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Assessment of herbicide distribution practices, regulatory compliance and hazard profile in western Burkina Faso

Bazoma BAYILI [1], Bernard KOURSANGAMA [2, *], Koama BAYILI [2, 3, 4], Tédébouaouga BAZONGO [2, 3] and Abdoulaye DIABATE [3]

[1] *Ecosystem Management and Monitoring Programme, Western Regional Directorate for Environmental and Agricultural Research, Institute for Environmental and Agricultural Research (INERA), National Centre for Scientific and Technological Research (CNRST), 01 BP 910, Bobo-Dioulasso 01, Burkina Faso.*

[2] *Laboratory for Research and Teaching in Health and Animal Biotechnology, Nazi BONI University (UNB), 01 BP 1091, Bobo-Dioulasso 01, Burkina Faso*

[3] *Laboratory for Research on Infectious and Parasitic Diseases, Regional Directorate of the West, Institute of Health Sciences Research (IRSS), National Center for Scientific and Technological Research (CNRST), 01 BP 545, Bobo-Dioulasso 01, Burkina Faso*

[4] *University Center of Banfora (CUB), Nazi BONI University (UNB), 01 BP 1091, Bobo-Dioulasso 01, Burkina Faso*

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Abstract

The study conducted in western Burkina Faso in 2020 assessed, through a survey, herbicide distribution and retail practices, their regulatory compliance, and their hazard profile. The survey involved 89 retailers across 12 localities in four regions. The results showed that most retailers sourced products from Bobo-Dioulasso (78.7%) and lacked training (84.26%), official authorisation/licensing (94.38%), and the list of authorised pesticides (97.75%). The inventory recorded 167 formulated products based on 25 active substances, of which nearly 60% were not registered/authorised. Banned substances, including paraquat, atrazine, acetochlor and butachlor, were identified. Among the characterised active substances, acute toxicity was dominated by WHO Classes III (40%) and II (28%), while 20% showed reprotoxic effects and 24% had confirmed endocrine-disrupting properties. Acetochlor combined CMR and endocrine-related hazard signals. Management practices included the sale of expired products (22.4%), frequent unsold stock (58.4%), rudimentary cleaning in the event of leakage (54.02%), and disposal of empty containers through dumping, burial or open burning. Overall, herbicide distribution appears insufficiently regulated, calling for strengthened traceability, retailer training, and surveillance of high-risk substances.

Keywords: Herbicides; Retailers; Regulatory Compliance; Toxicological Profile; Western Burkina Faso

1. Introduction

In Burkina Faso, the intensification of cereal-based farming systems and the increasing pressure from weeds have been accompanied by greater reliance on herbicides, which are perceived as a rapid, labour-saving option. This trend reflects a broader pattern across Africa, characterised by rising volumes and a growing diversity of pesticides in use, with risk-management challenges arising at every stage of the product life cycle [1]. In the Sahelian region, placing pesticides on the market is governed by the CILSS Common Regulation and by decisions of the Sahelian Pesticides Committee (CSP), which aim to ensure access to pesticides that have been assessed and authorised at regional level [2]. However, the challenges are not limited to on-farm use: studies in the sub-region show that registration, distribution and market control mechanisms at the level of vendors also represent a major determinant [3].

* Corresponding author: Bernard KOURSANGAMA

The literature therefore highlights that the distribution/retail segment represents a critical point. The FAO/WHO International Code of Conduct emphasises the importance of licensing/authorisation, storage and labelling, the information provided to users, and the management of stocks, waste and obsolete products at the point of sale [4]. In many low- and middle-income countries, agro-input retailers are often the primary source of advice for farmers, yet their safety knowledge and regulatory compliance remain variable, which limits the effectiveness of preventive measures [5,6]. Moreover, the persistence of informal supply chains and the circulation of unregistered, substandard or counterfeit pesticides have been documented in West Africa, with direct implications for human health and the environment, as well as for the credibility of regulatory systems [7–9].

In Burkina Faso, available studies more often focus on farmers' practices and the risks of exposure/contamination [10,11]. By contrast, published data remains limited regarding the actual supply available at points of sale, its regulatory compliance, and in-shop management practices, which nonetheless determine the nature of the products that reach farms. Beyond administrative status, hazard assessment is also essential, as some active substances may present CMR signals (carcinogenicity, mutagenicity and reproductive toxicity) and/or endocrine-disrupting potential. International evaluations of the carcinogenic potential of certain pesticides illustrate the value of incorporating a hazard-based approach when assessing risks in the context of marketing and use [12]. Likewise, international frameworks (WHO/UNEP, OECD) and regulatory tools (ECHA assessment lists) promote a structured identification of these hazards in order to prioritise risk-management measures [13–15]. From this perspective, risk control also depends on the compliance and quality of products available on the market, with distribution acting as an upstream determinant of human exposure and environmental impacts [16].

