Feed the Future Innovation Lab for Food Security Policy

Research Paper 157 December 2019

Mali Food Security Policy Research Program

A MARKET SURVEY OF FRAUDULENT PESTICIDES SOLD IN MALI

By

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Food Security Policy *Research Papers*

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Authors' Acknowledgment:

The authors wish to thank Pierre Traore and his survey staff at the Observatoire du Marché Agricole (OMA) who administered this survey instrument and fastidiously photographed every product formulation on sale at each of 120 agro-dealers across Mali. Without their careful documentation and their long relationship with the retailers, this study would not have been possible. Pierre Traoré and Naman Keita conducted enumerator training and monitored the field work in real time. We are grateful for their efforts to ensure quality control of these data. Financial support for this study came from USAID/Mali under the Projet de recherche sur la politique de sécurité alimentaire au Mali (PRePoSAM) financed through Cooperative Agreement no. AID-688-A-16-00001 under the Innovation Lab for Food Security.

This study is made possible by the generous support of the American people through the United States Agency for International Development (USAID) under the Feed the Future initiative. The contents are the responsibility of the study authors and do not necessarily reflect the views of USAID or the United States Government

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Published by the Department of Agricultural, Food, and Resource Economics, Michigan State University, Justin S. Morrill Hall of Agriculture, 446 West Circle Dr., Room 202, East Lansing, Michigan 48824, USA

EXECUTIVE SUMMARY

This study aims to quantify the share of unregistered pesticides on sale in Mali. To do so, the research team conducted a survey of agro-dealers operating in 10 different markets across Mali in June 2019, at the beginning of the 2019/20 cropping season. Fraudulent pesticides include both unregistered generic products as well as counterfeits. While identification of unregistered products is relatively straightforward, counterfeits are very difficult to identify with certainty, even by the authorized distributors, particularly without laboratory testing. Given the prohibitive cost of laboratory testing, and the limited resources available for this study, our team has focused solely on quantifying ***unregistered*** pesticides, which we can measure with some confidence. By omitting the additional unknown level of counterfeits, these results provide a ***lower bound*** on fraudulent pesticide volumes in Mali.

The survey results suggest that illegal, unregistered pesticides account for about 26% of all pesticide volumes sold in Mali. Of these roughly 5% come from Ghana, 2% from Côte d'Ivoire and the remaining 19% are not registered anywhere.

Mali's designated regulator, the Comité Sahélien des Pesticides (CSP), authorizes pesticides for sale based on their efficacy and safety. The high level of unauthorized pesticides currently on sale in Mali results in frequent complaints from farmers as well as potential danger to human health and the environment. Improved post-registration monitoring and enforcement will be critical to ensuring quality inputs for farmers as well as safety for farmers and consumers.

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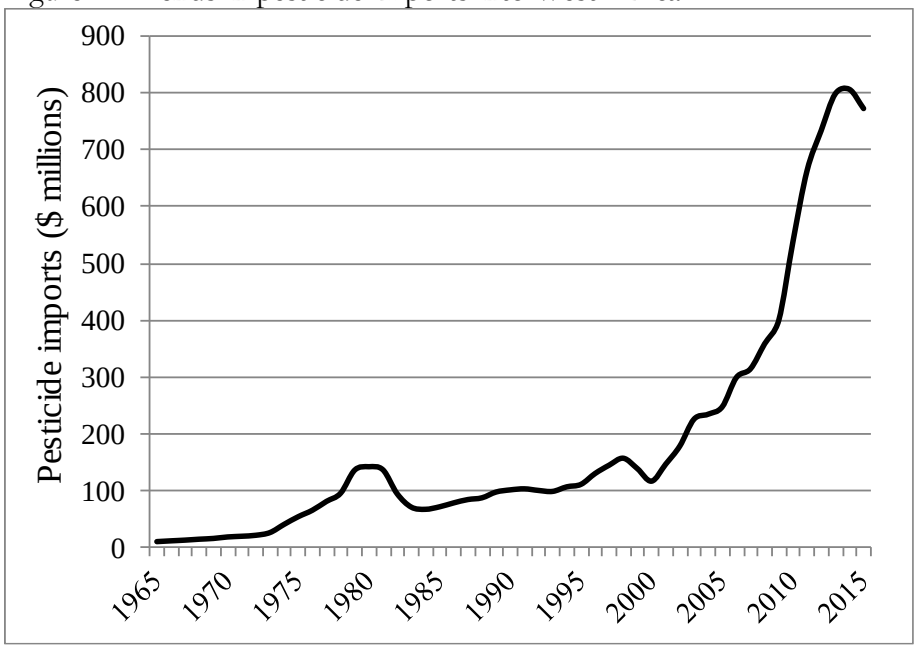
1. INTRODUCTION

Pesticide markets have grown rapidly in West Africa over the past decade and a half, increasing over sevenfold (Figure 1). Because regulatory monitoring and enforcement capacity has not kept pace with this rapid market growth, sales of fraudulent pesticides have increased as well (Mir Plus 2012). Fraudulent products include both counterfeits and unregistered generics. Counterfeiters strive to pass off their products as originals by using packaging identical to well-established registered brands. In contrast, suppliers of unregistered products produce low-cost generic products by circumventing regulatory controls in order avoid the costs associated with regulatory testing and registration requirements.

