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Exploration of Synthetic Pesticides Available For Crop Production in Somalia

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Abstract
The specific core objectives of the study were to identify the types of pesticides present, evaluate and screen out the highly hazardous ones and assess their safe handling in the marketplace of Mogadishu, Somalia. The study conducted in 2019 targeting the pesticide companies in Bakara market. Fifteen giant companies were purposively selected and various pesticides were taken as a sample from them. The names of the pesticides regarding their active ingredients were recorded. Pesticides were brought from the companies' retailers in the event that they were viewed as different sorts. Al though the study shows that there isa lack of regulatory policies and systems regarding the use and trade of pesticides in the country but there is a light at the end of the tunnel as the government is hardly working on the establishment of sustainable marketing system in the country. With the consequence of the ongoing current situation, it had led to theintroduction and trade of significant percentage (91%) of highly or extremely hazardous pesticide products in the country. Eldrin and dieldrin, which are obsolete pesticides and internationally banned, are also among those that were extensivelyaccessible in the market. Only three pesticides viz. MCPA, metalaxyl and pyrethrin were identified to be safe for minimal use in garden and field crop production.

Key words: *pesticide, hazardous, market*

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I. Introduction

Agriculture is the most important economic sector in Somalia. Approximately 65% of the Somali people engage in agriculture and many of them use pesticides to protect the crops they produce. Other people such as those working in public health and veterinary sectors use pesticides for relevant applications in or around home and farm buildings.

Pesticides are plant protection products that include a variety of chemicals used to kill or control living organisms such as rodents (rodenticides), insects (insecticides), plant weeds (herbicides) and microorganisms including algicides, fungicides or bactericides. (Department for Environment Food and Rural Affairs of UK (DEFRA, 2006).

According to DEFRA pesticides can be harmful if it is appropriately dealt with. It is very important to use them sustainably with judicious and proper handling facilities to minimize its risks associated in the environment, people and society.

In most countries, the use of agrochemicals is regulated by government agencies and legalized by issuing official permits for their purchase and use in order to protect its users. On the contrary, Somalia has been lacking that system for about three decades and the policies regulating the import, registration, utilization and handling pesticides are not in place. This has led to introducing poor quality, banned or obsolete pesticides in the market and eventual hazard to the users including agro-dealers, farmers, workers and lastly to the crop consumers. There is an immense and urgent need for the basic information related to the actual type of pesticides available in the local markets to determine the potential uses of the pesticides and streamline the programs aimed at pesticide management. Lacking such information became panic to the local authorities, farmers and policy makers in order to promote the sustainable use of pesticides. As far as anyone is concerned, there have been no published studies that have identified the types of pesticides sold and used in local communities in Somalia.

Pesticides don't respect national borders. With this said, using inappropriate pesticides doesn't lead merely to a negative impact to the local farming system but also to the ecological system and niches existing in the environment posing resistant pests to the chemicals and disturbing the sustainable agriculture in the locality.

The core objective of the study is to explore the agro-pesticides available in the local market especially in Mogadishu, Somalia. The specific objectives of the study are to identify the types of pesticides available in the marketplace, evaluate the existing pesticide products and screen out the HHPs (Highly Hazardous Pesticides) based on the criteria established by Pesticide Action Network (PAN) in 2019; and lastly assess the safe handling of the pesticides including the obsolete ones in Bakara market of Mogadishu, Somalia.

II. Research Methodology

Study Area and Sample Size

This study conducted in 2019 targeting agrochemical companies based in Bakaramarket located in Mogadishu, Somalia. Bakara market is the biggest market and business hub in the country hosting many giant business companies whereby the goods including pesticides are primarily supplied and then transferred to other regional markets. There are about 30 companies serving as agro-dealers in the market, of which half them are only registered as importers of pesticides. For this, the 15 registered companies are purposely selected and considered as key respondents for the study. Other companies serve as retailers with smaller capacity and merchandize only with those pesticides delivered by the big companies in the market.