The overall objective of this study is to assess the marketing and retail practices, regulatory compliance, and hazard profile of herbicides sold in western Burkina Faso. This study provides evidence to inform the strengthening of retailer licensing/authorisation, the training of agro-input dealers, targeted market surveillance, and the prevention of health and environmental risks associated with herbicides.

2. Materials and Methods

2.1. Study design, period and study area

A descriptive cross-sectional study was conducted during the 2020 cereal-growing season. The study covered 12 localities across four regions of western Burkina Faso—Bankui (formerly Boucle du Mouhoun), Tannounyan (formerly Cascades), Guiriko (formerly Hauts-Bassins) and Djôrô (formerly Sud-Ouest)—identified as major areas of herbicide use and circulation.

2.2. Target population, recruitment and sampling

The target population comprised herbicide retailers operating points of sale in the visited localities. An exhaustive convenience sampling approach was used: all retailers encountered who agreed to respond were included. Some vendors were reluctant to participate due to fear of inspection and sanctions related to the sale of products not authorised by the CSP or prohibited products. This context was considered during questionnaire administration (reassuring approach, anonymity, non-accusatory wording) and may explain occasional non-response/missing data.

2.3. Survey setting and data collection procedures

The survey was conducted directly at points of sale (shops, stores and distribution outlets) among herbicide distributors/retailers. Data were collected using a semi-structured questionnaire administered through on-site interviews. The questionnaire covered the retailer's profile and experience, supply channels, knowledge and compliance indicators (training, official authorisation/licensing, awareness of the CSP, possession of the CSP list, and perception of pesticide hazardousness), as well as marketing and management practices (expired products, unsold stock/leftovers, response in the event of leaks/incidents, and management of empty containers and related waste). The units of analysis were the retailer (practices, compliance and management) and each recorded formulated product (trade name and label information).

2.4. Herbicide inventory and extraction of label information

An inventory of available herbicides was conducted at each point of sale. Information was collected through direct reading of product labels, including the trade name, active ingredient(s), formulation type (when indicated), and any available information on packaging and the manufacturer/distributor. Recorded products were subsequently harmonised by correcting spelling variants and standardising trade names.

2.5. CSP status and toxicological characterization of active substances

Information obtained from label reading was complemented by a documentary review based on the CSP global list of authorized pesticides (November 2019 version), used as the operational reference, and on the regional registration framework. Pesticide property databases, particularly the PPDB/BPDB [17], were used to confirm the identification of active substances and to retrieve selected hazard information. For CSP compliance, a formulated product was classified as “authorized” if it appeared on the CSP global list of authorized pesticides, whereas active substances were considered not authorized in herbicide formulations when they were subject to CSP decisions prohibiting their use. Toxicological characterization focused primarily on CMR status and endocrine-disrupting potential; each active substance was coded using reference sources (mainly the PPDB/BPDB) under categories such as “signal present/absent/not documented”, to allow a cautious interpretation. Acute toxicity was assigned according to the WHO recommended classification [18].

2.6. Data management and analysis

Data collection forms were checked after fieldwork to verify internal consistency and identify missing values. Data were entered and cleaned in Microsoft Excel and then analysed using RStudio. Analyses were mainly descriptive (counts, proportions, cross-tabulations and graphs) and covered retailers’ experience, sources of supply, compliance indicators, the product inventory and CSP status, and management practices.

3. Results

3.1. Length of experience in the retailing activity

Overall, the survey included 89 herbicide retailers across the four study regions. Most retailers reported [0–5[years of experience (50.6%), followed by [5–10[years (28.1%). Overall, nearly 99% of retailers had [0–20[years of experience, with a predominance of ≤10 years (78.7%). Data on length of experience in the retailing activity are presented in Figure 1.