Figure 1. Trends in pesticide imports into West Africa



Source : FAOSTAT (2019)

As a result, Malian farmers complain regularly about low and variable pesticide quality (Assima et al. 2017). They routinely ask how to identify quality products from among the bewildering array of generic products available for sale, even for a single active ingredient. Figure 2 illustrates the range of choices available for the herbicide glyphosate, the most widely sold pesticide in Mali[1]. Mali's pesticide regulator, the Comité Sahélien des Pesticides (CSP), has approved 38 different glyphosate products for sale. In addition to these authorized products, market visits by our research team reveal new, unregistered generic pesticides on sale every season, magnifying the range of choices available and amplifying farmer confusion.

[1] Glyphosate accounts for roughly 40% of all pesticide volumes sold in Mali, five times more than the second leading pesticide product. See Table 10 below for details.

Available empirical analysis suggests that farmers have good reasons to doubt the quality of these fraudulent products. Recent laboratory analysis of 36 different glyphosate brands on sale in Mali concluded that fraudulent generic brands contain 8-10% lower doses of active ingredient than products duly registered by the CSP (Haggblade et al. 2019).

Figure 2. A partial display of the profusion of glyphosate brands sold in Sahelian West Africa

a. Roundup and imitators (above)

b. Glycel and "Red Beret" imitators (above)

This study aims to quantify the share of fraudulent pesticides in total pesticide sold in Mali. This requires enumerating the full range of product offerings for each of the major pesticide active ingredients sold in Mali and then determining which of the multiple offerings are registered by the CSP and, in contrast, which are fraudulent. Section 2 below describes the research methods and primary data collected for this purpose. Section 3 summarizes key results, while the final section of this report highlights key policy implications.

2. Data and methods

2.1. Agricultural input retailer survey

In June 2019, at the beginning of the 2019/20 cropping season, the research team conducted a survey of agro-dealers in 10 different markets across Mali. This timing specifically aimed to target market visit early in the cropping season, at a time when input sales and applications normally peak (Table 1).

Table 1. Timing of herbicide application in Mali

Month	Frequency	Percentage C
January	2	0
February	6	0
March	6	0
April	38	1
May	734	16
June	2,265	48
July	1,298	27
August	359	8
September	24	1

Source: IER/MSU farm household survey, 2017/18 (See Haggblade et al. 2019 for survey details and basic descriptive results).

The markets selected included five permanent markets as well as five weekly markets. This selection aimed to capture a range of markets and cropping systems representative of all major agricultural production zones in Mali (Table 2). In contrast to permanent markets, weekly markets are markets that are held on a specific day on the week. Typically, these weekly markets contain no permanent agro-input dealer shops.

Given trader sensitivities to enquiries about fraudulent products, the research team worked in close collaboration with with Mali's market information system, the Observatoire du Marché Agricole (OMA). Because OMA's field survey staff circulate weekly in major agricultural markets across Mali to collect input and output prices, agro-input dealers recognize and trust them. For this survey, the OMA enumerators conducted the survey as a special one-time baseline effort to collect price and quantity data on the full spectrum of pesticide products being sold. Since OMA tracks prices of a selected basket of pesticide products (herbicides, insecticides and fungicides), this survey served as a baseline helping them to identify which active ingredients and product brands to include in their ongoing monitoring efforts.

Table 2. Markets selected for retailer interviews

Permanent markets	Weekly markets	Principal crops
Bamako		National import center for all crop inputs
Sikasso		Cotton, cereals, horticulture
Koutiala		Cotton, cereals
Niono		Irrigated rice, horticulture
Kati		Horticulture
	Massigui (Southern Mali, Wednesday)	Cereals, cotton
	Ouelessebougou (Friday)	Cereals, cotton
	Kouri (Burkina border, Monday)	Cotton, cereals
	Yanfolila (Guinea border)	Horticulture, cotton, maize
	Zegoua (Cote d'Ivoire border, Sunday)	Horticulture, cotton

On arrival in each market, the survey team initially conducted a listing of all retailers selling farm inputs that day, both formal and informal. From this listing, they selected 10 formal retailers and 5 informal retailers at random from their census listing. This resulted in up to 15 retailer interviews in each market. Table 3 provides a summary of the retailer populations and sampling fractions in each of the ten markets surveyed. In total, the team interviewed 122 retail establishments, 72 formal and 50 informal (Table 3). The total number of interviewed retailers is less than 150, since there were less than 10 formal and less than 5 informal retailers in most markets. The number of informal retailers is, on average, greater in weekly markets than in permanent markets.

