



Pesticides and Fertilizers Use in Parts of Rivers Niger and Kaduna Catchments, North Central, Nigeria

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Abstract

Pesticides and fertilizers use in parts of Rivers Niger and Kaduna catchments, north central, Nigeria was investigated. Contamination of the rivers and their resources due to unsustainable use of pesticides and fertilizers by local farmers are a major problem in the study area. Also, data from the study of pesticides and fertilizer use remain scanty and therefore needed. The objective is to find the opportunity for all stakeholders to improve on the overall environmental performance. Extensive field survey was conducted using various participatory appraisals techniques involving key stakeholders in the area. Collated data were analysed using descriptive statistical methods (frequency percentage). The results of findings identify unsustainable use of fertilizers and pesticides by farmers in the study area. It further shows respondents in the study area applied high rate of fertilizers and pesticides during farming activities which obviously improved crop yield but in turn lead to water quality degradation. Virtually, majority of the farmers have little or no measures towards ensuring protection of water and biota from the potential danger of pesticides and fertilizers use in the study area. These attitudes discovered could lead to water quality degradation, biodiversity disruption and subsequent negative impact on economic development in the study area. In view of the above, it is recommended that visible and effective environmental management policies in respect of agrochemicals use in the study area be put in place to guarantee cleaner and healthier environment for all.

Keywords: Fertilizers, Pesticides, Catchments, Rivers, Sediments, Water quality, Health, Environment.

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Contents

1. Introduction	19
2. The Study Area	19
3. Materials and Methods	20
4. Results and Discussion	20
5. Conclusion and Recommendations	24
References	24

Contribution of this paper to the literature

This study has been able to establish a background information on pesticides and fertilizers use attributable to water quality degradation which no other known researches have ever considered in the study area. This research contribution will serve as a baseline for further empirical researches in the area of laboratory analysis of water, sediment and biota in the study area.

1. Introduction

Pest infestations, government subsidies, rapid population growth in addition to change in climate has resulted to a driving force for farmers to use more pesticides and fertilizers in agricultural activities [1]. Fertilisers and pesticide are intended to facilitate plant growth and protections. Although initially used to improve crop production. Sequel to application of these chemical compounds on farm lands to achieve the essential mission to care for crops, they have been reported also to compromise water quality [1]. They move into the surrounding water bodies, therefore having a widespread effect on the physical, chemical and biological processes within aquatic ecosystems [2].

It is established that banned pesticides are still being imported illegally in to Nigeria through porous borders [3]. The use of synthetic fertilizers and pesticides in many parts of the world are on the increase [4]. River Niger catchment are arable land where people practice farming involving intense use of agrochemicals [5]. This practice can eventually cause degradation of water quality and disproportionate effect on the socio-economic wellbeing of the communities in the area. Communities' dependant on the resources from the River for livelihood and lack of enough research information about the area that represent risk of fertilizers and pesticides contamination informed the need for this study to guaranty socioeconomic sustainability. Finding of this study is targeted at providing opportunity for relevant government authorities and all stakeholders in this sector to improve on overall environmental performance.

2. The Study Area

The study area for the investigation is communities in parts of Rivers Niger and Kaduna Catchment areas, Niger State which lies between Longitude 3°30'N and 7°20'E and Latitude 8°22'N and 11°30'N; located at the Guinea Savannah vegetation zone in the north central part of Nigeria Figure 1. Rivers Niger and Kaduna catchments are arable land where people practice agricultural activities close to the Rivers [6]; [5]. The study area was divided into zones according to agroecological factors. Along River Niger, the Upper zone is from Rabba village in Mokwa Local Government Area (LGA), Middle zone is at Muregi and the Lower zone is after Muregi in Mokwa LGA down to Baro village in Agaie LGA. Study area along River Kaduna was divided into two zones. Upper zone is from Wuya village in Lavun LGA and the Lower zone from half way down to Muregi. The major economic activities of the communities living around the area are agriculture and fishing. These are the leading sector in terms of employment, income earning and overall contribution to the socio-economic wellbeing of the people. The Kaduna and Niger River flood plains are many kilometers wide at the downstream of Nupe basement boundary, two major streams Yanko ikko, Dumi, Ebigi. All these empty their waters in to Niger River [6].