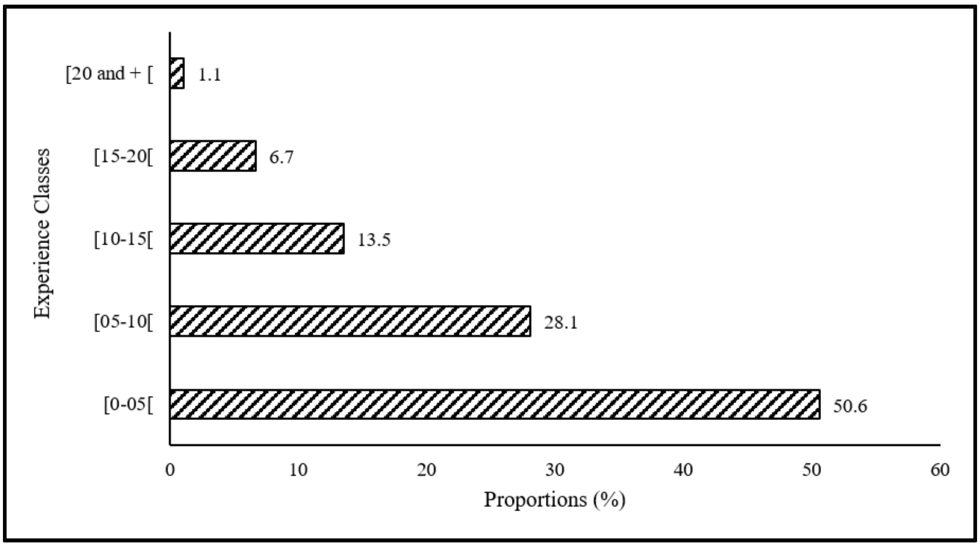

Figure 1 Classification of herbicide sellers according to their length of experience in the activity

3.2. Retailers’ sources of supply

The distribution of retailers by source of supply is shown in Figure 2. Retailers sourced herbicides mainly from the Bobo-Dioulasso market (78.7%). Cross-border supplies were reported at low proportions, notably from Ghana (4.5%) and Côte d’Ivoire (3.4%).

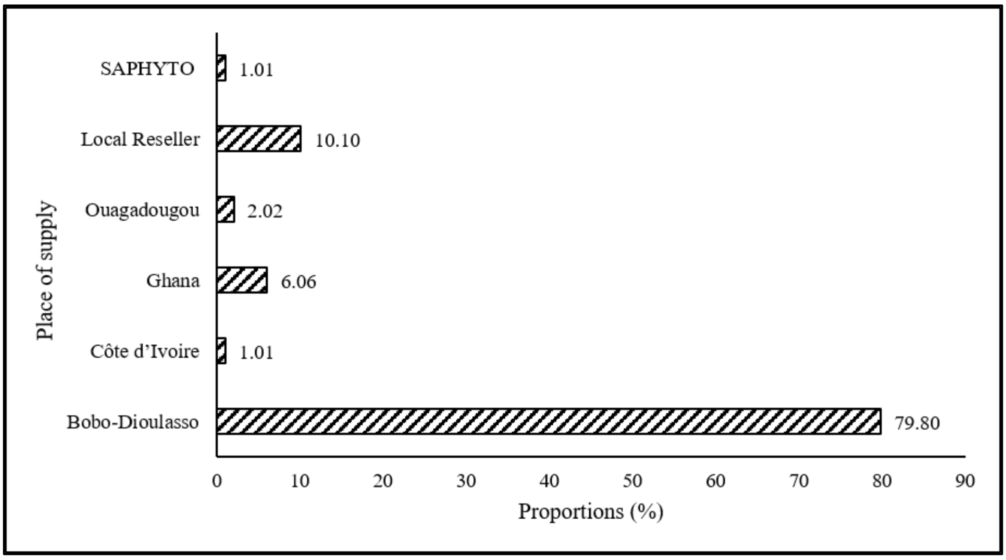

Figure 2 Distribution of herbicide sellers according to their place of supply

3.3. Indicators of compliance and professionalisation of retailing

Indicators of compliance and professionalisation of herbicide retailing are presented in Figure 3. A high proportion of retailers reported having received no training on pesticide retailing (84.26%) and not holding official authorisation/licensing (94.38%). Most respondents indicated that they were not aware of the CSP (88.76%) and did not possess the list of authorised pesticides (97.75%). However, 84.27% reported being aware of the hazardous nature of pesticides.