Research Tools

In order to conduct the study, it has used different methods for data collection including sample collection, desk review, observation and questionnaires.

To profile the pesticides present in the market, one sample of each sort of item identified by a seller as a pesticide was reviewed and its active ingredient was registered. Various pesticides were taken from all pesticide companies targeted in the study.Pesticides were also brought from theirretailers in the event that they were viewed as different sorts.

A desk review was conducted specifically aiming at generating information from collected samples sourced from the various agrochemical companies in the target market. This involved synthesizing all the relevant information related to the available pesticides in the market such as their names based on active ingredients present and assessing the status of the pesticides regarding its sustainability standard by identifying the obsolete or banned pesticides based on the criteria agreed by Pesticide Action Network (PAN) in 2019.

A questionnaire was also developed as another assessment tool to undertake data collection from the intended respondents. To avoid data inconsistency, biasness and lack of enough knowledge of the business, the data collector was requested to speak to the business owner if available or representative above the age of 18.

In addition, comprehensive observation was also used and served as a supplementary tool for the study. The study captured a bird view on the inclusive handling approaches of the pesticides by the traders including the wholesalers and retailers of the target product in the target market.

Data Analysis

Preliminary field pre-analysis was carried out to ensure that the data captured is accurate, well organized, complete and consistent with the intent of the research. Data from various sources was analyzed using the 2019 PAN International list of highly hazardous pesticides (HHP) as it's only credible and recordconsolidatedavailable which and consideredthe criteria agreed by both FAO and WHO.

III. Research Findings

Pesticides Available in the Market: Principally, the types of pesticides supplied in the market mainly depends on the farmers' need and demand based on type of infested pests in the field as well as the crops grown which are mostly seasonal in growth habit. Table 1 lists all the pesticide components that were identified in the study market. Thirty-five different active pesticide ingredients were discovered in the study. These were the most common pesticides that are extensively available in the market and used to control plant pests and disease vectors.

TABLE 1: Identities of Pesticides Available in Bakara Market Mogadishu, Somalia.

#	**Identified Pesticide**	Uses in Crop Production	Chemical Class	WHO Classification	PAN Classification	# of Banned Countries
1	Abamectin	Insecticide Nematicide	Avermectin	Class Ib	Group 1 Group 3	
2	Aldicarb	Insecticide Nematicide	Carbamate	Class Ia	Group 1 Group 3 Group 4	103
3	Aldrin	Insecticide	Organochlorine	Obsolete	Obsolete	
4	Aluminum phosphide	Insecticide	Fumigant		Group 1 Group 3	1

