision (30.18%), tremors of upper limbs (28.75%) and convulsions (26.79%) were also attested by the producers.

Charlier et al. (2003) indicated that the most common symptoms of poisoning after spraying pesticides seemed to be skin irritation and stomach ache after inhalation. Moreover, several studies have highlighted different approaches assessing the effects of pesticides on producers' health. The vast majority have confirmed their significant role in the development of various health complications such as chronic diseases, degenerative diseases, neuronal disorders and certain cancers. It would be therefore imperative to consider the implementation of structured interventions to reduce exposure to health risks.

Correlation between the effect of pesticides and producers' perception of risk

The results of the Pearson's point biserial correlation and Spearman's correlation tests between producers' perceptions of risks and their socioeconomic characteristics are shown in Table 5. The first observations indicate that producers' perception had significant and positive correlations at the 1% level of significance with age, level of education, training on pesticide management, health effects, and knowledge. While sex, awareness, and pesticides training were significant at 5% and membership of rural organization and experience were at 10% level of significance. In contrast, household size and farm area showed a negative and non-significant correlation with producers' perception.

Determinants of market garden producers' risk perception of pesticides effects

Results of the producers' perceptions of pesticides effects obtained from use of an ordered Logit model through the maximum likelihood approach are shown in Table 6. Furthermore, in order to measure the robustness of the relationship between dependent variable and socioeconomic parameters, we have analyzed and interpreted the coefficients of the statistical regression.

Table 5. Correlations between producers' risk perception and socioeconomic characteristics.

Variable	Correlation coefficient	p-Value	Correlation type
Age	0.0453	0.000***	Spearman
Sex	-0.0364	0.009**	Point biserial
Education	0.0022	0.000***	Spearman
Exp	-0.0033	0.093*	Spearman
Membership	0.0633	0.013*	Point biserial
Pesti_training	0.0087	0.006**	Point biserial
Size	0.0026	0.9517	Spearman
Area	-0.0261	0.5382	Spearman
Health	0.0165	0.000***	Point biserial
Knowledge	0.0754	0.000***	Spearman
Awareness	-0.0548	0.008**	Spearman

Significant at p<0.01; significant at p<0.05; significant at p<0.10.
Source: Authors' Construction (2021).

Table 6. Estimated results of the producers' risk perception of pesticide using the ordered Logit model.

Variable	Estimate	Std. error	Sig	Lower bound	Upper bound
Age	0.024802	0.0122916	0.044**	0.0007109	0.048893
Sex	-0.148876	0.1603057	0.353	-0.463066	0.1653207
Education	0.002845	0.1094798	0.079**	-0.2117309	0.2174222
Exp	-0.01308	0.0145746	0.036**	-0.0416539	0.0154751
Membership	0.323127	0.1734207	0.062*	-0.0167759	0.6630209
Area	-0.086683	0.0502886	0.085*	-0.1852474	0.0118804
Ownership	-0.546845	0.3468379	0.115	-1.226635	0.1329449
Pesti_training	0.051919	0.1911596	0.000***	-0.3227466	0.4265851
Size	-0.023241	0.0262506	0.376	-0.0746902	0.0282101
Health	0.035909	0.2021921	0.009***	-0.3603795	0.432199
Knowledge	0.048642	0.1902586	0.000***	-0.2411678	0.3526187
Awareness	-0.023759	0.2047321	0.000***	-0.1937836	0.0127489

Significant at p<0.01; significant at p<0.05; significant at p<0.10.
Source: Authors' Construction (2021).

Thus, this shows that there is a positive relationship between the producers' risk perceptions and some variables like age (β=0.2480), education level of producers (β=0.00284), health (β=0.0359), training on pesticides (β=0.0519) and knowledge (β=0.0486). Furthermore, the results of this table revealed that there are four variables (training on pesticides, health, knowledge, and awareness) at 1% level of significance $p < 0.01$, while age, education level, and producers 'experience were significant at 5% $p < 0.05$, and membership of rural organization and total area at 10% of significance $p < 0.10$, respectively. These results are globally confirmed by other existing studies like the one of Abdollahzadeh et al. (2015) and Raimi (2021). Other statistical results, including pseudo measures (0.174), log-likelihood statistics (-265), and LR

χ^2 (108.53) indicate the robustness of the ordered Logit model.

From Table 7, the marginal effects indicate that market garden producers in the study area are very likely to perceive the use of pesticides for food production as leading to significant health and biodiversity impacts.