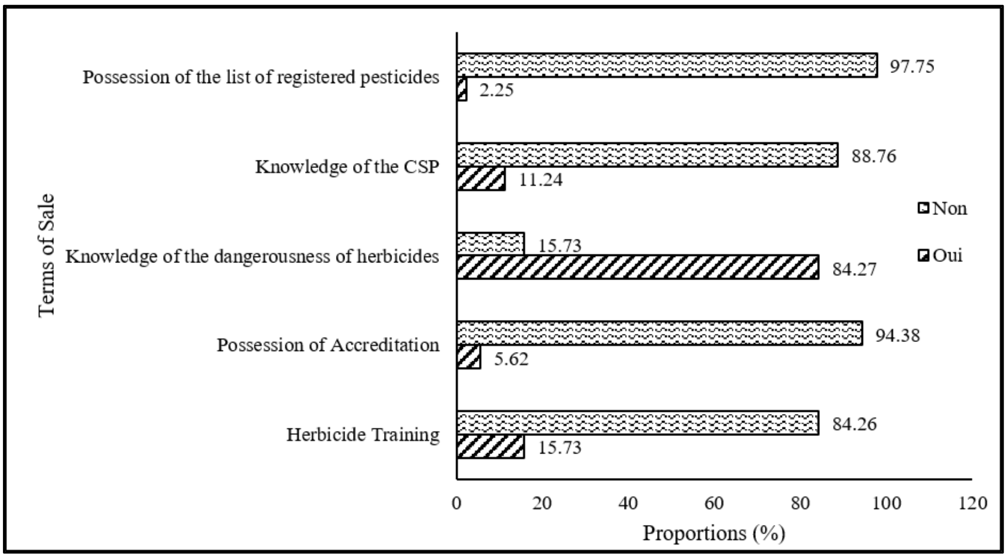

Figure 3 Distribution of herbicide sellers according to retail compliance conditions

3.4. Management of empty containers at the point of sale

Reported practices for managing empty containers mainly included discarding (28.1%), burying (12.14%), incineration (28.1%) and, less frequently, returning containers to a source/collection structure (4.5%), as reported by retailers. All reported empty-container management options are presented in Figure 4.

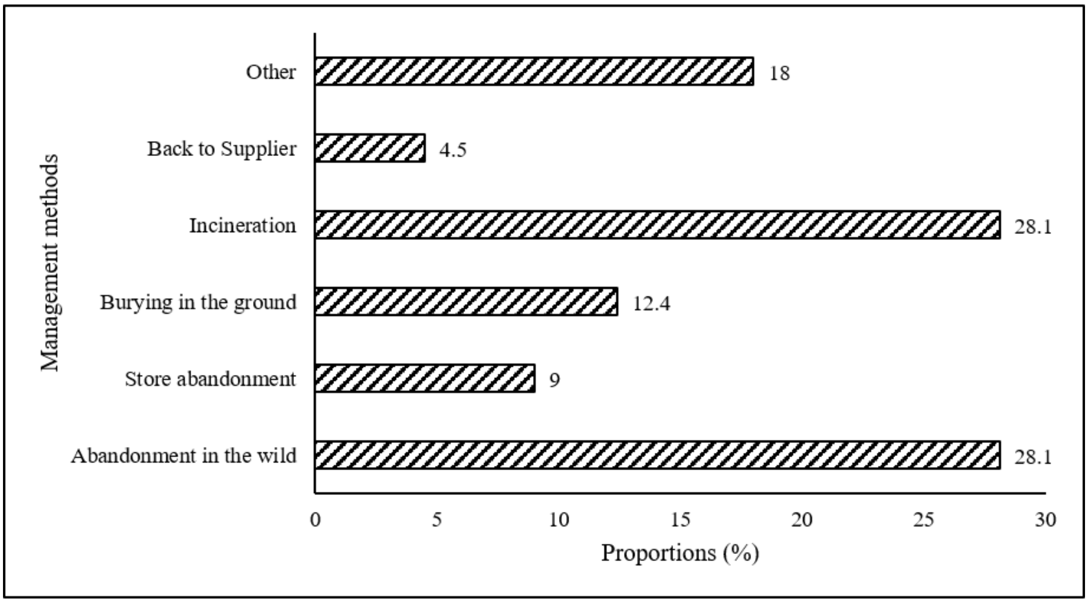

Figure 4 Distribution of herbicide sellers according to empty-container management practices

3.5. Management of expired products and response in the event of leakage

Practices reported for expired products were heterogeneous: 22.4% of retailers reported selling them, 18.8% reported returning them to the supplier/source, 21.2% reported destroying them, while 37.6% reported other options. In the event of leakage, the most frequently reported response was simple cleaning (54.02%), followed by ventilating the premises (12.64%) and disposing of the product (11.49%); other options were less common and are shown in Figure 5.