5	Atrazine	Herbicide	Triazine	Class III	Group 2	37
6	Benomyl	Fungicide Nematicide	Carbamate	U	Group 2 Group 4	34
7	Beta-cyfluthrin	Insecticide	Pyrethroid	Class Ib	Group 1 Group 3	1
8	Bifenthrin	Insecticide	Pyrethroid	Class II	Group 2 Group 3	2
9	Calcium Cyanide	Insecticide Rodenticide	Fumigant	Class Ia	Group 1	33
10	Carbaryl	Insecticide	Carbamate	Class II	Group 2 Group 3	35
11	Carbendazim	Fungicide	Carbamate	U	Group 2	29
12	Carbofuran	Insecticide Nematicide	Carbamate	Class Ib	Group 1 Group 3 Group 4	63
13	Chloropyrifos	Insecticide Nematicide	Organophosphurus	Class II	Group 3	4
14	Cyfluthrin	Insecticide	Pyrethroid	Class Ib	Group 1 Group 3	29
15	Cypermethrin	Insecticide	Pyrethroid	Class II	Group 3	8
16	Deltamethrin	Insecticide	Pyrethroid	Class II	Group 2 Group 3	
17	Diazinon	Insecticide	Organophosphurus	Class II	Group 2 Group 3	32
18	Dichlorvos/DDVP	Insecticide	Organophosphurus	Class Ib	Group 1 Group 3	33
19	Dieldrine	Insecticide	Organochlorine	Obsolete	Obsolete	
20	Dimethoate	Insecticide Nematicide	Organophosphurus	Class II	Group 3	4
21	Endosulfan	Insecticide	Organochlorine	Class II	Group 1 Group 4	115
22	Glufosinate (inc ammonium)	Herbicide	Organophosphurus	Class II	Group 2	28
23	Glyphosate	Herbicide	Organophosphurus	Class III	Group 2	
24	Malathion	Insecticide	Organophosphurus	Class III	Group 2 Group 3	2
25	Mancozeb	Fungicide	Carbamate	U	Group 2	1
26	MCPA	Herbicide	Phenoxy	Class II		2
27	Metalaxyl	Fungicide	Anilide	Class II		1
28	Methomyl	Insecticide	Carbamate	Class Ib	Group 1 Group 3	12
29	Nicotine Sulphate	Insecticide	Botanical	Class Ib	Group 1	29
30	Paraquat	Herbicide	Quaternary ammonium	Class II	Group 1 Group 4	46
31	Permethrin	Insecticide	Pyrethroid	Class II	Group 2 Group 3	29
32	Profenofos	Insecticide	Organophosphurus	Class II	Group 3	29
33	Pyrethrin	Insecticide	Botanical	Class II		
34	Warfarin/Coumaphene	Rodenticide	Coumarin	Class Ib	Group 1 Group 2	28
35	Zinc Phosphide	Rodenticide	Inorganic	Class Ib	Group 1	2

TABLE 2: Types of Pesticides Available in the Market Based on its Use Category

#	Pesticide Category	# of Pesticide Components	% of Total Categories
1	Insecticides only	18	51
2	Herbicides only	5	14
3	Fungicides only	3	9
4	Rodenticides only	2	6
5	Both Insecticides &Nematicides	5	14
6	Both Insecticides & Rodenticides	1	3
7	Both Fungicides &Nematicides	1	3

Considering its conventional use, the most abundant category of pesticides available in the market were insecticides which were about 68% of the total inclusively, and 51% exclusively. This is due to the attitude of most local farmers believing that only insects other than weeds can act as pests and hence use insect killers for every type of damage seen in the field. Most small scale farmers in Somalia don't know that fungus, bacteria, viruses, and nematodes can also disturb the crops and lead malformation and malfunctioning ofdifferent morphologicalparts of the plant (SARTEC, 2018). This led other chemicals including fungicides, nematicides, and rodenticides to deliver smaller amounts in the market. The study didn't come across any chemicals related to the control of bacteria (bactericides), viruses (virucides) or other pests and pathogens.

The informants of the study pointed out that communities other than farmers purchase herbicides and rodenticides for their garden and in-house control of rats respectively. Adopting traditional techniques like trapping and hoeing by the farmers against rats and weeds respectively also makes the subject chemicals to be accessible in the market with less extent than insecticides.

Demand of Pesticides in the Market: All the respondents asked to rank the category of pesticides that has the demand of their demand in the market. All of them agreed that the farmers primarily prioritize insecticides in its different types being the highest demand existed in the market, herbicides were the second highest while the rest put in the third rank. This specifically complies with the hypothesis that the local farmers don't have adequate knowledge of the different pests that attack the crop plants and assume in blind that merely insects can destroy crops and look for insecticides only to tackle all pests(SARTEC, 2018).

It has been highlighted that farmers have the principle of "buy what you know", though it isn't certainly a merit for them in this subject. So, they purchase what they have blindly experienced from other farmers or applied by themselves. This leads to pull-off the unwanted products from the market and keep using the same pesticides repeatedly and hence the arise of pesticide resistance phenomenon accordingly. Incorrect and excessive use of pesticidesleads to contaminate the soil and water sources, destroys biodiversity, demolishes beneficial insects that serve as natural enemies of pests and reduces the nutritional value of crops(FAO, 2011).