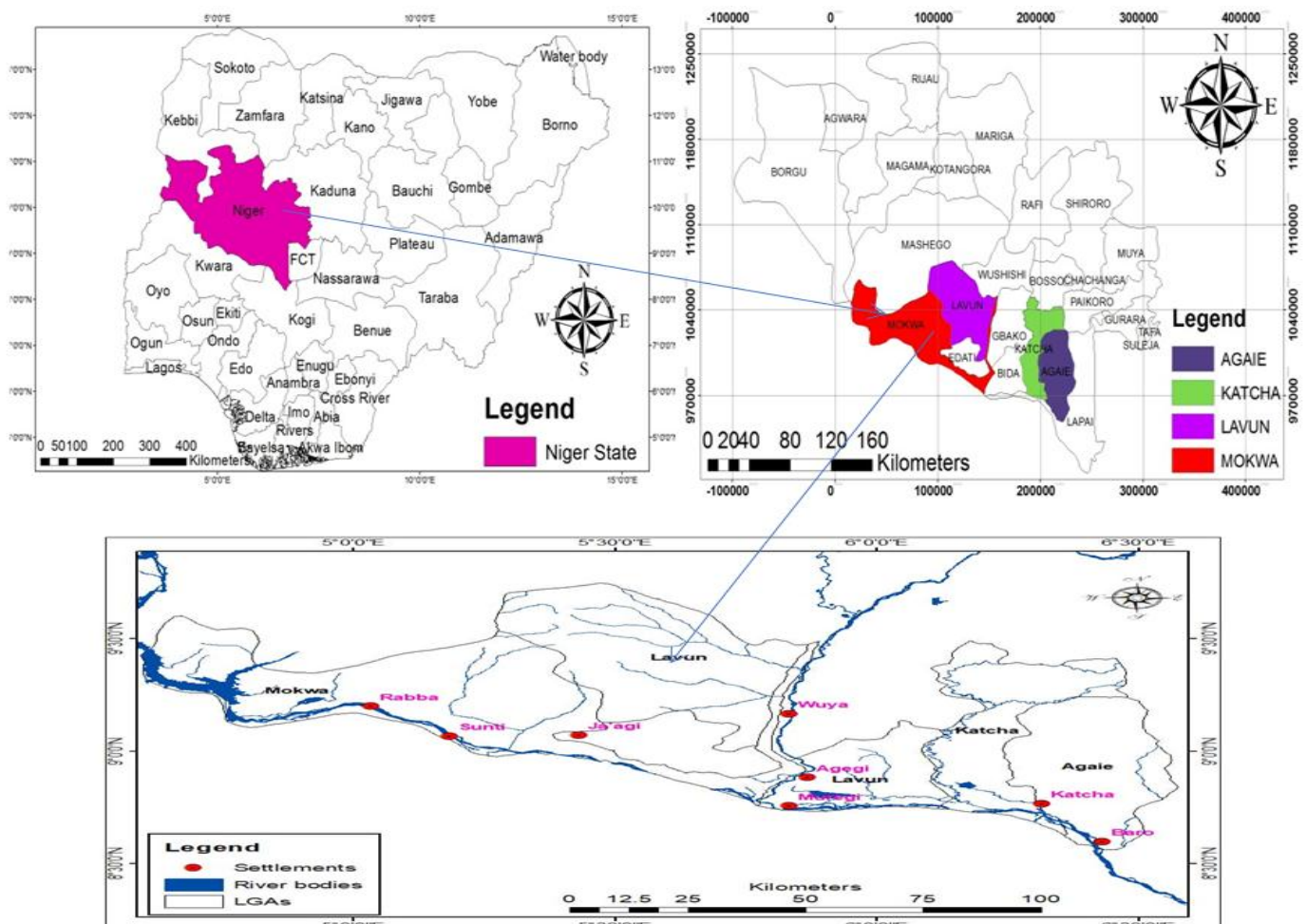


Figure-1. Map of the study area showing parts of Rivers Niger and Kaduna Catchment, North Central, Nigeria.

3. Materials and Methods

(a) Primary Data. The study was achieved through a prospective cross-sectional study in the study area. It utilizes primary data from structured questionnaires, scheduled interview, visual observations and ground photograph as described by Banerjee, et al. [7].

(b) Secondary Data. Secondary data were obtained from study area map, demographic data (population) and relevant literature materials to identify gaps and missing links in the existing body of knowledge. Furthermore, information were sourced from standardized National and International documents relevant to agrochemical regulations and enforcement i.e. National Gazetted Regulations from National Environmental Standards and Regulations Enforcement Agency, (NESREA), regulatory documents from National Agency for Food and Drug Administration and Control (NAFDAC), National Policy on Environment, and other relevant documents.