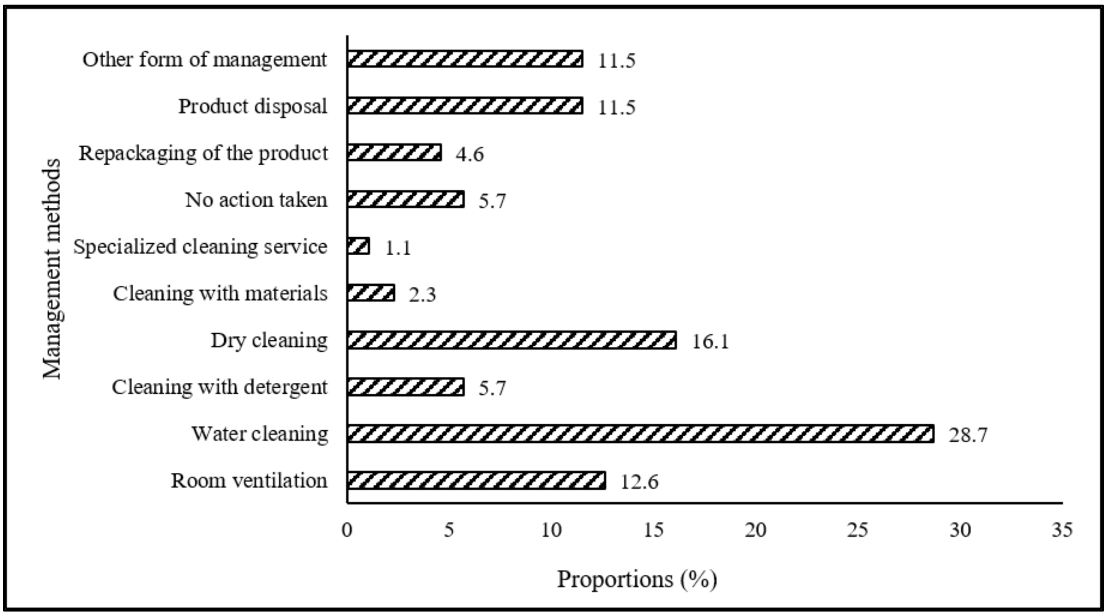

Figure 5 Distribution of herbicide sellers according to the management of expired products and leakages

3.6. Presence of unsold stock/leftovers and management options

Herbicide retailing generated unsold stock/leftovers at points of sale. A substantial proportion of retailers reported having unsold stock/leftovers (58.4%). Regarding how these leftovers were managed, 73.1% reported keeping them intact for later sale, while 13.5% reported returning them to the supplier/source. The management options for unsold stock/leftovers are detailed in Figure 6.