A team of two enumerators then visited each of the selected retailers to administer a two-page survey instrument (Annex A). The survey protocol called for the retailer to first display a sample of each herbicide product on sale that day and to place the bottles or dry granule packages along the display counter in order of sales volume. While one enumerator noted down the name, price and sales percentage of each product, his/her partner photographed the front label of each product on display. The survey team then repeated this procedure with all insecticide products and, finally, with all fungicides and other pesticide treatments. Figure 3 provides an illustration of the photographs taken of each product on sale. In total, the interviews lasted 30 to 60 minutes each.

Table 3. Agricultural inputs retailers sampled, by market

Market	Permanent retailers		Informal retailers		Total
	total	selected	total	selected	selected
Bamako*	31	10	0	0	10
Kati	9	9	2	2	11
Koury	9	9	2	2	11
Koutiala	11	11	0	0	11
Massigui	0	0	48	16	16
Niono	18	10	5	5	15
Ouélessébougou	6	6	6	4	10
Sikasso	13	10	11	5	15
Yanfolila	0	0	20	8	8
Zégoua	9	7	8	8	15
Total	106	72	102	50	122

* Main market, quartier du fleuve.

Source: OMA/MSU agro-dealer survey 2019.

Following completion of the field interviews by OMA's enumerators, the MSU research team worked to identify the active ingredients and registration status of each product sold. This requires knowledge of all products registered and their chemical composition. To make these assignments, our team reviewed photographs, survey results and the CSP listing of authorized pesticide products to identify the active ingredients in each product as well as the registration status of each item on sale. These designations, conducted by specialists on our team, took place over several weeks. In the end, the MSU team produced an annotated, completed data file listing all products sold, their price, market share, active ingredient and registration status. This completed data set forms the basis for the analysis presented in Section 3 of this report.

Figure 3 Possible counterfeit pesticide products on sale in Mali, June 2019

a. registered product

b. likely counterfeit

c. registered product

d. possibly tampered with

2.2. Key informant interviews

During the month following the retail interviews, in July 2019, two senior researchers returned to the ten market towns to interview key pesticide sector stakeholders in order to solicit their qualitative assessment of the scope and impact of fraudulent pesticide in the Malian market. Those interviewed included pesticide importers, farmer support organizations and government extension and regulatory agencies. The questionnaire in Annex B provides the half-page interview guide of eight, mostly open-ended questions posed to the key informants.

In total, the team interviewed 63 key informants in the 10 market towns, 18 from the private sector, 26 from farm support organizations and 19 from government extension and regulatory agencies (Table 4). The quantitative results presented below provide a comparison between the quantitative results from the retail survey and the key informants' estimates of the volume of fraudulent products. In addition, the discussion below draws on the key informants' qualitative observations in assessing the state of regulatory enforcement in Mali's agricultural markets, summarized by Traoré and Keita (2019).

Table 4. Key informants interviewed, by location

Market	Key informants, by category			Total
	Government	Trader	Farmer groups	
Bamako*	1	0	1	2
Bougouni*	1	1	3	5
Koury	0	8	5	13
Koutiala	0	5	4	9
Massigui	3	0	2	5
Niono	2	2	1	5
Ségou*	4	0	2	6
Sikasso	4	2	4	10
Yanfolila	2	0	4	6
Zégoua	2	0	0	2
Total	19	18	26	63

* Bamako: center of key informants for Bamako and Kati.
* Bougouni: centre of key informants for Ouélessébouou.
* Ségou: source of key informants for the central zone of Mali.

Source: Key informant interviews (Traoré and Keita et al. 2019).

3. RESULTS

3.1. Overview of pesticide products sold in Mali

Herbicides account for the vast majority of pesticide volumes sold in Mali, about 75%, while insecticides make up about 20% of sales volumes, with fungicides and other pesticides (nematicides, rodenticides, etc.) accounting for about 5% of sales (Table 5). Among informal retailers, the dominance of herbicide sales jumps to 85% of total sales.

Across all markets surveyed, herbicides account for a majority of pesticide sales. However, the shares vary across locations. Retailers in Koutiala, where the principal crops grown are cotton and cereals, sell less herbicides than elsewhere, while insecticides shares (31%) and fungicides (15%) exceed the levels found in most locations. Bamako and Kati, where peri-urban horticulture is prominent, likewise sell higher than average shares of insecticides, 32% and 33% respectively.

Table 5. Share of pesticide volumes sold, by category

	Pesticide products			Total
	herbicides	insecticides	other	volume
Total sample	75%	20%	5%	100%
Retailer status				
formal	68%	25%	7%	100%
informal	85%	12%	3%	100%
Market				
Bamako	64%	32%	5%	100%
Kati	61%	33%	6%	100%
Koury	85%	11%	4%	100%
Koutiala	54%	31%	15%	100%
Massigui	93%	6%	1%	100%
Niono	69%	26%	5%	100%
Ouélessébougou	80%	18%	3%	100%
Sikasso	74%	21%	5%	100%
Yanfolila	89%	9%	2%	100%
Zégoua	78%	15%	7%	100%

Source: OMA/MSU agro-dealer retailer survey.

