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- Le titre de l'article (15 mots maximum) doit être clair et concis. De taille 14 pts gras, il doit être centré.
- Juste après le titre, l'auteur doit mentionner son identité (Prénom et NOM en gras et en taille 12), ses adresses (institution, e-mail, pays et téléphones en italique et en taille 11)
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Les références des sources d'archives, des sources orales et les notes explicatives sont numérotées en série continue et présentées en bas de page.

- Pour les sources orales, réaliser un tableau dont les colonnes comportent un numéro d'ordre, nom et prénoms des informateurs, la date et le lieu de l'entretien, la qualité et la profession des informateurs, son âge ou sa date de naissance et les principaux thèmes abordés au cours des entretiens. Dans ce tableau, les noms des informateurs sont présentés en ordre alphabétique
- Pour les sources d'archives, il faut mentionner en toutes lettres, à la première occurrence, le lieu de conservation des documents suivi de l'abréviation entre parenthèses, la série et l'année. C'est l'abréviation qui est utilisée dans les occurrences suivantes :
  Ex. : Abidjan, Archives nationales de Côte d'Ivoire (A.N.C.I), 1EE28, 1899.

- Pour les ouvrages, on note le NOM et le prénom de l'auteur suivis de l'année de publication, du titre de l'ouvrage en italique, du lieu de publication, du nom de la société d'édition et du nombre de page.
  Ex : LATTE Egue Jean-Michel, 2018, *L'histoire des Odzukru, peuple du sud de la Côte d'Ivoire, des origines au XIX*^{e} *siècle*, Paris, L'Harmattan, 252 p.

- Pour les périodiques, le NOM et le(s) prénom(s) de l'auteur sont suivis de l'année de la publication, du titre de l'article entre guillemets, du nom du périodique en italique, du numéro du volume, du numéro du périodique dans le volume et des pages.
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Health risk linked to the use of pesticides in The sub-prefecture of bazra-natis (ivory coast)

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Abstract

The objective of this study is to assess and analyse the level of health risk (intoxication) related to the use of pesticides in the Bazra-Natis sub-prefecture. The methodology of data collection was based on documentary research and field survey. Thus, based on a quota survey and a simple random draw, 5 villages and 50 farmers were selected as the statistical unit. The combination of data analysis from the documentary research, the field survey and Delphi refined to the analysis of risk by the epidemiological method, made it possible to retain sixteen (16) risk factors of human intoxication considered preponderant. The results show that there are numerous pathologies linked to the use of pesticides (skin diseases, respiratory and eye irritations, digestive and hormonal disorders, frequent headaches) as well as the routes (modes) of human intoxication (by the skin, by ingestion, by the respiratory route). The evaluation and analysis of the risks of intoxication indicate that the risks linked to the use of these pesticides are higher in farmers who use risky practices (RR = 2.45 > 1; RR = 1.24 > 1; RR = 1.88 > 1). Similarly, the pathologies from which they suffer (or have suffered) are attributed to these practices identified as risk factors for skin, digestive and inhalation intoxication by these pesticides (AR = 0.58; AR = 0.18; AR = 0.44). In order to reduce the risk of human poisoning, preventive measures are needed, including training and awareness-raising of farmers on agricultural systems, pesticide handling and the wearing of protective equipment.

Key words: Bazra-Natis, health risk, Ivory Coast, pesticides, rural environment

Risque sanitaire lie à l'utilisation des pesticides dans la sous-préfecture de Bazra-natis (Côte d'Ivoire)

Résumé

Cette étude a pour objectif d'évaluer et d'analyser le niveau de risque sanitaire (d'intoxication) lié à l'utilisation des pesticides dans la Sous-préfecture de Bazra-Natis. La méthodologie de collecte de données s'est basée sur la recherche documentaire et l'enquête de terrain. Ainsi, à partir d'un sondage à choix raisonné (quota) et d'un tirage aléatoire simple, 5 villages et 50 agriculteurs ont été retenus comme unité statistique. La combinaison d'analyse de données issues de la recherche documentaire, de l'enquête de terrain et Delphi affinée à l'analyse du risque par la méthode épidémiologique, ont permis de retenir seize (16) facteurs de risque d'intoxication humaine jugés prépondérants. Les résultats révèlent que, les pathologies liées à l'utilisation des pesticides sont nombreuses (affections cutanées, irritations respiratoires et oculaires, troubles digestives et hormonales, céphalées fréquentes) ainsi que les voies (modes) d'intoxication humaine (par la peau, par ingestion, par voie respiratoire). L'évaluation et l'analyse des risques d'intoxication indiquent que, les risques liés à l'utilisation de ces pesticides est plus élevé chez les agriculteurs ayant recours aux pratiques à risque (RR = 2,45 > 1 ; RR = 1,24 > 1 ; RR = 1,88 > 1). De même, les pathologies dont ils souffrent (ou dont ils ont souffert) sont attribués à ces pratiques identifiées comme étant des facteurs de risque d'intoxication par la peau, par la voie digestive et par inhalation de ces pesticides (RA

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= 0,58 ; RA = 0, 18 ; RA = 0,44). Pour réduire donc ces risques d'intoxication humaine, des mesures de prévention sont souhaitées et passent par la formation et sensibilisation des agriculteurs sur les systèmes agricoles, la manipulation des pesticides et le port des équipements de protection.