Chemical Classes of the Identified Pesticides: Based on the chemical class of the ingredients, the most prominent families pesticide components identified were primarily organophosphurs (22.9%), carbamate (20%), pyrethroid (17.1%), organochlorine (8.6%), botanical (5.7%) and fumigants classes (5.7%), with organophosphurus pesticides being as the most abundant (Table 3). Abamectin(avermectin),Atrazine (triazine), MCPA (phenoxy), metalxyl (anilide), paraquat (quaternary ammonium),warfarin (coumarin) and zinc phosphide (inorganic) formed20% of the gross chemicals offered in the market as pesticides (Table 3).

TABLE 3 : Chemical Classes of Pesticide Components Collected From the Bakara Market.

Chemical classes	# Components	% Total components
Organophosphurus	8	22.9
Carbamates	7	20
Pyrethroids	6	17.1
Organochlorines	3	8.6
Botanicals	2	5.7
Fumigants	2	5.7
Others	7	20

Though pesticides are invaluable in the crop protection sector, they are inherently hazardous, and among them, a generally modest number of Highly Hazardous Pesticides (HHPs) which causes serious environmental hazards, high intense and everlasting toxicity to the humans. Pesticides vary greatly in the hazardousness based on its toxicity level of the active ingredient contained in it. Some of the pesticides are quite hazardous while others are extremely or highly hazardous by which some of the countries are totally banned its use and trade. There is no uniform system in the world for regulating hazardous pesticides as some countries recognize the pesticide as HPP and impose its restriction or ban only in response to its problems experienced by itself, or in other countries. For this, PAN (Pesticide Action Network) developed an International List of HHPs and classified them into four groups based on the criteria recognized by the FAO/WHO Joint Meeting on Pesticide Management (JMPM) and/or by the International conventions for pesticide use and trade regulations. This can serve for the countries as a basic source for action to regulate the use of pesticides and elimination of the highly hazardous ones.

TABLE 4: Hazard classification of identified pesticide components in Bakara Market, Mogadishu, Somalia.

	No. of pesticide components	% of all pesticide components
Obsolete or discontinued use pesticides	2	5.7
Pesticides classified hazardous by PAN	30	85.7
Un-registered pesticides by PAN	3	8.6

The study demonstrated that there was a wide range of varieties of pesticides in circulation in Somalia. Thirty-two which is accounting about 91% of the total 35 pesticide products are considered unsafe to be used by Pesticide Action Network (PAN) and World Health Organization (WHO). MCPA (Herbicide), metalaxyl (Fungicide) and pyrethrin (Insecticide) were the only pesticide ingredients that were found in the market and are not included in the list of HHPs developed by PAN in 2019, and hence considered tobe safe if used properly. Although metalaxyl is included in class II based on WHO hazard classification system but wasn't mentioned in all the PAN records of HHPs. However, MCPA and pyrithrin were included in the previous list of high-hazardous pesticides and later removed in November, 2013 when it has been proven to be unrelated to the speculation of linking them with the carcinogenic pesticides.

Amongst the identified hazardous pesticides werealdrin and dieldrin which are under the list of the Stockholm Convention on Persistent Organic Pollutants and considered to be obsolete (have been previously discontinued for use as a pesticide) by WHO due to their experience of extreme hazard to the public health system and a severe menace to the environmental components.

Aldrin and dieldrin are along with DDT in the chlorinated insecticide group and have been severely restricted or banned for crop use in most developed countries. Unluckily, they can still be found using a termite controller in numerous third world countries including parts of Africa. Both organochlorine compounds are persistent in the environment and degrade very slowly hence contaminate the soil and are going to be with us for some time in our food supply, in our homes, and all around us even after six decades of its use. Even the plants store and remain in their bodies if they take up the from the soil. They can build up over the body leading to cancer and reproductive health hazards to the people and even can pass their toxicity to the pro born fetus and children along with the placental and breastfeeding systems.

