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Pesticides in Burkina Faso: Overview of the Situation in a Sahelian African Country

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1. Introduction

Sahelian Africa is a transition zone which is located between the arid Sahara in the north and the humid tropical area from the south. The list of countries covering this area is such as follows; Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Chad, Sudan as well as the so called "Horn" of Africa which is formed by Ethiopia, Eritrea, Djibouti, and Somalia. Among the most striking characteristic concerning the climate from this particular African area, we find its instability which means that either it may register heavy rainfalls in short periods, normally between June and September, or suffer from severe droughts.

Burkina Faso is an agricultural country with a large rural population. The total area in cultivation is estimated to be 2,900,000 hectares. Synthetic pesticides have been used in Burkina Faso for about eight decades. At a global level, some studies have been carried out on impacts of pesticide use (Eddleston et al., 2002, Konradsen, 2007, Lee and Cha, 2009). However, few updated studies have been carried out on patterns and impacts of pesticides use in Sahelian countries. The purpose of this paper is to provide an overview of pesticides in Burkina Faso, almost one century after the introduction of synthetic pesticides. Assuming that the other Sahelian countries have the same socio-economic level as Burkina Faso, their patterns of pesticides use may be not different.

This briefing summarizes the findings of studies regarding the situation of pesticides in Burkina Faso and the subsequent recommendations for taking action at policy and program levels.

2. Geographical description of Burkina Faso

2.1 Description of the physical environment

The country of Burkina Faso is located in the central area of West Africa (Fig. 1). It is 273 187 km² in area, and its altitude ranges from 150 to 750 m above sea level. It lies in the transitional areas between the Sahel in the north and the Sudano-Guinean zone in the south. The topography of Burkina Faso is mostly flat and eroded. The natural soil fertility is poor. It has been estimated that over 50% of Burkina is still covered with natural vegetation, which ranges from grass savannah in the north, to gallery forests in the south. Rainfall

ranges from 400 mm in the north to 1300 mm in the south-west. The monthly average temperatures vary between 12 and 42 °C. The country is drained to the south by the Black Volta (Mouhoun), Red Volta (Nazinon), and White Volta (Nakanbe) rivers and to the east by the Sirba, Gorki and Mahiou rivers connecting with the Niger. Other rivers include the Comoe, Léraba and Banifing, and the Pendjari on the frontier with Benin (FAO, 2010, INSD, 2010).

Fig. 1. No. 4045 Rev. 5 UNITED NATIONS Department of Field Support
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2.2 Agricultural resources

The people of this landlocked Sahelian country are engaged primarily in agriculture. Agriculture plays a vital socio-economic role in Burkina Faso in term of export, employment opportunities, and food self-sufficiency. Burkina Faso is a country with agricultural vocation with 85 to 95% of the population which draws its subsistence from agriculture. The contribution of the agricultural sector to the GDP (gross domestic product) is 33.3%. The total area in cultivation is estimated to be 3.6 million hectares. It is dominated by the cereal cultures (approximately 82%) followed by market crops (15%), mainly the cotton and the groundnut which constitute 14%. The market gardening represents less than 1% of the total area in cultivation. The annual agricultural productions are dominated by the cereals (75%) followed by market crops, mainly cotton and the groundnut. The important crops in Burkina Faso are millet and sorghum. Other crops are grown in lesser quantities: corn, bean, rice, fonio, potatoes, vegetables, sesame (INSD, 2010).

During the crop year 2008-2009, the cereal production (sorghum, millet, corn, rice and fonio) was estimated at approximately 4,500,000 tons. An analysis of the composition of this production shows that the sorghum is the most produced cereal, followed by millet, corn and finally fonio. The production of the market crops was 1,100,000 tons in 2008. Cotton represents nearly 70% of this production. The production of bean always exceeds the 100, 000 tons whereas those of the yam and potato don't reach 100,000 tons of production per annum. The diseases and insects of the cultures cause considerable damage, being able to generate in certain cases, losses in production rising more than 30% (CountrySTAT, 2010). The use of phytosanitary products is consequently necessary to dam up these enemies of cultures in particular those of the market crops: cotton, sugar cane, market gardening, etc.