Mots clés : Bazra-Natis, Côte d'Ivoire, milieu rural, pesticides, risque sanitaire

Introduction

The rapid increase of the world population and that of developing countries poses several problems among which that of food security (UNEP/FAO, 2005 In A. D. Mondedji, 2015, p.98). Meeting the high demand for food products of this population requires intense production, and this can only be guaranteed through the use of pesticides (O. Saadane, 2018, p.2). According to the WHO, African countries import less than 10% of the pesticides used in the world (E. S. Tachin, 2011 In H. Compaore et al., 2020, p.3). Although the level of pesticide use in African agriculture is still low compared to other regions of the world, it is clear that it is increasing G. (Fleischer et al., 1998, p.1). Thus, we are witnessing an excessive and inappropriate use of these phytosanitary products, but also the non-respect of their residual time before harvest (PAN-Africa, 2000 In A. D. Mondedji, 2015, pp.99). However, according to B. Cisse (2003, p.181), if pesticides contribute, in a general way, to the improvement of agricultural yields, they nevertheless raise many concerns related to their toxicity and their negative impact on humans and the environment. Ivory Coast, an agricultural country, employs two-thirds of its active population (66%) and contributes 30% of GDP and 70% of export earnings (B. Halle et al., 2006, p.134). In order to modernize the agricultural sector, increase farmers' incomes and reduce poverty, the use of pesticides is encouraged in crops. In 2020, more than 20,000 tons of pesticides were sold in the country for an estimated market value of 20 billion CFA francs (MEMADR, 2021, p.13). Moreover, each year, nearly 4000 tons of fraudulent pesticides are dumped on the Ivorian markets (T. Mamadou, 2018, p.1). Like their counterparts in other regions of Ivory Coast, farmers in the Bazra-Natis Sub-Prefecture, in an effort to increase agricultural production and productivity, also make massive use of synthetic chemicals (whether recommended or not), while ignoring the risks associated with this use on human and environmental health. Therefore, this article aims to evaluate and analyze the level of health risk (or intoxication) related to the use of pesticides in rural areas in the Sub-Prefecture of Bazra-Natis. According to the Fund and Agriculture Organization (FAO), pesticides are substances (molecules) or products (formulations) that eliminate harmful organisms, whether they are used in the agricultural sector or in other applications (ACTA, 2000 In FAO, ONSSA, 2015, p.12).

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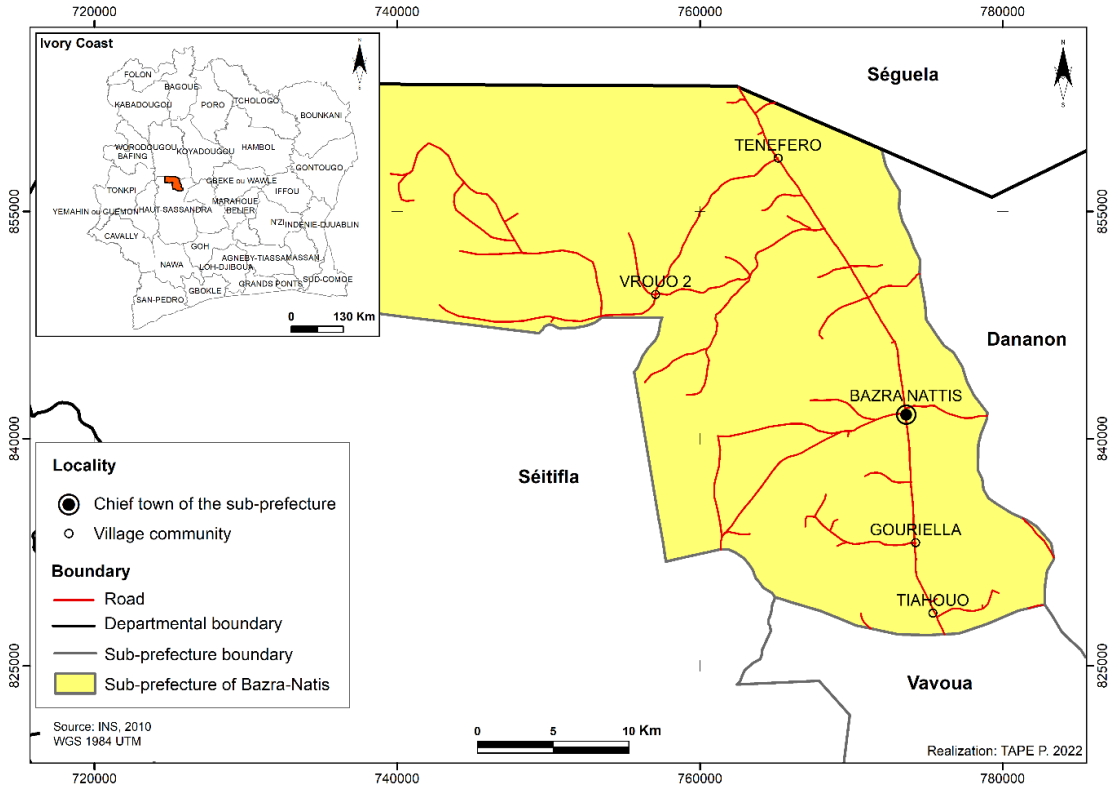
1. Materials and Methods