Farmers face an array of pesticide product choices. An average agro-dealer in Mali sells 10 different herbicide products, 2 different brands of insecticide and 1 fungicide (Table 6). Even among specific active ingredients, retailers often stock a range of different generic brands. Especially high levels of variety emerge in Koury and Massigui, where retailers stock 20 and 17 different herbicide products on average (Table 6). Both are large weekly markets without permanent shops or storage depots. The itinerant retailers who service these markets provide a wide range of different product choices, particularly for herbicides.

Table 6. Average number of different pesticide product sold by individual retailers

	Number of pesticide products			Total
	herbicides	insecticides	other	products
Total sample	10.4	2.4	0.8	13.5
Retailer status				
formal	9.8	3.0	1.1	13.9
informal	11.3	1.5	0.3	13.1
Market				
Bamako	7.7	3.2	0.7	11.6
Kati	4.5	4.6	0.8	9.9
Koury	19.6	1.9	1.7	23.3
Koutiala	7.9	2.8	1.2	11.9
Massigui	17.2	0.8	0.1	18.1
Niono	5.9	2.9	0.8	9.5
Ouélessébougou	8.3	1.6	0.1	10.0
Sikasso	9.7	3.1	1.1	13.9
Yanfolila	9.0	1.9	0.5	11.4
Zégoua	11.7	1.5	0.7	13.9

3.2. Fraudulent pesticide market shares

Fraudulent pesticides include both ***unregistered*** generic products as well as ***counterfeits***. Counterfeiters strive to pass off their products as originals by using packaging virtually identical to well-established registered brands (Figure 3). In contrast, suppliers of unregistered pesticides produce low-cost generic brands with a variety of inventive names and with packaging that imitates that used by registered products containing the same active ingredient (Figure 4). Suppliers of the unregistered pesticides short-circuit regulatory controls in order to avoid the significant financial costs associated with testing and registration requirements.

Identification of unregistered products is relatively straightforward. In contrast, counterfeits are very difficult to identify with certainty, even by the authorized distributors, particularly without laboratory testing. Given the prohibitive cost of laboratory testing, and the limited resources available for this study, our team has focused solely on quantifying ***unregistered*** pesticides, which we can measure with some confidence. By omitting the additional unknown level of counterfeits, these results provide a ***lower bound*** on fraudulent pesticide volumes in Mali.

Unregistered pesticides – that is, products not authorized for sale by the CSP -- accounted for 31% of all pesticide products inventoried (Table 7). By volume, the unregistered products account for 26% of total pesticide volumes sold. This observed level of unregistered pesticide volumes in Mali aligns closely with averages across West African. A study commissioned by the

CSP in 2012 measured wide variation in the levels of fraudulent pesticides across the 8 largest pesticide markets in the region. Their results, weighted by market size, suggest that fraudulent pesticides account for 34% of total pesticide sales in West Africa, 27% unregistered products plus another 7% counterfeits (MirPlus 2012; Haggblade et al. 2019).

Figure 4. Registered versus unregistered brands of glyphosate on sale in Mali

a. registered brands (top row, above)

b. unregistered brands (bottom row)

Table 7. Unregistered pesticides as a share of total products and volumes sold in Mali

Pesticide category	Authorized by CSP	Pesticides unregistered by the CSP					Total sold
		Total unregistered by the CSP	Registered nowhere	Registered elsehwere			
				Cote d'Ivoire	Ghana	other	
Total number of products inventoried							
Herbicides	69%	31%	18%	4%	10%	0%	100%
Insecticides	68%	32%	29%	0%	3%	0%	100%
Fungicides and others	75%	25%	21%	4%	0%	0%	100%
Total pesticides	69%	31%	20%	3%	8%	0%	100%
Total pesticide volumes sold							
Herbicides	76%	24%	16%	3%	5%	0%	100%
Insecticides	63%	37%	32%	0%	5%	0%	100%
Fungicides and others	81%	19%	16%	3%	0%	0%	100%
Total pesticides	74%	26%	19%	2%	5%	0%	100%

Table 8. Key informant estimates of fraudulent pesticide market share

Localities	# responses	Frauds (%)
Bougouni	5	63
Koutiala	9	54
Sikasso	10	49
Segou	6	49
Massigui	5	46
Yanfolila	6	43
Niono	5	41
Bamako	3	37
Koury	13	23
Zegoua	2	20
Total	64	43

Source: Traoré and Keita (2019).

In general, key informants estimate higher levels of fraud than the retailer inventories. On average, the key informants estimated 43% market share of fraudulent pesticides (Table 8). In border areas such as Koutiala and Bougouni, awareness and estimates of fraud levels exceeds 50%. In part, regulators and other market observers may see the high number of fraudulent products in the market. Because registered products sell in larger volumes than the fraudulent pesticides, the prevalence of frauds among all products inventoried (31%) is higher than the total volume of unregistered products sold (26%). Possibly, market watchers track the number of products on sale rather than total volumes sold, leading to an upward bias in their estimates. In addition, retailer complaints of counterfeiting likely influence the key informant estimates. Since our survey has not measured counterfeits, it would be normal to expect a higher level of fraudulent estimates from the key informants, if they include both unregistered and counterfeits in their overall estimates.