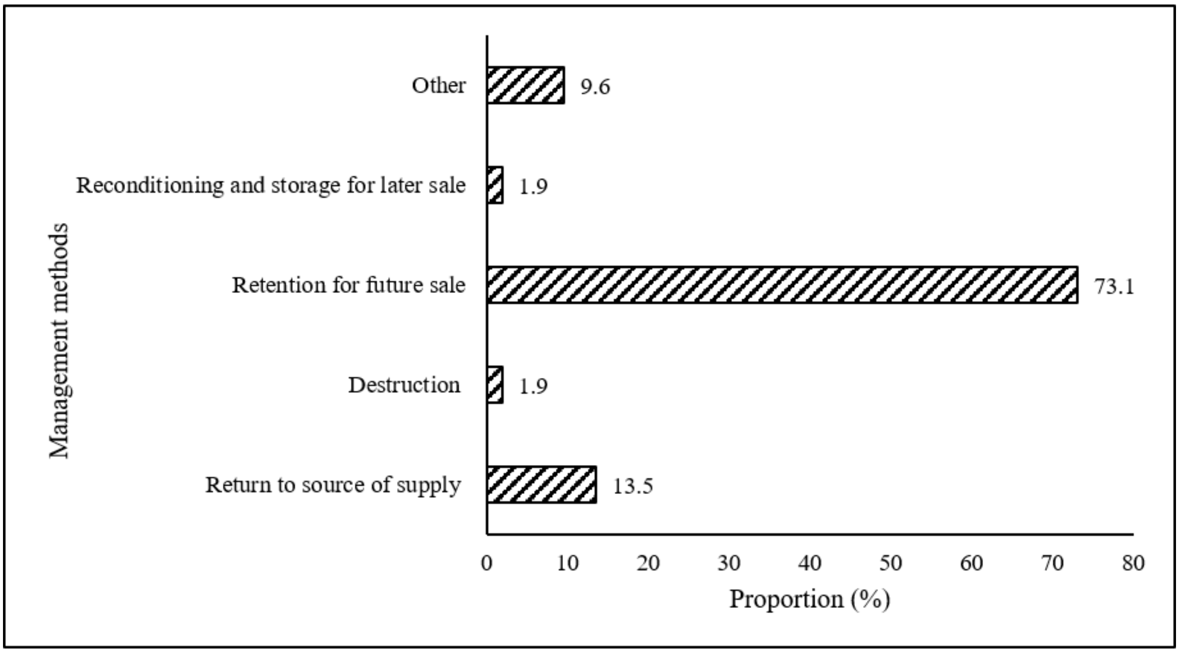

Figure 6 Distribution of herbicide sellers according to the management of unsold herbicides

3.7. Commercialised products, active substances and registration status

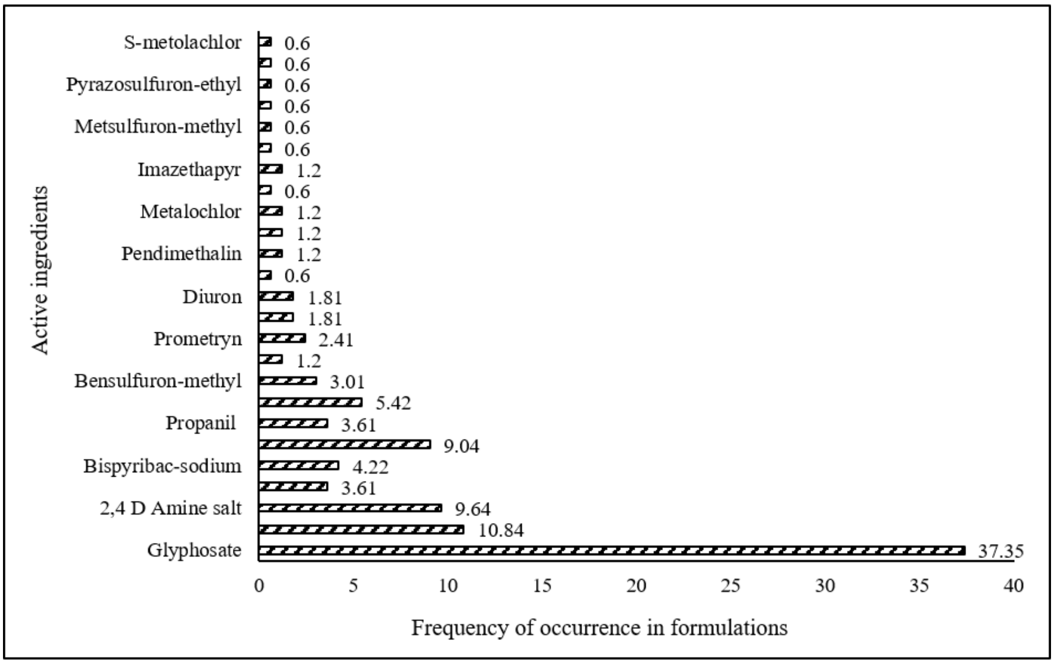

Figure 7 Representativeness of herbicide active substances across the different formulations

The inventory conducted at retailers' level recorded 166 formulated herbicide products corresponding to 25 active substances. Based on the CSP reference used for verification, 59.04% (98/166) of the recorded products were not registered/authorised, compared with 40.96% (68/166) that were registered/authorised.

Table 1 Toxicological characteristics of herbicide active substances sold in western Burkina Faso

Active substances	WHO toxicity class	CMR toxicity			Endocrine disruptor	Authorisation in CSP-registered formulations
		Carcinogenicity	Reprotoxicity	Mutagenicity		
2,4-D-ammonium	II	Possible	Yes	No data available	Possible	Yes
Acetochlor	III	Possible	Yes	No data available	Yes	No
Atrazine	III	Possible	Possible	No data available	Yes	No
Bensulfuron-methyl	U	No	Possible	No	No	Yes
Bispyribac-sodium	III	No	No	No	No data available	Yes
Butachlor	III	Possible	No data available	No data available	No data available	No
Diuron	III	Possible	Possible	No	Yes	Yes
Fluometuron	U	Possible	Yes	No	No data available	Yes
Glyphosate	III	Possible	Possible	No	No	Yes
haloxyfop-R-methyl	II	No	No	No	No data available	Yes
Imazethapyr	U	No	No	No	No data available	Yes
Metolachlor	III	Possible	Possible	No data available	Possible	Yes
Metsulfuron-methyl	III	No	Possible	No	No	Yes
Nicosulfuron	U	Possible	No	No	No	Yes
Paraquat	II	Possible	Possible	No data available	No	No
Pendimethalin	II	Possible	Possible	No data available	Yes	Yes
Pretilachlor	U	No	No data available	No data available	No data available	Yes