1.1. Presentation of the Study Area

The study was conducted in the Bazra-Natis sub-prefecture located in the central-western part of Ivory Coast. It is bordered by the sub-prefectures of Vavoua and Séguéla to the south and north respectively. In its eastern part, there is the sub-prefecture of Dananon and in the west the sub-prefecture of Séitifla (see Figure 1). This sub-prefecture is made up of twelve (12) villages (Bazra-Natis, Brouafla-Natis, Deragon, Goulaonfla, Gouriela, Tenefero, Tiahouo, Toutouman, Trafla-Natis, Vrouo 1, Vrouo 2, Yuala). Its population, mostly rural, is estimated at about 400912 inhabitants and is composed of Ivorians and West African nationals (INS, 2015). The sub-prefecture of Bazra-Natis is located in a transitional sub-equatorial climate, marked by rainfall that is conducive to agricultural activity. It is an area with high agricultural potential for both export and food crops. The major crops are plantain, cashew nuts, cocoa, peanuts, corn, yams, rice, cassava, beans, chili, eggplant, tomatoes and cotton.

Figure 1: Location of the Sub-Prefecture of Bazra-Natis



1.2. Data Collection and Analysis

This study is the continuation of a research project entitled "Socio-Sanitary and Environmental Impact of Pesticide Use in Rural Areas in the Sub-Prefecture of Bazra-Natis (Central West Ivory Coast)" that we conducted and that is currently being published (B. S. A. Tape, 2023, pp.335-344). The objective was to show the socio-sanitary and environmental impact related

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to the use of pesticides in rural areas in the sub-prefecture of Bazra-Natis. Thus, the methodology for collecting the data for this second article was based on documentary research and field surveys (direct observation, directed interviews, and administration of questionnaires). The documentation made it possible to collect data on demographics, agricultural activities, and the administrative territorial division. The practice of cultivation techniques, production units, agricultural inputs and phytosanitary products were also observed. Interviews were conducted with the heads of the rural health centers in the villages, the departmental directorates and local representatives of the Ministry of Agriculture and Rural Development (MARD) and the National Agency for Support to Rural Development (NASRD). These different interviews focused on the health and epidemiological profile of the farmers, the quality of drinking water, the types of pesticides used by the farmers and where they come from, the cultivation techniques, the agricultural data, the logic of attachment to pesticides, the mode of use of pesticides and the perception of risks.

Based on a reasoned choice survey (quotas), 5 villages and 50 farmers were selected as the statistical unit on the recommendation of the High Level Specialized Technicians in Annual and Perennial Crops (HSTAP) and the Rural Development Animators (RDA) of the National Agency for Support to Rural Development (NASRD) on the basis of the dynamics of agricultural activities and the strong presence of phytosanitary products in these localities. In Ivory Coast, NASRD is in charge of supervising farmers, improving the living conditions of the rural world by professionalizing farmers and agricultural organizations, implementing appropriate tools and approaches, and adapting programs to ensure sustainable and controlled development (ANADER, 2017, p.1). The selected villages are Tiahouo (10 individuals), Gouriela (10 individuals), Bazra-Natis (10 individuals), Tenefero (10 individuals) and Vrouo 2 (10 individuals). The farmers, selected following a simple random draw, were interviewed with the help of translators (Gouro[1], Dioula[2], Baoulé[3], Moré[4]) according to their availability on the farms and at home. The questionnaire administered to the farmers covers identity, pesticides used, reasons for attachment to pesticides, mode of pesticide use, perception of risks and pathologies encountered. The Delphi survey was also used according to the S. Cardoen et al. model (2014, p.9) to identify risk factors for pathology emergence according to the infectious agent (toxicity), human activity and exposure, and environmental changes. Thus, eighteen (18)