Table 9. Unregistered pesticides as a share of volume sold, by retailer type and location

	Unregistered pesticide sales		
	herbicides	insecticides	other
Total sample	24%	37%	19%
Retailer status			
formal	21%	29%	20%
informal	29%	51%	13%
Market			
Bamako	20%	18%	-
Kati	8%	15%	35%
Koury	35%	32%	14%
Koutiala	34%	38%	19%
Massigui	26%	98%	-
Niono	17%	18%	0%
Ouélessébougou	9%	6%	-
Sikasso	18%	48%	9%
Yanfolila	33%	51%	33%
Zégoua	40%	52%	18%

The level of fraudulent pesticides sales varies across retailers and markets. In general, informal retailers sell a higher proportion of unregistered herbicides and insecticides than the formal retail shops (Table 9). Informal traders, with less technical backstopping and less regulatory supervision, tend to sell more fraudulent products – 29% of the herbicides they sell are unregistered and 51% of insecticides (Table 9). Among formal retailers, aggregation across all categories of pesticides leads to an overall share of unregistered pesticides that falls slightly, to 23% of total volumes. In contrast, among informal retailers, the share of unregistered pesticides rises to 31% of total volumes sold. This disparity suggests unusually weak enforcement and regulatory compliance among informal, itinerant pesticide retailers.

Higher than average levels of fraudulent pesticide sales emerge in border markets – including Koury, Massigui, Yanfolila and Zégou – plus those with high levels of informal traders – including Massigui, Yanfolila, Zégou and Sikasso. In contrast, much lower levels of fraud emerge in Bamako in and Kati where formal agro-dealers dominate pesticide sales and regulatory control is more prevalent than in outlying areas (Table 9).

3.3. Product proliferation for common active ingredients

Several active ingredients account for the bulk of Mali's pesticide sales. The non-selective contact herbicide, glyphosate, dominates the market, accounting for 38% of total pesticide volumes sold (Table 10). A handful of weed-specific selective herbicides – including nicosulfuron (a post-emergence maize-specific herbicide), haloxyfop-R-methyl (a broad-leaf weed control herbicide used frequently in cotton and horticultural production), pendimethaline (which controls grasses in cotton, rice and maize fields) and 2,4-d (used to control broad-leafed weeds, particularly in rice and maize production) – account for 4% to 7% each.

Among insecticides, lambda-cyhalotrine dominates sales, accounting for 7.2% of total pesticides volumes sold. In addition, acetamipride, chlorpyriphos-ethyl, emmectine benzoate, cypermethrine and deltamethrine account for 2% to 3% each.

Among fungicides and other pesticide products (nematicides, rodenticides and growth regulators), thirame is most widely used in Mali, primarily as a seed treat. Overall, thirame accounts for 3.1% of total pesticide volumes sold (Table 10).

Popular, off-patent active ingredients attract widespread emulation and multiple brands. For glyphosate, the most widely sold pesticide in Mali (Table 10), this survey enumerated 59 different generic brands selling this single active ingredient (Table 11). Herbicides including nicosulfuron, pendimethaline, haloxyfop-R-methyl, prometrine and 2,4-d and t insecticides containing lambda-cyhalothrine, acemetapride and cypermethrine are all available in 10 or more different branded products. No wonder farmers complain of difficulties in deciding which brand to purchase (Assima et al. 2017).

Table 10. Major pesticide active ingredients on sale

Pesticide category	Number of products sold		Herbicide	Pesticide
Active ingredients	number	percent	volume	volume
Herbicides				
glyphosate	469	36.6%	50.8%	38.1%
nicosulfuron	148	11.6%	9.4%	7.1%
pendimethaline	113	8.8%	7.9%	5.9%
haloxyfop-R-methyl	120	9.4%	6.8%	5.1%
2,4-d	88	6.9%	5.5%	4.1%
metolachlore	69	5.4%	4.5%	3.4%
prometryne	62	4.8%	4.5%	3.4%
atrazine	56	4.4%	2.6%	1.9%
bensulfuron methyl	18	1.4%	2.3%	1.8%
paraquat	33	2.6%	1.4%	1.0%
acetochlor	15	1.2%	1.1%	0.9%
propanil	25	2.0%	1.1%	0.8%
trifloxysulfuron	27	2.1%	0.8%	0.6%
bispyribac-sodium	20	1.6%	0.8%	0.6%
diuron	17	1.3%	0.5%	0.4%
subtotal herbicides	1280	100.0%	100.0%	75.1%
			Insecticide	
Insecticides			volume	
lambda-cyhalothrine	83	27.8%	36.5%	7.2%
acetamipride	36	12.0%	14.0%	2.7%
chlorpyriphos-ethyl	39	13.0%	11.1%	2.2%
emamectine benzoate	36	12.0%	9.9%	1.9%
cypermethrine	41	13.7%	9.9%	1.9%
deltamethrine	22	7.4%	9.0%	1.8%
carbofuran	15	5.0%	4.3%	0.8%
permethrine	14	4.7%	3.6%	0.7%
imidaclopride	13	4.3%	1.9%	0.4%
subtotal insecticides	299	100.0%	100.0%	19.7%
			Other pesticide	
Fungicides and other pesticides			volume	
thirame	42	59.2%	59.5%	3.1%
thiamethoxam	6	8.5%	12.6%	0.7%
mefenoxam	6	8.5%	12.6%	0.7%
difenoconazole	6	8.5%	12.6%	0.7%
others	11	15.5%	2.8%	0.1%
subtotal fungicides	71	100.0%	100.0%	5.2%