3.Pesticides management in Burkina Faso

3.1 Pesticides production and distribution

The alone company producing pesticides in Burkina Faso is SAPHYTO. This company imports active ingredients, and fabricates products. While this company primarily serves the cotton industry, it also sells pesticides to other parties. The principal pesticides produced in term of weight and volume are diversified (Table 1).

The majority of pesticides used in Burkina Faso are imported from other countries. Points of origin include Senegal, Cote d'Ivoire, Nigeria, Mali, South Africa, Tunisia, Japan, Indonesia, China, Thailand, Europe and the United States. Once a pesticide arrives in Burkina Faso, it is distributed to the end-user through merchants. Import and in-country distribution is controlled by several governmental agencies. While a regulatory structure exists, it is not always followed by the distributors involved. From 1997 to 2001, more than thirteen million liters of liquid pesticides and 900000 kg solid pesticides were imported in Burkina Faso. The growth rate of the use of the pesticides per annum would reach 11% (Toé and Kinané, 2004).

The obstacles to the performance of the distribution system of the pesticides in Burkina Faso are mainly: the absence of association of the professionals of phytosanitary products, the weak application of the existing lawful texts, the low technical level of the actors of this market, the insufficiency of the quality control of the pesticides.

3.2 Managing pesticides stocks

Only the cotton companies have suitable stores for the storage of the pesticides. The agricultural producers do not have in general suitable storerooms. Indeed it can happen that

the products are stored in the rooms, in the dwellings, in containers that are not labeled (Ouédraogo et al., 2009).

Trade name	Active ingredients	Pesticide type	Annual production
Calthio	lindane - thriname	Insecticide	20.8 tons
Durexa	chlorpriphos-ethyl	Insecticide	10 tons
Percal M	permethrin - malathion	Insecticide	4 tons
Cypercal 50 EC	cypermethrin	Insecticide	3.5 million liters
Cotodon plus	metolachlore – terbutryne	Herbicide	14 900 liters
Gramoxone	paraquat	Herbicide	14 262 liters
Primagram 500	atrozime - metolachlore	Herbicide	11 651 liters

Table 1. Principal pesticides formulated in Burkina Faso by SAPHYTO Company

Fig. 2. A pesticide box, kept under a traditional attic located in a dwelling

3.3 Pesticides labeling

Pesticides labeling is a way to give important information to the pesticide users. The label is the main and often only medium for instructing users in correct and safe use practices. The pesticide product label can be effectively used to communicate a number of important properties of the pesticide and precautions appropriate to its use. In addition to directions for use, the label should include needed protective measures, first aid measures, precautions recommending against use in certain environments, methods of container disposal, and application rates for particular pest species.

Pesticides labeling in Burkina Faso is quite variable. In general, pesticides in the original container carry a label with adequate information for application. Some labels, though not all, contained some information on first-aid or disposal. However, pesticides sold in the markets have either lost what labels did exist, or are illegible due to handling and exposure (Tankoano, 2008).

3.4 Obsolete pesticides and containers

The obsolete pesticides indicate products out-of-date, prohibited, or not identifiable. In Burkina Faso, the alone company producing pesticides set up a system of treatment and valorization of the obsolete pesticides: decontamination of empty packing, suitable storage of lost packing, crushing and decontamination of the container, incineration of biodegradable and decontaminated packing. Active ingredients are added to the expired, so they are usable at least for one year. The non-recoverable pesticides are eliminated after coagulation, flocculation, or decantation. The muds obtained in this case are stored in barrels. Then these barrels are sent to companies in Europe for ultimate elimination. Previous studies revealed the presence in Burkina Faso of enormous quantities of out-of-date pesticides going back to several years. These out-of-date pesticides are mainly organophosphates and pyrethrinoid insecticides (Toé and Kinané, 2004).

Once the pesticide has been used, the management operation is left with an empty container. This container can be either reused or destroyed. If reused it should be only be used for the same pesticide or to store fuel. It should never be used to store water or food. In Burkina Faso, the empty metal boxes and plastic cans are either abandoned in nature (48%), or are washed and reused (12%), or hidden in the fields (40%) by users (Tankoano, 2008). The majority of these modes of elimination of empty packing (abandon in nature, wash and re-use) increase the risks of intoxication of populations and pollution.