[1] The most widely spoken dialect in the sub-prefecture of Bazra-Natis (indigenous language)
[2] Dialect commonly spoken in the northern part of Ivory Coast
[3]Dialect commonly spoken in the central part of Ivory Coast
[4] Dialect spoken by a community coming from Burkina-Faso and settled in Ivory Coast

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risk factors of intoxication were selected and submitted to specialists in human and animal health, agro-pastoral and toxicology of the Ivory Coast Anti-Pollution Center (ICAPC), the Directorate of Veterinary Services of Ivory Coast (LANADA-Regional), the National Agency for Support to Rural Development (NASRD) and medical and pharmaceutical sciences of the Felix Houphouët-Boigny University. The risk factors considered preponderant according to the types of pesticides were encoded for each mode of intoxication (or penetration into the body). All data collected were processed using STAT⁄SE12 (masses of entries) and Microsoft office 2013 (Word and Excel) software. The assessment of the risk level was done according to the epidemiological table model inspired by L. Foucan (2012 In M. Coulibaly, 2017, pp.196-197). The geographical position of the villages was obtained using an OSMTracker GPS for AndroidTM. As for the map, it was developed using ArcGis software (ArcMap 10.2.1).

2. Results

2.1. Socio-Demographic Characteristics of Respondents

The farmers surveyed in this study were 94% male, 76% Ivorians of all origins and 24% West Africans. Of all the respondents, 54% had never been to school compared to 22% who had stopped their schooling at the primary level. 20% have secondary school education and 4% have higher education. The proportion of this category of respondents in rural areas can be explained by the reverse phenomenon of rural exodus due to unemployment in urban areas, but also by the interest of certain civil servants (teachers and health workers) in agriculture. The study also shows that 72% of the statistical units are landowners, compared to 18% of tenants and 1% of sharecroppers. In addition, all age groups are interested in agriculture, except for minors who are not old enough or strong enough to till the land. Furthermore, out of 100% of the respondents, none have ever received training in agricultural systems and pesticide use from the National Agency for Support to Rural Development (NASRD).

2.2. Typology of Pesticides used by the Respondents

The different types of pesticides used by the farmers are contained in Table 1 below.

Table 1: Distribution of respondents by type of pesticides used

N°	Type of pesticides used	Trade name of the products used	Active ingredient content active ingredient	Price purchase price	Workforce
1	**Insecticides** *Mode of action* *Controls insects*	Duel 186EC	Profenos 150g/l + cypermethrin 36g/l emulsifiable concentrate	1000f CFA (1,15€)	48/50 (96%)
		Altes 45EC	Acetamiade 20g/l + cypermethrin 25g/l	5000f CFA (7,62€)	

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	Acts after contact between the insect and the product *Acts after the insect inhales the product* *Acts when the insect feeds on the product*	Triforce	Triffoxy sulfuron –sodium 11g/l	1000f CFA (1,15€)	
		Top Lambda 25EC	25lambda cynkato	1000f CFA (1,15€)	
		Miomas 40 WP	Nicosulfuron : 10 g/kg Dicamba : 30 g/kg	3500f CFA (5,34€)	
		Maïa 40 OD	Nicosulfuron : 40 g/l	5000f CFA (7,62€)	
		Glufostar 200 SL	Glufosinate: 200 g/L Butachlor: 500 g/l	4000f CFA (6,10€)	
2	**Herbicides** *Mode of action* *Controls weeds* *Acts on the parts of the plant with which it comes into contact* *Moves within the plant as it absorbs the product* *Controls only some of the plants treated* *Acts on the seed to prevent germination* *Acts on the emerged plant* *Controls all treated plants* *Degrades slowly and controls plants for a long time.* *Is rapidly inactive after application and controls plants only for a short period.*	Bifagan 480SL	Sel de glyphosate IPA 480g/l ; SL	4000f CFA (6,10€)	50/50 (100%)
		Bazooka 720SL	24-Dsel d'ambre 720g/l	1000f CFA (1,15€)	
		BÂRÂKÂ 432EC	360g/I projanil +72g/l Triclopyr	4000f CFA (6,10€)	
		Akateli 108 EC	Laloxyfop R-netty 109g/l	1000f CFA (1,15€)	
		Sun-Complet 480SL	Bentazone 480g/l	1000f CFA (1,15€)	
		Gramoquot	Paraquat dichloride	5000f CFA (7,62€)	
		Dyfolette	Paraquat chloride	5000f CFA (7,62€)	
3	**Fungicides** *Mode of action* *Controls diseases* *Treatment of the aerial parts of the soil or seeds and plants* *Protects the plant by preventing the disease from developing.* *Suppresses a disease that has already developed.*	Impulse 800EC	Spiroxamine 800g/l	4000f CFA (6,10€)	46/50 (92%)
		Luna sensation 500SC	Fluopyram 250g/l Trifloxystrobin 250g/l	3500f CFA (5,34€)	
		Nativo 300g/l	Tebuconazol 250g/l Trifloxystrobin 250g/l	5000f CFA (7,62€)	
		Sérénade ASO	Bacillusamyloliquefaciens QST713	5000f CFA (7,62€)	