DISCUSSION

The producers' risk perception seems to be an important issue in vulgarizing the safe management of pesticides in the farms. Yet, there are still much emphasis on education and technical training of producers for their safe handling in Cameroon. As there is a lack of information in the literature on this concern, the present study highlights the perception of health-related risks

Table 7. Marginal effects of producers' health-related risk perceptions of pesticides effects

Variable	dy/dx	Std. error	Sig	Lower bound	Upper bound
Age	-0.0026009	0.00131	0.047**	-0.005162	-0.00004
Sex	0.0156117	0.01687	0.355	-0.017454	0.048677
Education	-0.0002984	0.01148	0.979	-0.0228	0.022203
Exp	0.0013726	0.00153	0.071**	-0.001633	0.004378
Membership	-0.034733	0.01928	0.072*	-0.072519	0.003053
Area	0.0090902	0.00532	0.088*	-0.001337	0.019517
Ownership	0.0487679	0.02614	0.062*	-0.002464	0.185403
Pesti_training	-0.0053923	0.01967	0.784	-0.043948	0.033163
Size	0.0024371	0.00276	0.377	-0.002969	0.007843
Health	-0.0037875	0.02145	0.006***	-0.045824	0.038249
Knowledge	0.04864219	0.00287	0.000***	-0.034573	0.025786
Awareness	-0.0265972	0.001391	0.000***	-0.0246579	0.013546

Significant at $p<0.01$; significant at $p<0.05$; significant at $p<0.10$.
Source: Authors' Construction (2021).

among agricultural producers, through the context of the theoretical link between the main socioeconomic characteristics and producers' perception of the risk of pesticide effects; in addition to the health symptoms of pesticide poisoning which provide valuable recommendations for policymakers, association of producers, rural communities and so far health agencies. Thus, the coefficients of the ordered Logit model which represent age, level of education, and training on pesticides revealed a positive and significant relation on the risk perception of pesticide effects and some socioeconomic variables. Then, years of conventional learning completed by producers indicate that education, as a source of human capital, has positive effects on health risk perception.

This empirical evidence has been confirmed earlier by Khan et al. (2015) and Damalas and Eleftherohorinos (2011) who concluded that education provides well informed producers with better technical capacities for effective pesticide use. Furthermore, Damalas and Eleftherohorinos (2011) showed that educated producers are more aware of the dangers of mishandling pesticides and thus adopt the necessary protective measures to reduce their level of exposure to harmful products. Although the educational level is very low among the producer community of our study area, unexpectedly, its related coefficient was found to be positive and significant.

The adverse health effects brought by the overuse of pesticides have led to a high perception of risks. The results of this study are consistent with Gaber and Abdel-Latif (2012) who stated that the adverse health effects faced by producers could strongly influence risk perception. In the same line, Abdollahzadeh et al. (2015) observed that producers confronted with the adverse health effects of pesticides "were more expected to consider pesticides as very hazardous [...]." Following

this empirical observation, underlying evidence indicates a relationship between pesticide poisoning and some specific diseases such as respiratory problems (Ye et al., 2013) or breast cancer (Alavanja et al., 2013). Moreover, the toxic effects of pesticides were investigated. Farmers interviewed faced different health-related issues, and the major symptoms reported are excessive sweating, general tiredness, nausea and vomiting, excessive salivation and loss of appetite, headaches, and dizzy (Table 4).

This study showed that technical training on pesticides definitely reduces health risks for producer. Some studies have stated that an access to extension services is important for enlightening producers' knowledge, and awareness of the rational spraying of pesticides (Raimi, 2021). Thus, the level of perception in our investigation was significantly associated with farmers' knowledge and awareness are usually transmitted through online media, and multiple additional sources, which is in line with Mahmood et al. (2020). An empirical research study piloted by Bouma et al. (2008) highlighted that the social community in rural areas facilitated the flow of information, and influenced local farmers' decisions about the adoption of new agricultural practices.

Similar results have been established by Keraita et al. (2009) who observed that awareness is generally based on previous experiences, and information concerning modern farming are mainly received from development workers, traders, input suppliers, social networks, and farm training schools. Additionally, Peres et al. (2006) concluded that knowledge and awareness critically determine how health risks are perceived and systematically handled by farmers. Considering the increase of diseases and health issues costs is associated, the latter can be mitigated through health insurance. However, in Cameroon, health insurance seemed to be weak for certain reasons, such as credit

constraints and information asymmetry about health insurance.

CONCLUSION AND RECOMMENDATIONS

In this study, health hazards and the main determinants of risk perception toward pesticides effects of market garden producers from Foumbot subdivision in West Region of Cameroon have been highlighted. This paper is one of the first to attempts to analyze Cameroonian market garden producers' perceptions towards pesticides effects by using TPB theory. The results of the ordered Logit model used indicated good efficiency in identifying the main determinants of producers' risk perceptions. At the end, a sufficiently robust set of policies initiatives are required in Cameroon rural areas, to ensure the reduction of health risks from pesticides spraying.

This could be accomplished by increasing producers' knowledge of pesticides and initiating pesticide health safety education training with qualifications certified programs through ministry of agriculture and rural development. In addition, retailers are also concerned, and should be oriented to better assist farmers. Further investigations and strict monitoring by agricultural field officers at the retail and farm levels should also be strengthened.

Government policy approaches are recommended to involve media actors to defuse information regarding food production security and the role of extension workers. Moreover, implementation of the Good Agricultural Practices (GAPs) at national level would help to control the inappropriate use of pesticides as well as, encouraging partnerships with some organic food producers and traders to ensure bio-agricultural products' certification and national traceability system.

Finally, a perspective of this study's further research on consumers' perception on the health risks of pesticide residues can be realized since it has not been captured in the present study.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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