(c) Data Sampling. The number of farmers included in the study (participants) was determined using Yamani's formula. This formula is concerned with applying a normal approximation with a confidence level of 95% and a limit of tolerance level (error level) of 5%.

To this extent the sample size was determined by
$$n = \frac{N}{1 + Ne^2} \tag{1.0}$$

Where: n = the sample size.

N = population.

e = the limit of tolerance (0.05)

Therefore,
$$n = \frac{30,229}{1 + 30,229(0.05)^2} = \frac{30,229}{1 + 30,229(0.0025)} = \frac{30,229}{1 + 75.5} = \frac{30,229}{76.5}$$

n = 390 respondent.

The study respondents were 395 and simple random sampling was used to distribute the questionnaires among the respondents who are mainly farmers in the study area. Three hundred and ninety-five questionnaires were distributed and 350 were returned. Questionnaires were administered following proper institutional and field validations.

Interviews schedules were directed to Key Informants which include experienced district officers, extension agents and agrochemical vendors in the study area. The respondents were approached by the study team. The objective of the study was explained to them following which consent were obtained from them. The questions include: sizes of farms, type of farming, types of crops grown, when are the planting seasons, pest and other problems, types and quantities of farm chemicals used on farms, consideration for label instructions, farmer's knowledge and attitude towards agro-chemicals, where the farmers procure the agro-chemicals from, disposal of used cans, washing of applications tools and measures taken to conserve the River and use of the River water. This provides the opportunity for capturing the required information to achieve this objective.

(d) Statistical Analysis. Data obtained from administered questionnaire and interview schedules of farmers and key stakeholders in the area was analysed for pesticide and fertilizers use using descriptive statistical methods (frequency percentage) and then presented in tables and figures for clarity.

4. Results and Discussion

4.1. Farming Analysis

As indicated in Table 1, the hectare of land used by the respondents in the study area ranges from 2 to 15. Upper zones ranked the highest in number of hectares of land used for farming with 142 respondents, lower zones ranked second with 122 respondents and middle zone ranked the least with 86 respondents. In 2 to 5 hectares' ranges, upper zones ranked the highest with 69 respondents and middle zone ranked the least with 21 respondents. In 6 to 10 ranges, lower zones ranked the highest with 47 respondents and middle zone ranked the least with 20 respondents. In 11 to 15 ranges, middle zone ranked the highest with 45 respondents and lower zones ranked the least with 30 respondents.

Table-1. Number of hectare of land used by the respondents in parts of Rivers Niger and Kaduna Catchment, North Central, Nigeria.

Options	Upper zones		Middle zone		Lower zones	
2 – 5	69	19.7%	21	6.0%	45	12.9%
6 – 10	31	8.8%	20	5.7%	47	13.4%
11 – 15	42	12%	45	12.9%	30	8.6%
Total	142	40.5%	86	24.6%	122	34.9%

The findings imply that majority of the respondents in all the zones were subsistence farmers since they used between 2 – 10 hectares of land in the study area. Rice, maize, beans, groundnut, millet and melon are the mostly crops grown across the zones in the area. Most of the farm lands have been in use for over 30 years. The farmers in the area also practiced crop rotation involving maize, beans, sorghum, melon and pepper. Interview findings from experienced district officers, extension agents and agrochemical vendors corroborated all the submissions by the farmers in the study area. Similar farming system have been reported around riverine areas in developing countries like Kenya indicating majority of communities practicing subsistence farming [8].

4.2. Planting Season

As indicated in Table 2, majority of the respondents affirmed that they plant most of their crops rainy seasons. Rainy season ranked the highest with 274 respondents and dry season ranked the least with 76 respondents across the zones. The number of farmer involved in rainy season farming at the upper, middle and lower zones constitutes 30.5%, 18.6% and 29.1% respectively. Those involved in dry season farming at upper, middle and lower zones constitutes 46%, 6% and 11.2% respectively.

Table-2. Planting Season in Parts of Rivers Niger and Kaduna Catchment, North Central, Nigeria.