Source: Field survey; TAPE, 2022-2023

The data in the table indicate that 100% of respondents use herbicides to slow the growth or destroy weeds. To kill insects, their larvae and/or eggs, 96% of respondents use insecticides. As for those who use agricultural fungicides to combat phtyopathogenic fungi that can cause damage to crops, they number 46, or 92% of all respondents.

These pesticides contain active ingredients such as glyphosate, cypermethrin, triffoxy sulfuron sodium, bentazone, spiroxamine, paraquat dichloride and chloride. Most of these active ingredients are toxic in the aquatic environment. As for paraquat, it is a very dangerous product even at very low doses and is prohibited, but it is used due to ignorance linked to the low level

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of education of farmers (54% are illiterate) and lack of supervision. However, rodenticides are also used by some farmers as a means of hunting rodents such as mice, rats and agoutis for consumption. These products are available in different formulations (liquid, solid or gas) to make their application as effective as possible. The attractive price of these products and their effectiveness are at the base of the craze observed in the population. However, according to specialists, the risk with these pesticides lies in their toxicity and the way they are used by farmers despite the fact that the Lethal Dose 50 (LD50) of most of these products is less than 50. The picture 1 and 2 below gives an overview of the pesticides sold and the conditions of their application by the populations.

Picture 1: View of some pesticides on sale store without in Equipment (PPE)

Picture 2: A pesticide applicator in Tiahouo in a Bazra-Natis Personal Protective

Source: Survey image, TAPE, 2023

Photo 1, gives an overview of some products prized by farmers in cashew plantations. These are Altes 45EC and Tako-Kele 300Sl. Photo 2 shows the conditions in which farmers use pesticides without a minimum of protection. This exposes them to all the risks that can seriously harm their health.

2.3. Pathologies Encountered in the Respondents

According to health service officials and toxicology specialists, pesticides can enter the body (human poisoning) through voluntary or involuntary ingestion (dirty hands), inhalation and skin contact. The risk of intoxication for humans results both from the danger linked to the toxicity of the active substance (acute and chronic toxicity) and from exposure to the pesticide (daily dose absorbed, quantity of residues present). Table 2 below shows the pathologies and ailments contracted by the respondents as a result of the use of pesticides.

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Table 2: Pathologies and clinical signs observed in the respondents

Pathologies and discomforts related to to the use of pesticides	Workforce	Percentage
Skin conditions (Burning, itching, dermatitis)	17	34%
Respiratory irritations (Coughing, dyspnea, pulmonary edema, nosebleeds, nasal ulcers, chronic bronchitis, respiratory distress)	7	14%
Eye irritations (Poor vision, tearing, eye pain)	2	4%
Gastric disorders (Diarrhea, vomiting)	14	28%
Hormonal disorders (Sexual weakness, miscarriage, congenital malformations)	1	2%
Headaches (frequent)	5	10%
No discomfort	4	8%
Full	50	100%

Source: Survey data; TAPE, 2022-2023

The analysis of the table shows that skin diseases and gastric disorders are the most frequent ailments encountered by farmers after pesticide use. These ailments represent respectively 34% and 28% against 14% for respiratory irritations and 10% for frequent headaches. However, 8% of the respondents stated that they did not suffer any adverse effects from these plant protection products after their application. However, for all these respondents, prolonged exposure to these products could be fatal. In addition, it appears from the consultation registers of the rural health centers that, after malaria, the greatest number of cases of illness recorded concern skin irritations, respiratory ailments and digestive disorders. According to the managers of these rural health centers, although it is difficult to establish an irrefutable link between the use of these pesticides and the pathologies recorded among the farmers, the probability of the occurrence of these pathologies and discomforts following the handling of these chemical products seems plausible. Moreover, according to them, a significant increase of some cognitive disorders (attention, visuomotor capacities, verbal abstraction, perception) has also been observed in farmers after a chronic exposure to carbamates that they use abusively every year. However, according to O. Saadane (2018, p.49), the effects of pesticide intoxication occur immediately or within hours of significant exposure. The knowledge of these effects makes it possible to apprehend the degree of dangerousness of pesticides and the risks incurred in case of accidental exposure.