Prometryn	III	No	No	No data available	Possible	Yes
Propanil	II	Possible	Possible	No data available	Yes	Yes
Pyrazosulfuron-ethyl	U	No data available	No data available	No data available	No data available	Yes
Pyribenzoxim	Not listed	Non	No data available	No data available	No data available	Yes
S-metolachlor	II	Possible	Yes	No data available	Possible	Yes
Terbutryn	III	Possible	No data available	No data available	Yes	Yes
Triclopyr	II	No	Yes	No	No data available	Yes
Trifloxysulfuron-Sodium	Not listed	No	No data available	No data available	Non	Yes

II (moderately hazardous); III (slightly hazardous); U (unlikely to present acute hazard); CMR (Carcinogenicity, Mutagenicity, Reprotoxicity)

Among these formulations, the most frequently encountered active substances were glyphosate (present in 62 different herbicides), followed by nicosulfuron (18 formulations), 2,4-D amine salt (16 formulations), paraquat (15 formulations), atrazine (9 formulations) and bispyribac sodium (7 formulations). Figure 7 shows the distribution of herbicide active substances across the different formulations.

3.8. Hazard profile of herbicide active substances

The hazard characteristics of the active substances are summarised in Table I. Of the 25 herbicide active substances characterised, 84.0% were authorised in CSP-registered formulations, compared with 16.0% that were not authorised. The most represented WHO acute toxicity classes were III (40.0%) and II (28.0%), followed by Class U (24.0%), and two active substances not listed (8.0%). For CMR criteria, no "Yes" signal was reported for carcinogenicity or mutagenicity; however, 56.0% of active substances showed possible carcinogenicity, and confirmed reprotoxicity was reported for 20.0%. Regarding endocrine disruption (ED), a confirmed signal was observed for 24.0% of active substances. Overall, 10 active substances (40.0%) presented at least one confirmed hazard signal (CMR and/or ED): 2,4-D amine salt, acetochlor, fluometuron, S-metolachlor and triclopyr (confirmed CMR via reprotoxicity), and acetochlor, atrazine, diuron, pendimethalin, propanil and terbutryne (confirmed ED). Acetochlor was the only active substance presenting both a confirmed CMR signal and a confirmed ED signal.

4. Discussion

The findings from the diagnostic assessment of herbicide distribution practices, regulatory compliance and hazard in western Burkina Faso show that herbicide distribution relies on retailers who remain poorly professionalised, with a clear lack of oversight at the point of sale. Yet, this segment determines the compliance of the products available, the quality of advice provided to farmers, and the magnitude of health and environmental risks. The literature indicates that, in many African settings, agro-dealers are a major source of technical information for farmers, but that their safety knowledge, storage/retail practices and regulatory compliance may be inadequate, thereby increasing the risk of exposure, misuse and adverse events [6]. In the present study, the lack of training (84.26%) and official authorisation/licensing (94.38%), limited awareness of the CSP (88.76%) and the absence of the authorised pesticide list at points of sale (97.75%) contrasted with a self-reported awareness of pesticide hazardousness (84.27%), suggesting a gap between risk awareness and operational capacity for risk management. Similar gaps have been reported elsewhere, where retailers may downplay certain risks, fail to consistently convey safety messages, or do not meet recommended in-store good practices [6]. Conversely, recent evidence suggests that certification/licensing can improve selected knowledge and practice indicators: in Uganda, the analysis by Tambo et al. [19] shows that certification is associated with better knowledge and practices that are more supportive of sustainable pesticide management, highlighting the value of structured professionalisation of the sector. These shortcomings also reflect broader regional challenges in implementing pesticide regulatory systems. In Ghana, Onwona Kwakye et al. [3] similarly describe issues related to registration, distribution and use practices, emphasising that the effectiveness of regulatory frameworks depends strongly on the control of retail supply chains, vendor compliance and the effective enforcement of rules. This perspective supports the view that improving compliance cannot rely solely on end users and requires incentives and effective control at the level of points of sale.