Thirty types of the total identified pesticide components in the study are related to either public health concerns or environmental hazards and most of them are restricted and totally banned in at least one country or more. For convenience and according to PAN classification, a pesticide is categorized in group 1, if it causes health problems soon after exposure to the humans via swallowing, skin contact or inhalation; in group 2, if it has a long-term effect to human health leading ultimately to produce cancer, birth defects and reproductive damage, disruption of hormone systems or damage to the genetic material; in group 3, if it can lead to environmental hazards like keeping in persistent in soil or water; be able to accumulate in the food chain; acting highly toxic to bees and to the aquatic organisms; and in group 4, if it's recognized by International Conventions as causing serious irreversible harm under natural conditions of use in a particular country.

In simply, based on the scientific lab experiments carried out, the first two groups are specialized for those pesticides negatively linked with the public health concerns while the third group are for those directly related to the threat of environmental components. The fourth group are categorized to those pesticides that their hazards are experienced at least by one of the countries in the world such as DDT, aldrin, dieldrin and others.

Pesticides associated with the public health hazards: The study reveals that 29 ingredients making out 90% of the total identified pesticides are directly linked to the public health implications. Three of these chemicals were considered to be obsolete, as mentioned in above, while the rest were cataloged under group 1 with high acute toxicity (having immediate effect to the exposed persons) or group 2 with chronic toxicity (having long term effect to the humans) according to the PAN classification system of hazardous pesticides.

The study shows that 14 types of pesticides available in the marketplace in Mogadishuwere directly associated with high acute toxicity products having immediate occupational poisoning to the individuals involved in the business and application of the chemicals (Table 1). Two of these pesticides *viz.*aldicarb and calcium cyanide are extremely hazardous and are categorized under class Ia based on WHO classification system of hazardous pesticides. WHO also recorded 9 of the pesticides found in the study area under class 1b or Highly hazardous pesticides. These are abamactin, beta-cyfluthrin, carbofuran, cyfluthrin, dichlorvos, methomyl, nicotine sulphate, warfarin, and zinc phosphide. Some pesticide such as aluminum phosphide, paraquat and endosulfanwere listed under group 1 but neither rated 'Extremely hazardous' nor 'Highly hazardous' (i.e. not in Class Ia or Ib) due to having documented or believed to be associated with highest rates of fatalities in the world (PAN, 2019).

Majority of the acute toxicity pesticides in the study market were among those with the highest number of banned countries of which some of them such as endosulfan and aldiracb having banned by more than hundred nations. Acute toxicity pesticides cannot only affect on individuals who are preparing, mixing or applying chemicals, but also with people getting into with the applied fields, consumers eating the treated crop soon after application and etc. Others involving in the handling of such pesticides can also be risked in the storage during cleaning or managing the products, or during the disposal of the empty containers and contaminated materials like gloves.

Beside high acute toxicity pesticide products mentioned above, there were 12 other pesticides being dominant in Bakara market and were highly bonded with the public health hazards. They have been categorized under group 2 by PAN, dubbed with chronic toxicity pesticides and classified under class II by WHO posing adverse effects after repeated or prolonged exposure to individuals. As in table 1, eight of the 12 pesticides mentioned above which are used largely in Somalia have been banned in twenty eight or more countries in the world. Such pesticides can be carcinogenic (like carbaryl, diazinon, glyphosate, malathion, mancozeb, and permethrin), reproductive toxicants (like glufosinate), endocrine disrubters (like atrazine, bifenthrin, and deltamethrin), or mutagenics leading inheritable changes in human germ cells (such as benomyl and carbendazim).