4. Pesticides usage in Burkina Faso

4.1 Socio-demographic characteristics of the users

The majority of the users of pesticides are male (more than 95%). The users are young (median age, 37 years). More than 80% of the users are illiterate and two users out of three are married. More than 50% of the users of pesticides have done it for at least 10 years (Konaté, 2010, Tankoano, 2008).

4.2 Pesticides commonly used in Burkina Faso

Pesticides are used in Burkina Faso mainly in agriculture for control of pests, weeds, rodents; in public health for control of malaria, and for control harmful domestic animals. Cotton is one crop which is grown only on 5% of the cultivated areas, but consumes more than 90% of total pesticides used in Burkina Faso. Thus, the use of pesticides is high intensive in parts of the country where cotton is cultivated i.e where soils are fertile. All the chemical classes of synthetic pesticides are used in Burkina Faso. The most used are organochlorines (endosulfan), organophosphates (profenofos), carbamates (carbofuran), pyridines (paraquat), and pyrethrinoids (cypermethrin). Among the pesticides used in Burkina Faso, they are PIC (Prior Informed Consent) Pesticides (Toé and Kinané, 2004) .

The (PIC) procedure provides a framework for governments primarily aimed at developing countries to prohibit the import of certain pesticides which have been banned or severely restricted for health or environmental reasons. Convention on Prior Informed Consent (PIC) serves as an early warning system to notify developing countries of hazards and limit export of toxic pesticides by requiring exporting countries to receive prior approval from the recipient country (Konradsen et al., 2003). Among the PIC pesticides, lindane and methamidophos are found in Burkina Faso. The first is used in combined with thiram to treat cotton seeds, the second combined with cypermethrin to treat cotton plants.

Pesticides belonging to the class Ia or Ib (Classification WHO) are also used in Burkina Faso (Tables 2 and 3). However, the restrictions relating to their uses are generally ignored, thus not respected (Konaté, 2010, Tankoano, 2008).

Class	Restrictions
Ia Extremely hazardous	Usable only by applicators having licenses
Ib Highly hazardous	Usable by well trained applicators
II Moderately hazardous	Usable by applicators who strictly respect the precautions
III Slightly hazardous	Usable by applicators who respect the usual precautions

Table 2. WHO classification of pesticides by hazard (WHO/PCS)

Officially, no pesticide belonging to the list of Persistent Organic Pollutants (POPs) is used in Burkina Faso. However, it is possible that this class of pesticide is still used because some pesticides are marketed illegally and fraudulently in Burkina Faso. POPs are chemicals that persist in the environment, accumulate in high concentrations in fatty tissues and are bio-magnified through the food-chain. Hence they constitute a serious environmental hazard that comes to expression as important long-term risks to individual species, to ecosystems and to human health. POPs chemicals may cause cancer and disorders in the reproductive and immune systems as well as in the developmental process. They constitute a particular risk to infants and children who may be exposed to high levels through breast-milk and food (Mörner et al., 2002).

Pesticides Ia	Pesticides Ib	culture
	cypermethrin-triazophos- diméthoate endosulfan cyfuthrin-chlorpyrifos deltamethrine-triazophos carbosulfan cypermethrin-métamidophos	Cotton
Carbofuran		Sugar cane
	cyfutrin-chlorpyriphos cypermethrin -métamidophos	Tomato

Table 3. Some Pesticides Ia and Ib (WHO classification) used in agriculture in Burkina Faso

4.3 Methods of pesticides application and factors affecting proper application

Pesticides application equipment used in Burkina Faso are mostly portable equipments which are manually operated. Most commonly used equipment is hand carried lever operated knapsack sprayer (Fig. 3) which is not very well designed. The applicators have experienced various problems with this equipment during spraying. The most common problems identified were replacement of the piston and clogging of the nozzles.

The major factors affecting the proper application of pesticides are operator knowledge, equipment design, and service conditions of equipment. Applicators still have wrong notion that high volumes, high pressure and high doses are the most appropriate ways of pesticides application. The quality of the equipments is low and they lack maintenance (Tankoano, 2008).