Options	Upper zone		Middle zone		Lower zone	
Rainy season	107	30.5%	65	18.6%	102	29.1%
Dry season	16	4.6%	21	6%	39	11.2%
Total	123	35.1%	86	24.6%	141	40.3%

This implies that majority of the respondents' plant most of their crops during the rainy season and those that farm during the dry season farms vegetables, rice and sugarcane. The farmers were asked as to why they prefer rainy season farming and the response was due to abundant rain and availability of farming accessories at lower cost. Those that adopt farming in both season gave the reasons that there are less pest infestations during dry season except bird attack which can easily be contained. The study also identified a number of farmers do plant some of their crop three times during rainy and dry seasons in a year. This crops include maize, rice sugarcane and vegetables. Findings in this study also revealed almost all the farmers complained about the problems of pest infestations, weeds and late and early stoppage of rain. They further submitted that dependant on agrochemical has been the viable method adopted by them to minimize the effects of the challenges. Interview findings also revealed that most farmers in the study area plant their crops in the rainy season do to abundant moisture. They also acknowledged farming activities in both season and presence of pest infestations during all seasons in the area. The planting season and cropping pattern identified in this study is in in line with the pattern in practice in northern Nigeria [9].

4.3. Use of Fertilizer and Pesticides in Farming

As indicated in Table 3, there were high use of pesticide and fertilizer in farming activities of the respondents in the study area. Lower zones ranked the highest with use of pesticides and fertilizer (39.4%); upper zones ranked second with 33.5% and middle zone ranked the least with 24.5%. Out of 100% of the respondents, 2.7% disaffirmed the use of pesticides and fertilizers in their farms due to inadequate financial support to farming and inadequate legit borrowing facilities in the study area. This implied that majority of respondents used fertilizer and pesticide for farming activities in the study.

Table-3. Use of Fertilizer and Pesticide in Parts of Rivers Niger and Kaduna Catchment, North Central, Nigeria.

Options	Upper zone		Middle zone		Lower zone	
Yes	117	33.5%	85	24.3%	139	39.7%
No	06	1.8%	01	0.3%	02	0.6%
Total	123	35.1%	86	24.6%	141	40.3%

Revelations from field interview shows that majority of the farmers across the zones have dropped the idea of traditional ways of crop improvements and presently adopted the use of synthetic fertilizers and pesticide. They gave the reasons that government subsidies, interventions and gifts from politicians have made it easier to acquire agrochemical. Other reasons are scarcity in getting animal manure as the people in the area are not much involved in animal farming and faster results due to usage of synthetic fertilizers. The finding also revealed that pest infestations have been the reasons for pesticides use for farming in the study area. Stakeholders' interview shows intense use of agrochemical by all farmers in the study area. Stakeholders' views for agrochemical use also corroborated revelations by the farmers in the study area. Similar indicators in this finding have been reported among smallholder farmers in developing countries [10].

4.4. Characteristics of the Fertilizers and Pesticides Used in the Study Area

Table 4, describe the types of fertilizers been used across the zones in the study area for over 15 years. Fertilizers identified been used in the study area include: Nitrogen, phosphorus and Potassium 17:17:17, Nitrogen, phosphorus and potassium 23:23:0, Diaminomethanal and Calcium ammonium nitrate. The findings revealed majority of the farmers use nitrogen and phosphate based fertilizers for cropping and dressing in the area. These identified compounds of fertilizers have been designated to present potential health hazards [11].

Table-4. List of Fertilizers Current Use in Parts of Rivers Niger and Kaduna Catchment, North Central, Nigeria.

Fertilizer	Trade name	Use
Nitrogen, phosphorus and Potassium 17:17:17	NPK 17:17:17	Growing
Nitrogen, phosphorus and potassium 23:23:0	NPK 23:23:0	Growing
Nitrogen, phosphorus and potassium 20:20:0	NPK 20:20:0	Growing
Diaminomethanal (46%)	UREA	Dressing

Field interview from experienced district officers, extension agents and agrochemical vendors in the study area affirm the use of all agrochemical revealed to be in use by the farmers in the study area. Further, pesticides identified in use currently in the study area include organophosphorus, synthetic auxins, thiadiazines, organochlorine, synthetic pyrethroids, triazoles flumiclorac pentyl-lactofen, triazine-amide, pyrazoles and organophosphorus-pyrethroids. As indicated in Figure 2 percentage of pesticides compounds currently in use by farmers across the zones in the study area shows organophosphorus constitute 8.69%, synthetic auxins constitute 4.35%, thiadiazines constitute 4.35%, organochlorine pesticides constitute 34.78% indicating the highest compound of pesticides in use in the study area, synthetic pyrethroids constitute 8.69%, triazoles constitutes 4.35%, 4.35% are flumiclorac pentyl-lactofen, 13.04% are fungicides, 8.69% are triazine-amide, 4.35% pyrazoles and 4.35% are organophosphorus-pyrethroids.