2.4. Modes of Poisoning and Risk Factors Associated with Pesticide Use

A health risk factor is defined as a variable associated with an increase in the probability of the occurrence, introduction, development, and/or expansion of a disease (S. Cardoen et al., 2014,

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p.7). In the context of this study, risk factors constitute all of the farmers' practices or attitudes likely to negatively impact their health following the application of plant protection products. Thus, out of the eighteen (18) risk factors of intoxication identified, sixteen (16) were retained and classified into three groups according to their mode of penetration (of intoxication), namely, the risk factors of intoxication by the skin (or mucous membranes), the risk factors of intoxication by the digestive tract (or by ingestion) and the risk factors of intoxication by the respiratory tract (or by inhalation). These risk factors and the modes of intoxication listed in Table 3 below have been deemed preponderant by specialists (in toxicology, human and animal health, agro-pastoral) in the risk of intoxication related to the use of pesticides in rural areas in agricultural activities.

Table 3: Risk factors by mode of pesticide intoxication (or entry)

Modes of intoxication or penetration of pesticides	Selected risk factors	Number of respondents using these practices	Percentage
Intoxication through skin or mucous membranes	Handling pesticides without proper attire	50/50	100%
	Handling of products without helmet, gloves, boots, glasses	48/50	96%
	Handling of products with used clothes (pants and shirt often torn or with holes)	50/50	100%
	Use of domestic buckets and cans used for the preparation of pesticide slurries	38/50	76%
Intoxication by the digestive tract or by ingestion	Failure to wash hands after handling and bringing hands to mouth	27/50	54%
	Use of empty containers in management	41/50	82%
	Use of kitchen utensils for product dosage	15/50	30%
	Consumption of dead animals with signs of intoxication due to ingestion of pesticide-treated grasses	37/50	74%
	Consumption of edible plants in the vicinity of treated crops	50/50	100%
	Body washing and treatment materials in drinking water points (stream, borehole, traditional well)	45/50	90%
	Inadvertent or deliberate ingestion of products in the diet	6/50	12%
Respiratory or inhalation intoxication	Unmasked handling of content in applications	50/50	100%
	Inhalation of contents evaporated in the area during treatments	50/50	100%
	Storage of treatment materials in the dormitories	39/50	78%
	Storage in the dormitories without being washed, of the clothes having been used for the application	44/50	88%
	Deposit and storage of empty containers in or near homes	36/50	69%

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Source: Survey data; TAPE, 2022-2023

3.5. Evaluation and Analysis of the Risks of Intoxication Related to the Use of Pesticides

The risk assessment and analysis is performed according to the epidemiological table template below (Table 4) adapted to this study (FOUCAN, 2012 In COULIBALY, 2017, pp.196-197).

Table 4: Epidemiological Model

		Sick farmers	
		Yes	No
Farmers' use of practices or attitudes practices or attitudes (corresponding risk factors)	Yes	A	B
	No	C	D

a + b = farmers using risky practices
c + d = farmers who do not use risky practices
a + b + c + d = total number of farmers

Source: FOUCAN L. (2012 In COULIBALY, 2017) Model adapted for study; TAPE, 2022-2023

To measure the level of risk, Relative Risk (RR) and Attributable Risk (AR) were calculated. The relative risk (RR) is the ratio of the incidence of diseases in the group of farmers using the risky practices to the incidence of diseases in the group of farmers not using these practices considered as risk factors. The interpretation of the relative risk (RR) is done as follows:

- If RR = 1: No association between the pathologies resulting from intoxication (or penetration) and the farmers' practices (practices corresponding to the risk factors of intoxication);
- If RR > 1: Positive association: the risk of diseases (or intoxication) is higher among farmers using these risk practices than among farmers not using these practices. This also means that the risk factors retained by the experts in this study are indeed risk factors for pesticide poisoning;
- If RR < 1: Inverse association: the risk of disease (or poisoning) is lower in farmers using these practices than in farmers not using these practices. In this case, the risk factors studied are protective factors.

The Attributable Risk (AR) is the share of the risk studied in the case of diseases to the exclusion of other factors and is expressed as a percentage (%).

- Assessment and Analysis of the Risk of Skin (or mucous membrane) Poisoning Related to Pesticide Use

Table 5 contains data on the health status of farmers in relation to their attitude towards pesticides.