Pesticides with potential environmental hazards: It is normal that pesticides are applied by spraying or spreading across the entire farm. This blanket application approach leads to reaching the chemicals off-side other than the target location or organism and may jeopardize the environment by killing beneficial insects like bees, reaching and polluting water sources like rivers and killing aquatic organisms. Each pesticide ingredient or class comes with a specific set of environmental concerns. Therefore, the study discovered 20 pesticides which makes about 60% of the total ingredients in the marketplace have potential environmental hazards withaldrin and dieldrin being the most dangerous ones. These two pesticides are grouped with DDT based on their persistent character on the soil and plants, and have banned almost all the countries in the world. The remaining environmental concerned pesticides found in the study were merely limited with the toxicity of the beneficial insects like honeybees that cover a crucial role in the farming ecosystem. These pesticides were abamectin, aldicarb, aluminum phosphide, beta-cyfluthrin, carbofuran, cyfluthrin, dichlorvos, methomyl, bifenthrin, carbaryl, deltamethrin, diazinon, malathion, permethrin, chloropyrifos, cypermethrin, dimethoate, and profenofos. Except the last four chemicals, others have undesirable consequences to the public health system in addition to their brutality to the ecologically beneficial organisms.

Handling of pesticides in the marketplace: The presence of a high percentage of hazardous pesticide in the local market is primarily due to the unregulated trade and lack of policies and inspectors under the governmental agencies. At this moment, the government is working hardly to establish rules and policies that regulate the marketing system of the agro-chemicals in the local market ad this generates light at the end of the tunnel to get sustainable and green environment in the country. Under thecurrent existing circumstances, pesticides that are disqualified worldwide can be disposed of on the local market threatening the environment and population. Though most pesticides sold are labeled but still others with unlabeled plastic bags or containers or with incomprehensible world languages, limiting the effectiveness of labels at times in communicating health risks to both vendors and customers. The study also found that most of the retailers sell the products with a manner by which the pesticides are displayed on the table in an open sunlit space with other agricultural inputs mainly seeds leading to disqualifying the ingredients and ineffectual to the control against pests.

Disposing the obsolete pesticides due to expiration of the products was another issue considered in the study. It was distressful to be found that most of the vendors claim that the farmers believe that pesticides cannot be expired unknowing that it is unsafe and incompetent to be used against crop pests. This indicates that the expired chemicals can be openly sold in the market despite the fact that the researcher didn't find it actually during the study period. Such chemicals are usually disposed of by vending them with the normal expected price to the farmers to be used in their fields which is literally harmful to the environment, the personnel applying and the consumers using the crop.

Based on the application of safety precautions, the study reflects that it's strange to see vendors wearing protective materials like gloves during manipulation with the pesticides though they were mostly familiar about the malicious impacts of pesticides and the safety measures related to their management. Occasionally, shopkeepers might have direct exposure to pesticides especially when there is intermittent spills due the leakage or damage of the containers. This can happen, even in the best run stores, and concentrates are repacked and then transferred into other containers. Un-using precautionary measure in such situations can exacerbate the inherent harmfulness of the pesticides to the health of the community.

IV. Conclusion

There has always been an immense need for a study regarding the sale of hazardous pesticides in Somalia. This is the first study to be conducted in Somalia to determine the exposure health risks associated with the pesticides in circulation. The results show that there is a significant high percentage(91%) of hazardous pesticides and considered to be unsafe in crop production. Some of these are extremely hazardous while others are considered to be futileas a pesticide by WHOand should not be used by untrainedindividuals and without proper protection equipment. Even worse, these pesticides can be found as expired exacerbating their inherent hazardousness. This is mainly due to the lack of regulative policies and laws in place and hence led the country to be used as a disposal for the unwanted products including such highly hazardous pesticides. Lastly, the study emphasizes the placement and enforcement of pesticide importation laws and regulations to target major issues that could minimize pesticide exposure risks and protect the environment and human health.

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