Table 11. Me-too's: Which active ingredients attract the largest number of generic brands?

Pesticide category	Active ingredients	Brands inventoried
Herbicides		
	glyphosate	59
	nicosulfuron	22
	pendimethaline	16
	haloxyfop-R-methyl	14
	prometryne	12
	2,4-d	11
	paraquat	8
	atrazine	7
	trifloxysulfuron	7
	propanil	7
	acetochlor	7
	metolachlore	6
	diuron	5
	bispyribac-sodium	2
	bensulfuron methyl	2
	subtotal herbicides	185
Insecticides		
	lambda-cyhalothrine	10
	acetamipride	10
	chlorpyriphos-ethyl	5
	emamectine benzoate	5
	cypermethrine	12
	deltamethrine	3
	carbofuran	4
	permethrine	3
	imidaclopride	4
	subtotal insecticides	65
Fungicides and other pesticides		
	thirame	6
	chlorpyriphos-ethyl	1
	thiamethoxam	1
	mefenoxam	1
	difenoconazole	1
	others	12
	subtotal other pesticides	22

Table 12. Fraud levels by active ingredients

Pesticide category	Authorized	Products unregistered by the CSP					Total
		Total	Not	Registered elsehwere			
active ingredient	by CSP	unregistered	registered	Cote d'Ivoire	Ghana	other	sold
Herbicides							
atrazine	0%	100%	1%	0%	99%	0.0	100%
paraquat	0%	100%	0%	0%	100%	0.0	100%
acetochlor	0%	100%	100%	0%	0%	0%	100%
trifloxysulfuron	0%	100%	58%	42%	0%	0.0	100%
metolachlore	45%	55%	55%	0%	0%	0.0	100%
diuron	46%	54%	0%	0%	54%	0.0	100%
propanil	60%	40%	7%	20%	13%	0.0	100%
nicosulfuron	72%	28%	22%	1%	5%	0.0	100%
glyphosate	79%	21%	17%	3%	0%	0.2%	100%
bispyribac-sodium	81%	19%	19%	0%	0%	0.0	100%
pendimethaline	83%	17%	17%	1%	0%	0.0	100%
prometryne	93%	7%	0%	0%	7%	0.0	100%
haloxyfop-R-methyl	95%	5%	4%	1%	0%	0.0	100%
2,4-d	99%	1%	0%	1%	0%	0.0	100%
bensulfuron methyl	100%	0%	0%	0%	0%	0.0	100%
subtotal	76%	24%	16%	3%	5%	0.0	100%
Insecticides							
carbofuran	0%	100%	100%	0%	0%	0%	100%
lambda-cyhalothrine	38%	62%	58%	0%	4%	0%	100%
cypermethrine	56%	44%	44%	0%	0%	0%	100%
chlorpyriphos-ethyl	65%	35%	0%	0%	35%	0%	100%
imidaclopride	71%	29%	29%	0%	0%	0%	100%
emamectine benzoate	98%	2%	2%	0%	0%	0%	100%
acetamipride	100%	0%	0%	0%	0%	0%	100%
deltamethrine	100%	0%	0%	0%	0%	0%	100%
permethrine	100%	0%	0%	0%	0%	0%	100%
subtotal	63%	37%	32%	0%	5%	0%	100%
Fungicides and others							
others	32%	68%	54%	14%	0%	0%	100%
thirame	93%	7%	7%	0%	0%	0%	100%
thiamethoxam	100%	0%	0%	0%	0%	0%	100%
subtotal	81%	19%	16%	3%	0%	0%	100%

The CSP authorizes pesticides for sale based on their efficacy and safety. The high level of unauthorized pesticides on sale in Mali means that farmers frequently use pesticides that the CSP considers harmful to human health or the environment. Even though paraquat, atrazine and carbofuran are specifically forbidden for sale by the CSP, our inventory revealed significant volumes of these products on sale as well as a range of product choices: 8 different brands of paraquat, 7 different brands of atrazine, 7 different brands of acetochlor and 4 different brands of carbofuran. Carbofuran and paraquat are, respectively, classified as highly hazardous and moderately hazardous by the World Health Organization.