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Table 5: Classification of farmers according to their health status, practices (risk factors) and mode of skin poisoning

		Farmers with diseases		Total
		Yes	No	
Farmers' use of risky practices (corresponding to risk factors)	Yes	44	1	45 (90%)
	No	2	3	5 (10%)
Total		46 (92%)	4 (8%)	50 (100%)

Source: Survey data; TAPE, 2022-2023

The results indicate that 92% of the farmers are affected by diseases versus 4%. Out of all these farmers, 90% use risky practices.

- Calculation of the Relative Risk (RR)

RR= F1 / F0

F1: Frequency of disease cases in the group of farmers using risky practices. F1 = a / (a+b) = 44/(44+1) = 0.98 or 98%.

F0: Frequency of disease cases in the group of farmers not using these practices considered as risk factors. F0 = c / (c+d) = 2/(2+3) = 0.4 or 40%.

Thus, RR= F1 / F0 = 0.98/0.4 = 2.45

- Interpretation

The relative risk (RR = 2.45) is greater than 1, which means that the risk of poisoning is higher for farmers using risky practices than for farmers not using these practices. In other words, farmers using risky practices have a 2.45 times higher probability of being poisoned following the application of pesticides than those not using these practices. Therefore, the factors selected are indeed risk factors because 88% of the patients use these risky practices before, during and after the application of pesticides.

- Calculation of the Attributable Risk (AR)

AR= F1 - F0 = 0.98 - 0.4 = 0.58 or 58%.

- Interpretation

This result means that 58% of the pathologies suffered by the farmers (or from which they suffer) are attributed to their recourse to practices at risk of intoxication (or penetration by the skin) of pesticides following their use.

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- **Evaluation and analysis of the risk of digestive intoxication (ingestion) related to the use of pesticides**

Table 6 below records the data on the health status of farmers in relation to their attitude towards pesticides.

Table 6: Classification of farmers according to their health status, practices (risk factors) and mode of digestive intoxication

		Farmers with diseases		Total
		Yes	No	
Farmers' use of risky practices (corresponding to risk factors)	Yes	43	3	46(92%)
	No	3	1	4 (8%)
Total		46 (92%)	4 (8%)	50 (100%)

Source : Field survey, TAPE, 2022-2023

The table shows that as many respondents have used risky practices as those who have had contact with a disease, i.e. 92% respectively. The table also shows that as many people who are ill and do not use risky practices as those who are not ill but do use risky practices (6%). This indicates that each individual's reaction to the disease is unique.

- Calculation of the relative risk (RR)

RR= F1 / F0

F1 = a / (a+b) = 43/(43+3) = 0.93 or 93%.

F0 = c / (c+d) = 3/(3+1) = 0.75 or 75%.

Thus, RR= F1 / F0 = 0.93/0.75 = 1.24

-Interpretation

The relative risk (RR = 1.24) is greater than 1, which means that the risk of intoxication among farmers using risky practices is therefore higher than among farmers not using these practices. These individuals have a 1.24 times higher probability of becoming ill as a result of their bad attitude towards the use of pesticides. Thus, the selected factors are indeed risk factors. 86% of the sick farmers use these practices.

-Calculation of the attributable risk (AR)

AR= F1 - F0 = 0.93 - 0.75 = 0.18 or 18%.

-Interpretation

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This result means that 18% of the pathologies from which farmers suffer (or have suffered) are attributed to their use of practices identified as risk factors for pesticide intoxication (or penetration into the body) by ingestion or digestion.

- **Evaluation and analysis of the risk of intoxication by the respiratory route (by inhalation) linked to the use of pesticides**

Table 7 below shows data on the health status of farmers in relation to their attitude towards pesticides.

Table 7: Distribution of farmers according to their health status, their practices (risk factors) and mode of intoxication by the respiratory tract

		Eleveurs atteints de maladies		Total
		Yes	No	
Farmers' use of risky practices (corresponding to risk factors)	Yes	45	3	48 (96%)
	No	1	1	2 (4%)
Total		46 (92%)	4(8%)	50 (100%)

Source : Field survey, TAPE, 2022-2023

The results in Table 7 show that 96% of the respondents used risky practices compared to 35% and those who contracted a pathology following the application of pesticides represent 92%.

-Calculation of Relative Risk (RR)

RR= F1 / F0

F1 = a / (a+b) = 45/(45+3) = 0, 94 or 94%.

F0 = c / (c+d) = 1/(1+1) = 0.5 or 50%.

Thus, RR= F1 / F0 = 0.94/0.50 = 1.88

-Interpretation

The relative risk (RR = 1.88) is greater than 1, which means that the probability of being poisoned by pesticides is 1.88 higher in farmers using risky practices than in farmers not using these practices. Thus, the risk of contracting diseases following the application of pesticides is higher in these individuals. Thus, the factors selected are indeed risk factors because 90% of the individuals who became ill used these risky practices before, during and after the application of pesticides.