The retailers' supply was dominated by Bobo-Dioulasso, with minor cross-border flows (Ghana and Côte d'Ivoire) and a limited share of sourcing from licensed/authorised retailers. At sub-regional level, this pattern is consistent with the existence of commercial hubs where formal and informal supply chains coexist. The literature on pesticide markets in West Africa indicates that growth in supply has often outpaced control capacity, creating a context conducive to unregistered products and counterfeits [7]. In this context, the high proportion of non-registered products observed in the inventory (59.04%) represents a strong signal of weaknesses in market control. Good practice frameworks reinforce this interpretation: FAO and WHO emphasise that illegal pesticide trade remains a major problem, particularly in low- and middle-income countries, and requires a coordinated response combining strengthened regulatory frameworks, inspection of points of sale, traceability and inter-agency cooperation [4,9]. In the present survey, the reported reluctance of some sellers towards enforcement authorities fits within this context and highlights the value of combining on-site surveys, documentary verification and hazard assessment to document market realities.

Marketing and management practices observed at points of sale represent a second key set of findings. Reported sale of expired products (22.4%) and the presence of unsold stock/leftovers (with storage for later sale and reported repackaging) indicate conditions that may favour the persistence of obsolete products and the circulation of formulations whose quality cannot be guaranteed. These practices depart from recommended good practice. The FAO/WHO International Code of Conduct states that distributors and authorities should prevent the distribution of obsolete or expired products, ensure their withdrawal and safe disposal, and guarantee storage and handling conditions that minimise exposure [4]. Likewise, the predominance of “simple cleaning” as the response to leakage (54.02%) suggests potentially insufficient spill management, with a risk of contamination of surfaces and wash water, consistent with FAO/WHO guidance on point-of-sale management and the prevention of storage/handling incidents [4,9]. The management of empty containers at shops, relying mainly on local disposal options (dumping/burying/incineration, with rare return), suggests the absence of a structured take-back or collection scheme. In Burkina Faso, the literature and operational reports on pesticide poisoning and related risks identify the management of leftovers and empty containers as a recurring critical point for preventing exposure and reducing environmental contamination [20,21]. More recent work highlights the systemic nature of the problem (limited enforcement of regulations, lack of collection systems, costs, lack of alternatives and weak incentives) [22], while container management programmes (collection/return schemes, drop-off points, awareness raising, extended producer responsibility) are described as operational options with implementation roadmaps [23]. Taken together, these elements support integrating the management of expired products, waste and empty containers as a mandatory component of retailer licensing and point-of-sale inspections.

Integrating a structured toxicological assessment beyond CSP status represents an important contribution of this work. Among the 25 herbicide active substances characterised, WHO acute toxicity was dominated by Classes II and III, indicating the presence of substances considered “moderately hazardous” and “slightly hazardous”, respectively, based on acute toxicity [18]. CMR signals were mainly driven by reprotoxicity (confirmed for 20%), while carcinogenicity was frequently classified as “possible”. Confirmed endocrine-disrupting properties were observed for 24%, with a notable proportion of missing data for some dimensions (mutagenicity and ED). This pattern is consistent with international frameworks for identifying endocrine disruptors, which emphasise the need to combine sources, lines of evidence and degrees of certainty, and caution that lack of data should not be interpreted as lack of hazard [13,14]. European criteria established for determining endocrine-disrupting properties in the context of plant protection products further illustrate the importance of explicit and up-to-date criteria for risk management [24]. Within this framework, identifying ten active substances presenting at least one confirmed signal (CMR and/or ED), including substances combining multiple signals (as in the case of acetochlor), provides an operational basis for prioritising market surveillance, analytical targeting and risk communication messages, and, where appropriate, informing discussions on substitution.

5. Conclusion

This study, conducted among herbicide distributors in western Burkina Faso during the 2020 cereal-growing season, highlights a market largely supplied through the Bobo-Dioulasso hub and characterised by low professionalisation at points of sale. Compliance indicators for the regional registration system show limited licensing/authorisation, limited training, and limited access to official lists. The inventory revealed a diversified supply with a high proportion of non-registered products, together with in-shop management practices that may increase exposure of retailers and users and promote environmental contamination. Moreover, hazard characterisation of the 25 recorded herbicide active substances identified a core set of substances presenting confirmed signals of reprotoxicity and/or endocrine disruption. Overall, these findings support coordinated strengthening of retailer licensing and training, traceability and market inspections, as well as the establishment of operational take-back and management mechanisms for expired products and empty containers, to improve health and environmental safety related to herbicide use in the region.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflicts of interest—financial, non-financial or relational—that could have influenced the work presented in this article.

Author contributions

All authors contributed to the study design, data analysis and interpretation, and the drafting and revision of the manuscript. All authors read and approved the final version of the manuscript.

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