Some of the unauthorized pesticides on sale in Mali have been authorized for sales in Ghana and/or Cote d'Ivoire. This highlights the lack of coherent regulations for pesticide in the region. In terms of volume, 19% of fungicides, 24% of herbicides and 37% of insecticides sold in Mali are unauthorized, fraudulent products. The highly hazardous active ingredient, Carbofuran, accounts for 4.5% of insecticide volume sold, while the illegal active ingredients, Atrazine and Paraquat, account for 2.6% and 1.4% of all herbicide volume sold. Among insecticides, lambda-cyhalothrine accounts for 40% of all insecticide volumes sold, yet over 60% of volumes sold are unregistered products. As Table 12 suggests, suppliers of fraudulent pesticides concentrate on

certain, widely used active ingredients. Many of these are smuggled in from neighboring countries, such as Ghana and Côte d'Ivoire, suggesting that combatting fraudulent pesticides in Mali will require regional collaboration and outreach with neighbors across the region.

4. POLICY IMPLICATIONS

The CSP authorizes pesticides for sale based on their efficacy and safety. The high level of unauthorized pesticides on sale in Mali means that farmers frequently use pesticides that the CSP considers harmful to human health or the environment. Moreover, recent laboratory analyses indicate that unregistered products tend to be under-dosed, containing 8-10% less active ingredient than pesticides duly registered by the CSP (Haggblade et al. 2019).

In order to protect farmers, Mali's responsible enforcement agency will need to step up enforcement efforts. Although the CSP registers pesticides for sale in Mali and 8 other Sahelian countries, in a single one-stop-shop, post-registration enforcement remains the responsibility of national authorities. In Mali, the Direction Nationale de l'Agriculture (DNA) has responsibility for monitoring pesticide markets, ensuring product quality and compliance with regulatory decisions. Given its acute resource constraints, DNA will likely need support from other stakeholders with a vested interest in combatting fraudulent pesticides. These potential allies include farmer groups, researchers and Mali's many honest traders who supply only registered products and who suffer significant commercial losses at the hands of illegal, fraudulent products smuggled in from outside of Mali. Côte d'Ivoire's model of district-level alliances of regulators, farmers and registered suppliers provides one possible model for stepping up regulatory monitoring of Mali's pesticide markets (Diarra and Haggblade 2017).

Many of the fraudulent pesticides on sale in Mali are smuggled in from neighboring countries, primarily Ghana and Côte d'Ivoire. This suggests that controlling fraudulent pesticides in Mali will require regional collaboration and outreach with neighbors across the region.

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ANNEX A. RETAILER SURVEY INSTRUMENT

Questionnaire pour les détaillants de pesticides

Localité _____
Entreprise _____
Nom du répondant _____

1. Depuis quand vendez-vous des pesticides ? _____

2. Quelle est la composition (en quantité) des pesticides vendus au cours des dernières 12 mois ?

Catégorie de pesticides	Pourcentage
a. herbicides	
b. insecticides	
c. autres (fongicides, nématicides, rodenticides, etc)	
Total	100%

3. **Herbicides.** Parmi les herbicides vendus, citez les 15 marques les plus vendues au cours des 12 derniers mois (prendre une photo de chaque).

Exemples : Glyphosate comme, par exemple les Bérets Rouge, les Roundup, Kalach, Glyphader, et autres Autres herbicides (comme, par exemple, Malo binfaga; les Dekade, Dokat, Herbestra, Caliherbe, Ikokadigne, Samory, Segaibana, Nico Mais, Nico Net, Nico Daf, Alligator, et autres)

Principaux herbicides vendus

Ordre	Marques vendues (noms commerciaux)	Matière active*	Prix unitaire	Pourcentages de quantités vendues
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
			Total	100%

'* ajouter après l'interview à partir des informations du CSP.

4. Insecticides: Parmi les insecticides vendus, citez les 10 marques les plus vendues au cours des 12 derniers mois (prendre une photo de chaque)

(comme, par exemple, Lambdacal, Pacha, K optimal, Dursban, Pychlorex, Pyrical, Savahaler, Bomec, Sunpyrifos, Caïman b19, Decis, Titan, Eforia, et autres)

Insecticides vendus

Ordre	Marques vendues (noms commerciaux)	Matière active*	Prix unitaire	Pourcentages de quantités vendues
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
			Total	100%

'* ajouter après l'interview à partir des informations du CSP.

5. Autres pesticides (fongicides, nématicides, rodenticides et autres :citez les 10 marques les plus vendues au cours des 12 derniers mois (prendre une photo de chaque)

(comme, par exemple, Caiman Rouge, Calthio, Monceren, Momtaz, Insector, Apron plus, Apron star, Vellum, les rodenticides et autres)

Fongicides, nématicides, rodenticides et autres pesticides vendus

Ordre	Marques vendues (noms commerciaux)	Matière active*	Prix unitaire	Pourcentages de quantités vendues
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
			Total	100%

'* ajouter après l'interview à partir des informations du CSP.