Fig. 3. Applicator operating in a cotton field with a knapsack sprayer

4.4 Factors related to pesticide safety in Burkina Faso

Pesticides usage must be safe for environment, humans, and animals. However, in Burkina Faso, many factors make safety impossible. These factors are enumerated below (Konaté, 2010, Ouédraogo et al., 2009, Toé et al., 2004, Zeba, 2003):

- Poor literacy, which makes it impossible to read or follow complex label instructions. In Burkina Faso, approximately 80% of applicators are illiterate.
- Lack of training in pesticide use; few applicators receive an adapted formation.
- Ignorance about potential dangers of pesticides to health and environment.
- Inappropriate mixing (insecticides combinations i.e. mixing of two insecticides without technical advice) and application methods; different pesticides are frequently mixed together by farmers to make "more effective" pesticides, ensuring that subsequent medical management of poisoned patients is particularly complicated.
- Repeated application of pesticides and application of same pesticides at all stage of life cycle.
- Over application of pesticides.
- Wrong application practices, such as use of same concentration mixture for different sprayers and measurement of dosage by own convenient scale.
- Poor or faulty application equipment.

- Long hours of spraying and spraying during hot weather.
- Smoking or chewing while spraying.
- Poor regulation and easy availability of hazardous pesticides, including sales by untrained dealers.
- Lack of personal protective equipment (boots, gloves and glasses), which are costly. When they exist, they are not used because they are not adapted to a tropical climate.
- Lack of suitable washing facilities for workers.
- Demand for containers, leading to reuse of poorly cleansed pesticide bottles, barrels or cans.
- Reconditioning of the pesticides in non-labeled inappropriate containers.
- Poor household storage and disposal.
- Lack of health centers, medical facilities, antidotes and poison treatment centers, as well as confusion of symptoms of pesticide poisoning with common illness.
- The use of the pesticides apart from their indications, in occurrence on the parasites of the domestic animals, the termites and other insects in the dwelling houses.
- Residence in an agricultural area (Fig. 4).
- Presence of well or river near the treated fields.
- Presence of wild fruit trees in the treated fields (Fig. 5).
- The proximity between the treated fields and cereals non-treated fields (Fig. 5).

Fig. 4. A residence in the middle of fields probably treated by pesticides

Fig. 5. Woman and child passing by a cotton field being sprayed with pesticides; on the left, a sorghum field.

5. Poisonings and pollutions due to pesticides in Burkina Faso

5.1 Acute poisoning

Acute pesticide poisoning has become a major public health problem worldwide, following the intensification of agriculture and the promotion of agrochemicals, with more than 300,000 deaths each year (Gunnell and Eddleston, 2003). The easy access to extremely toxic pesticides in the homes of the rural population has made pesticides the preferred means of suicide with an extremely high case fatality. The problem of acute pesticide poisoning in Burkina Faso is not well-documented though some preliminary epidemiologic studies were carried out in some parts of the country. The majority of the poisoned are over 15 years old, regardless of sex, possesses low levels of education and residing in rural areas. Etiologies are both accidental and deliberate self-poisoning (Toé et al., 2000). In two University Hospitals in Burkina Faso, agricultural pesticides are the chemicals the most implicated (29%) in acute poisoning after caustic agents (43%) in 2006 and 2007. The number of pesticides poisoning cases was the highest during the growing season from May to October (Yéré, 2007). The outcome of one-third of the acute intoxications is death (Toé et al., 2000). First aids given outside health centers to a minority (15%) of acute poisoned-patients are inadequate (e.g. drinking oil and/or milk). Drinking oil and/or milk is a worsening factor of intoxication because the majority of pesticides are soluble in fatty products. Evacuation, symptomatic or antidote treatment are often carried out in the health centers (Tankoano, 2008).