- Calculation of the attributable risk (AR)

RA= F1 - F0 = 0.94 - 0.50 = 0.44 or 44%.

- Interpretation

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This result means that 44% of the pathologies from which the farmers suffered (or from which they suffer) are attributed to their use of the practices retained as risk factors of intoxication (or penetration) by respiratory or inhalation of phytosanitary products.

Discussion

In the sub-prefecture of Bazra-Natis, the intensive use of pesticides by farmers in agricultural activity presents both environmental and health risks. The exposure of farmers to health risks as a result of poor practices in the face of pesticide toxicity is at the root of many of the pathologies and ailments encountered. Thus, 100% of the farmers admitted to having consumed edible plants in the vicinity of treated crops and 90% wash the treatment materials in drinking water points (stream, borehole, traditional well). 75% handle pesticides without personal protective equipment (mask, helmet, gloves, boots, goggles) and consume dead animals marked by signs of intoxication following ingestion of pesticide-treated herbs. As a result, farmers who use these risky practices have a higher risk of poisoning than those who do not use these practices. In Côte d'Ivoire, pesticide poisoning is a public health problem. Between 2001 and 2014, 84 deaths were recorded out of 191 people poisoned in the departments of Yamoussoukro, Divo, Bondoukou, Abengourou and Tiassalé (MEMADR, 2021, pp.83-84). Also in the sub-prefecture of Tapeguia, the results of a study on the risk factors of modernization of pesticide-based agriculture revealed that the risk factors of degradation of agro-ecosystems and human poisoning were related to overexploitation of fallow land, unregulated use of pesticides, and farmers' ignorance of the risks of poisoning because they lacked training on the use of pesticides (B. R. N'guessan et al., 2019, p.378). In order to reduce the use of pesticides in agriculture in Côte d'Ivoire, alternatives to persistent organic pollutants have been developed. They concern legislative, cultural, genetic, integrated, biological control as well as the use of bio-pesticides and pesticides of the organophosphate, carbamate, Pyrethroid family (MADR, 2018, p.42). The use of synthetic pesticides to optimize crop yields and its consequences on health have also been reported in other countries. In Morocco, according to O. Saadane (2018, p.51) the high prevalence of acute pesticide poisoning stems from the high frequency of voluntary circumstances of which 72.5% of cases are due to insecticides, 24.8% to rodenticides and 1.7% to herbicides. In Burkina-Faso, insufficient protection during the use of pesticides, storage of pesticides at home, rinsing of treatment equipment in drinking water points represent risks of intoxication and environmental pollution (H. Compaore, 2020, pp.12-16; V. R. Sawadogo, 2016, pp.17-18). Chromatographic analysis

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after extraction and purification in Senegal at the Pikine site showed the presence of pesticide residues in agricultural products with dicofol (0.056 to 2.050 mg/kg) and endosulfan (0.006 to 0.095 mg/kg) contamination as well as major metamidopho contamination varying between 0.011 and 0.035 mg/kg and 0.005 and 0.170 mg/kg (NGOM S. et al., 2012, p.119). However, according to M. Kanda et al, (2013 In B. R. N'guessan *et al.*, 2019, p.385), the general discomfort caused by these pesticides can be mild or severe.

Conclusion

In sum, farmers in the Bazra-Natis sub-prefecture use pesticides (herbicides, insecticides, fungicides) to protect crops and improve productivity while minimizing or even ignoring the health risks to which they are exposed. The pathologies linked to the misuse of these phytosanitary products are numerous (skin diseases, respiratory and eye irritations, digestive and hormonal disorders, frequent headaches) as well as the human intoxication routes (by skin, by ingestion, by respiratory route). The evaluation and analysis of the risks of intoxication according to the modes of contamination (by the skin, by ingestion, by respiratory route) indicate that the risk of intoxication related to the use of these pesticides is higher in the farmers having resorted to risky practices than in those not having resorted to these practices (RR = 2.45 > 1; RR = 1.24 > 1; RR = 1.88 > 1). Similarly, the medical conditions they suffer (or have suffered) are attributed to these risky practices as risk factors for intoxication or penetration through the skin, digestive tract, and inhalation of these pesticides (AR = 0.58; AR = 0, 18; AR = 0.44) before, during, and after application. To reduce all kinds of human intoxication problems related to the handling of pesticides in rural areas, preventive measures must be taken and include training and awareness-raising of farmers on agricultural systems (conventional, integrated, organic, integrated farming, crop rotation) as well as on the handling of pesticides and the wearing of personal protective equipment.

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