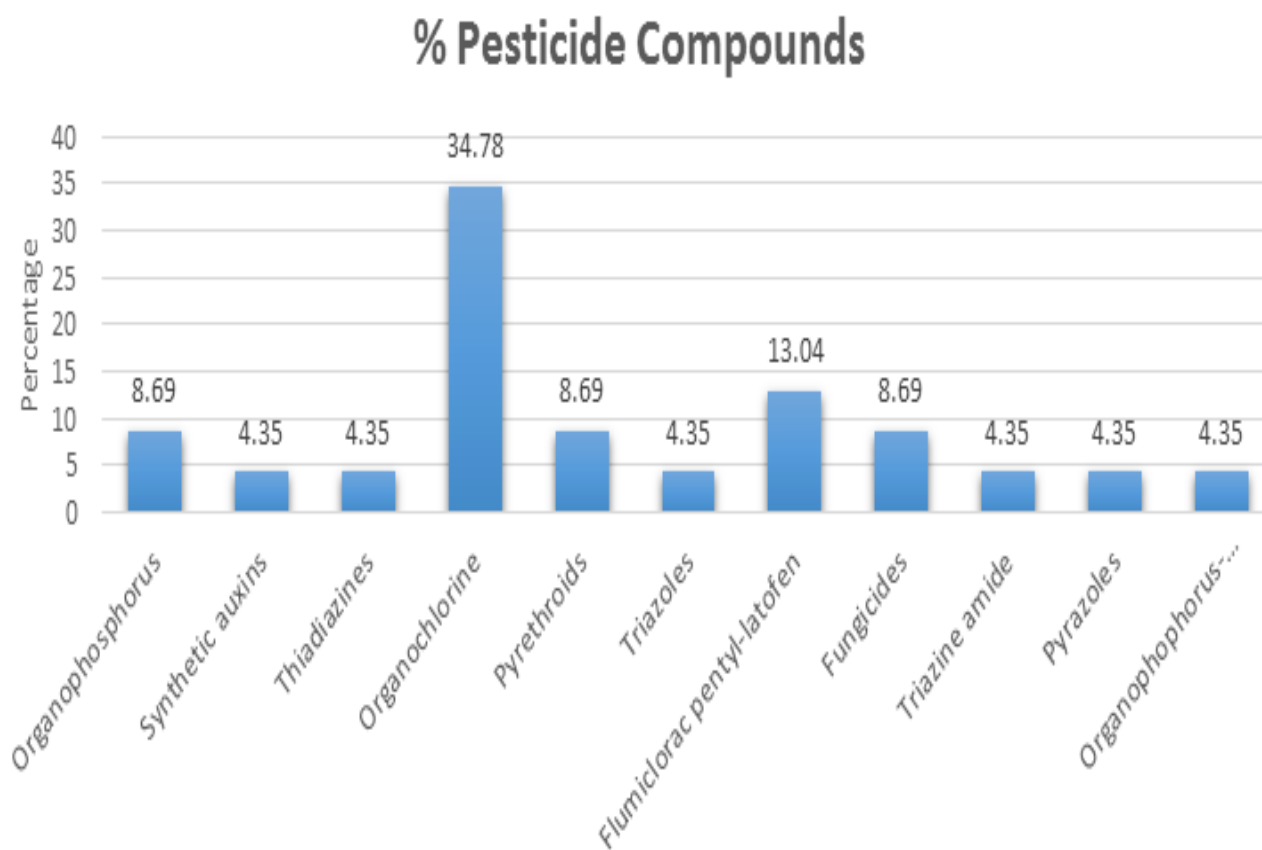


Figure-2. Percentage of pesticide compounds currently use in parts of Rivers Niger and Kaduna Catchment, North Central, Nigeria.



Figure-3. Open market vendor of pesticides in parts of Rivers Niger and Kaduna Catchment, North Central, Nigeria.

Revelations by farmers, experienced district officers, extension agents and agrochemical vendors in the study area, all these pesticides are currently in used to control weed, pests and diseases. Among them are pesticides banned in Nigeria such as organochlorine insecticide DDT and its metabolites DDD and DDE. A good number of synthetic chemical pesticides revealed being use in the study area are restricted for use and export in the European Union EU. These include: abamectin, chlordane, dieldrin, endosulfan and aldrin. Similar studies in developing countries reveals heavy use of pesticides in farming with much use of organochlorine pesticides as revealed in a number of previous studies [12];[13];[14].