5.2 Chronic poisoning and pollution

The pesticide practices of farmers can lead to poisoning in long-term. These practices include spraying without any safety equipment for far longer than recommended periods, residing in agricultural area where pesticides are used (Fig. 4). The chronic exposure to the pesticides may trigger a variety of chronic health effects, such as cancers, neurologic effects and reproductive effects. The significant problems of human illness and death that follow chronic exposure to pesticides in Burkina Faso are not well-documented. Chronic poisoning could be common because pesticides applicators never have complete and adequate individual protective equipment (Ouédraogo et al., 2009). They think it is expensive and impractical to use safety equipment in Sahelian climate (Konaté, 2010). A study in the cotton-production region of Mouhoun in Burkina Faso revealed that more than 80% of pesticides applicators had lowered cholinesterase activity during at least two months after application (Toé et al., 2000).

The inadequate management of pesticides in Burkina Faso is a source of pollution of the environment (soils, waters, air, plants) i.e. the introduction of contaminants into a natural environment that causes instability, disorder, harm or discomfort to the ecosystem (physical systems or living organisms). Some studies confirmed the pollution of the waters and grounds of Burkina Faso, especially in the zones of cotton culture. Evaluation of soils pollution by the pesticides used in cotton production was carried out in seven sites of cotton culture area of Burkina Faso. Soils samples were taken in the cotton fields during the rainy season and the dry season in 2003 and 2004. Then, residues of pesticides were analyzed by gas chromatography. The results showed that the soils were contaminated by endosulfan (an organochlorine) in the level of 1 to 22 μg/kg. A low pollution (1.7 to 5 μg/kg) by dimethoate (an organophosphate) was noted (Savadogo et al., 2006). That is not surprising because the organochlorines are known to be more persistent in the environment than organophosphates (Derkaoui et al., 2011). Another study revealed that in 2001, hundreds of fishers are found died on the edges of the main river that runs through the city of Bobo-Dioulasso in Burkina Faso. Chemical analysis indicated the presence of lindane and thiram in the organs of fishes, confirming the report that sacks containing the residues of pesticides had been washed in the river (Tarnagda et al., 2002). Such cases of pollution of waters could be frequent in the region of cotton culture where containers of pesticides are often washed in rivers or abandoned in the environment (Ouédraogo et al., 2009).

6. Alternatives to pesticides in Burkina Faso

6.1 Cultural, biological and traditional control

Sustainable pest management is a prerequisite to farming in semi-arid environments of Africa. Reliance on synthetic chemicals to control pests has also given rise to a number of problems such as destruction of beneficial non-target organisms (parasitoids and predators) thereby affecting the food chain and impacting on biological diversity. The injudicious use of synthetic pesticides can lead to secondary outbreaks of pests that are normally under natural control resulting in their rapid proliferation. There have also been cases of pests becoming tolerant to insecticides. In addition, due to other problems such as health hazards, undesirable side effects and environmental pollution caused by the continuous use of synthetic chemical pesticides there is renewed interest in the application of cultural and biological techniques, and in the use of botanical pesticides for crop protection. In Burkina Faso, researches have been undertaken to control pests by local plant materials. *Hyptis*

spicigera Lam., *Azadirachta indica* A. Juss. and *Euphorbia balsamifera* Ait. are investigated ; results from these studies are encouraging (Bambara and Tiemtoré, 2008). The use of such plant extracts to control pests is not a new innovation, as it has been widely used by small-scale subsistence farmers (Roy et al., 2005). Most of these botanical pesticides are non-selective poisons that target a broad range of pests. Botanical pesticides are biodegradable (Delvin and Zettel, 1999) and their use in crop protection is a practical sustainable alternative. They maintain biological diversity of predators (Grangen and Ahmed, 1988) and reduce environmental contamination and human health hazards. However, research on the active ingredients, pesticide preparations, application rates and environmental impact of botanical pesticides are a prerequisite (Buss and Park-Brown, 2002) for sustainable agriculture. The financial cost of these "biopesticides" could also be an obstacle to their development.

Research on field use of microbial agents in pests control is also an alternative to pesticides. In working with microbial pest control agents, attention must be given to handling and application techniques.

Numerous cultural and biological methods have been experimented by local populations for several years. For example, crop varieties which develop at different rates from the commonly planted varieties, or which show resistance to insect attack are often used by local populations. For example, sorghum is more resistant to attack by grasshoppers than millet.