ANNEX B. KEY INFORMANT SURVEY INSTRUMENT

Questionnaire pour les informateurs clés

Nom _____
Poste _____
Localité _____

1. Selon votre expérience, les pesticides frauduleux comptent pour quel pourcentage du marché des pesticides ? _____%

2. De quels pays proviennent ces pesticides frauduleux ?
a. _____
b. _____
c. _____

3. Quelles sont les catégories de pesticides les plus affectés par les fraudes? (en %)
   a. herbicides _____
   b. insecticides _____
   c. fongicides _____
   d. autres (nématicides, rodenticides et autres) _____
   Total 100%

4. Depuis quelle année avez-vous constatez la présence des pesticides frauduleux sur le marché ? _____

5. Quels produits en particulier? _____

6. Quelle est votre perception de la qualité des pesticides frauduleux ?
   Bonne _____
   Moyenne _____
   Mauvais _____
   Quelles sont vos raisons ? _____

7. Quels impacts voyez-vous des pesticides frauduleux:
   a) positifs ? _____
   b) négatifs ? _____

8. Comment pourrait-on combattre les pesticides frauduleux ? _____

_____

ANNEX C. COMBINATIONS OF PESTICIDE ACTIVE INGREDIENTS SOLD IN MALI

Table C1. Combinations of active ingredients sold in Mali

Active ingredients (alternative formulations)	Number of products inventoried		
	total	formulations	percent
Herbicides			
glyphosate	469		37.1%
nicosulfuron	148		11.7%
haloxyfop-R-methyl	120		9.5%
pendimethaline	113		8.9%
pendimethaline		109	
pendimethaline+s metolachlore		1	
clomazone+pendimethaline		3	
2,4-d	88		7.0%
2,4-d		70	
propanil+2,4-d		18	
atrazine	56		4.4%
metolachlore	69		5.5%
metolachlore		11	
metolachlore+prometryne		41	
terbutrine metolachlore		17	
prometryne	62		4.9%
prometryne+acetachlore		19	
prometryne+fluometuron		2	
prometryne+metolachlore		41	
paraquat	33		2.6%
paraquat		3	
paraquat chloride		15	
paraquat dichloride		15	
trifloxysulfuron	27		2.1%
trifloxysulfuron		17	
trifloxysulfuron-sodium		10	
propanil	25		2.0%
propanil		1	
propanil+2,4-d		18	
propanil+triclopyr		6	
bispyribac-sodium	20		1.6%
bensulfuron methyl	18		1.4%
diuron	16		1.3%
total herbicide products	1,259		100.0%

Table C2. Combinations of insecticide, fungicide and other active ingredients sold in Mali

Active ingredients (alternative formulations)	Number of products inventoried		
	total	formulations	percent
Insecticides			
lambda-cyhalothrine	83		28.8%
lambda-cyhalothrine		65	
lambda-cyhalothrine + acetamipride		18	
acetamipride	44		15.3%
acetamipride + bifentrhine		6	
acetamipride + cypermethrine		15	
acetamipride + emamectine benzoate		3	
acetamipride + indoxacarbe		2	
acetamipride + lambda-cyhalothrine		18	
emamectine benzoate	36		12.5%
emamectine benzoate		31	
emamectine benzoate + acetamipride		3	
emamectine benzoate + pyriproxyphene		2	
cypermethrine	39		13.5%
cypermethrine		14	
cypermethrine + acetamipride		15	
cypermethrine + imidaclopride		9	
cypermethrine + teflubenzuron		1	
deltamethrine	22		7.6%
chlorpyriphos-ethyl	22		7.6%
chlorpyriphos-ethyl		18	
chlorpyriphos-ethyl + thirame		2	
chlorpyriphos-ethyl + allethrine + permethrine + tetrametrine		2	
carbofuran	15		5.2%
permethrine	14		4.9%
permethrine		3	
permethrine + thirame		9	
chlorpyriphos-ethyl + allethrine + permethrine + tetrametrine		2	
imidaclopride	13		4.5%
imidaclopride + beta-cyfluthrine		3	
imidaclopride + cypermethrine		9	
imidaclopride + thiran		1	
subtotal insecticide products	279		100.0%
Fungicides and others			
thirame	61		63.5%
thirame + chlorpyriphos-ethyl		17	
thirame + endusulphan		2	
thirame + imidaclopride		8	
thirame + imidaclopride + metalaxyl		1	
thirame + lindane		2	
thirame + permethrine		31	
chlorpyriphos-ethyl	17		17.7%
thirame + chlorpyriphos-ethyl		17	
thiamethoxam	6		6.3%
thiamethoxam + mefenoxam + difenoconazole		6	
mefenoxam	6		6.3%
thiamethoxam + mefenoxam + difenoconazole		6	
difenoconazole	6		6.3%
thiamethoxam + mefenoxam + difenoconazole		6	
subtotal fungicides and other pesticides	88		100.0%