6.2 Introduction of genetically modified organisms (GMO)

As cotton culture is the main market crop in Burkina Faso and consumes more than 90% of total pesticides used in Burkina Faso, development of genetically modified cotton ("Bt cotton") has been undertaken by an American company in collaboration with Burkina Faso National Agricultural Research Institute. The American company has a gene derived from *Bacillus thuringiensis* (Bt) that protects the plants from specific lepidopteron insect pests. Bt cotton could reduce the need for costly pesticides and raising yields by around 30 percent. Two strains of Bt cotton, both developed from local varieties, have been approved for production and general sale in Burkina Faso. Bt cotton required only two pesticide treatments per season, compared with six or eight for non-modified cotton, according to its promoters. That cut pesticide use by at least 60 percent. 8,500 tons of Bt cotton were marketed in 2009. With its 115,000 hectares sown in 2009, a quarter of the surface area devoted to cotton, Burkina Faso will likely be into the top 10 producing countries of GMO cultivations with Bt cotton. Year 2010 marked the launch of large-scale genetically modified cotton on approximately 475,000 ha (Bonkoungou, 2008, Tao, 2010) .

However, use of genetically modified crops has faced opposition from environmentalists who say the release of GMO could upset delicately balanced habitats or even lead to uncontrolled super species.

7. Recommendations

At the end of the overview of the situation of pesticides in Burkina Faso, the following recommendations could be suggested:

- Development of a system for dynamic inventory of pesticide chemical stocks.
- Pesticides used should be those with the minimum impact on non-target species.

- Appropriate labeling of all pesticides containers.
- Development of training courses for health personnel in areas where pesticides are used frequently.
- Development of training for pesticides storage and applications management, for empty containers and obsolete pesticides management intended to the users.
- It is also recommended to limit the fraudulent importation of not approved pesticides.
- A periodic evaluation of the environmental impact of pesticides in the areas where pesticides are used frequently.
- Epidemiological case-control studies should be implemented in areas of heavy human exposure to pesticides.
- Research on bio-pesticides must be encouraged.
- Research on the impact of genetically modified organisms (resisting to some pests) on environment and human health must be frequently carried out after their use at large-scale.

8. Conclusion

Pesticides are used in Burkina Faso mainly in agriculture for control of pests and weeds, especially in the cotton culture. All chemical families of pesticides are used but mainly organochlorines, organophosphates, carbamates, pyridines, and pyrethrinoids. Pesticides are not always handled carefully or tracked to insure correct use and disposal. So, acute, chronic poising and environment pollution were reported. Improvements in the system for managing pesticides must be implemented to protect human health and the environment. As alternatives to pesticides, cultural and biological techniques have been developed but their success is limited. In recent years, trends are to develop genetically modified organisms plants which could resist to pests. So, transgenic cotton production has become widespread in Burkina since 2010. However, use of transgenic has faced opposition from environmentalists. An evaluation of the environmental impact, even on human health of these GMO could be necessary after their use at large-scale.

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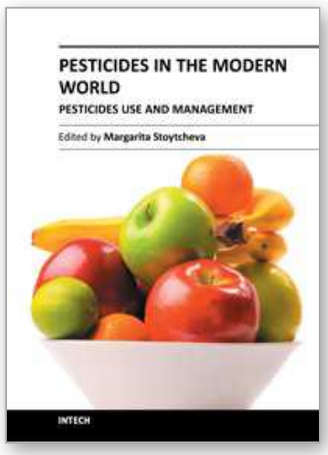

Pesticides in the Modern World - Pesticides Use and Management
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This book brings together issues on pesticides and biopesticides use with the related subjects of pesticides management and sustainable development. It contains 24 chapters organized in three sections. The first book section supplies an overview on the current use of pesticides, on the regulatory status, on the levels of contamination, on the pesticides management options, and on some techniques of pesticides application, reporting data collected from all over the world. Second section is devoted to the advances in the evolving field of biopesticides, providing actual information on the regulation of the plant protection products from natural origin in the European Union. It reports data associated with the application of neem pesticides, wood pyrolysis liquids and bacillus-based products. The third book section covers various aspects of pesticides management practices in concert with pesticides degradation and contaminated sites remediation technologies, supporting the environmental sustainability.

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