4.5. Fertilizer Application per Hectare

As indicated in Table 5, fertilizer application per hectare ranges from 50kg to 170kg across the zones in the study area. 121 – 170kg fertilizer application ranked the highest in lower zones and 101 – 120kg ranked the least in middle zone. This implies that the respondents in the study area applied high rate of fertilizer during farming activities and it improved crop yield but in turn lead to water quality degradation.

Table-5. Fertilizer application per Hectare in Parts of Rivers Niger and Kaduna Catchment, North Central, Nigeria.

Options	Upper zone		Middle zone		Lower zone	
50 – 100kg	47	13.4%	21	6.0%	41	11.7%
101 – 120kg	45	12.9%	20	5.7%	31	8.8%
121 – 170kg	31	8.9%	45	12.9%	69	19.7%
Total	123	35.2%	86	24.6%	141	40.2%

Field interview also revealed that all the farmers applied fertilizers to their crops manually by direct application to crops or hand spray. Fertilizers were mostly applied during land preparation and crops growing. The farmers mostly get their fertilizers from agrochemical vendors, government subsidies, intervention and gifts from politicians.

Farmers' interview in the area revealed not having been trained on agrochemical use but usually receive some guides from the local vendors. Most of the farmers in the study area revealed using fertilizers for the past fifteen (15) years. Finding during interviews and field observations show that most of the farmers do not care about sustainable use of fertilizers in their farming as it was evident that more quantities of fertilizers were been used above recommended rate.

The implication of this findings could have serious negative effect on environment, health risk and subsequent impacts on economic development in the study area. Similar situation of excessive and unsuitable use of fertilizers have been reported in most developing countries including Nigeria [15];[16].

4.6 Pesticide Application per Hectare

As indicated in Table 6, pesticide application per hectare ranges from 5 to 10litres in the study area. 10 litres and above of pesticide application ranked the highest in lower zones with 69 respondents and 5 – 7 litres ranked the least in middle zone with 19 respondents. This implies that the respondents in the study area applied high rate of pesticide during farming activities and it improved crop yield but in turn lead to water quality degradation.

Table-6. Pesticide application per hectare in Parts of Rivers Niger and Kaduna Catchment, North Central, Nigeria.

Options	Upper zone		Middle zone		Lower zone	
5 – 7litres	41	11.7%	19	5.4%	41	11.7%
8 – 9litres	45	12.9%	20	5.7%	31	8.8%
10litres and above	37	10.6%	47	13.4%	69	19.7%
Total	123	35.2%	86	24.6%	141	40.2%

The farmers in the area revealed getting the pesticides used in farming from local vendors, government intervention and gifts from politicians. These pesticides are applied by all the farmers across the zones using knapsack sprayer.

There was no consideration of wind direction, timing considerations and proximity to vulnerable areas by farmers during application. The findings also discovered that the farmers do not abide by the inscribed instructions or directives on the agrochemical containers and uses their own discretion for measurement and mixing, by so doing, higher rate of pesticides is being applied on the farmlands beyond recommended rates.

Most of the farmers revealed using pesticides on their farming since past ten years but much in last four to five years. Finding also shows that only 35% of the respondents are aware of banned and restricted pesticides in Nigeria but could not tell the categories of those pesticides involved.

The implication of these indicators will be counterproductive in achieving healthy socio-economic wellbeing of the inhabitants in the study area. Indicators identified in this study are similar to findings in a number of studies in developing countries including Nigeria [17];[18];[19].

4.7 Disposal Mechanism of the Used Containers

As revealed in Figure 4, empty pesticides containers/bottles were dispose into the disposal pit, throw in the latrine, just discard them in the farm, destroy and burn or bury and keep for re-use. Just discard them in the farm ranked the highest with 203 respondents, discard in the nearby bushes/roadsides ranked second with 70 respondents, disposing into the disposal pit ranked third with 50 respondents and dispose in latrine ranked the least with 27 respondents.

This implies that majority of the respondents dispose their empty bottles of pesticides in their farms and this will lead to increase of plastic waste in their farms as well as environmental pollution.

The findings from further appraisals revealed that most of the farmers in the area washed the application tools after spraying in the rivers, streams and pounds. Virtually all the farmers have little or no measures towards water conservation and protection in the study area. These attitudes discovered could lead to water quality degradation, biodiversity disruption and subsequent negative impact on economic development in the study area.

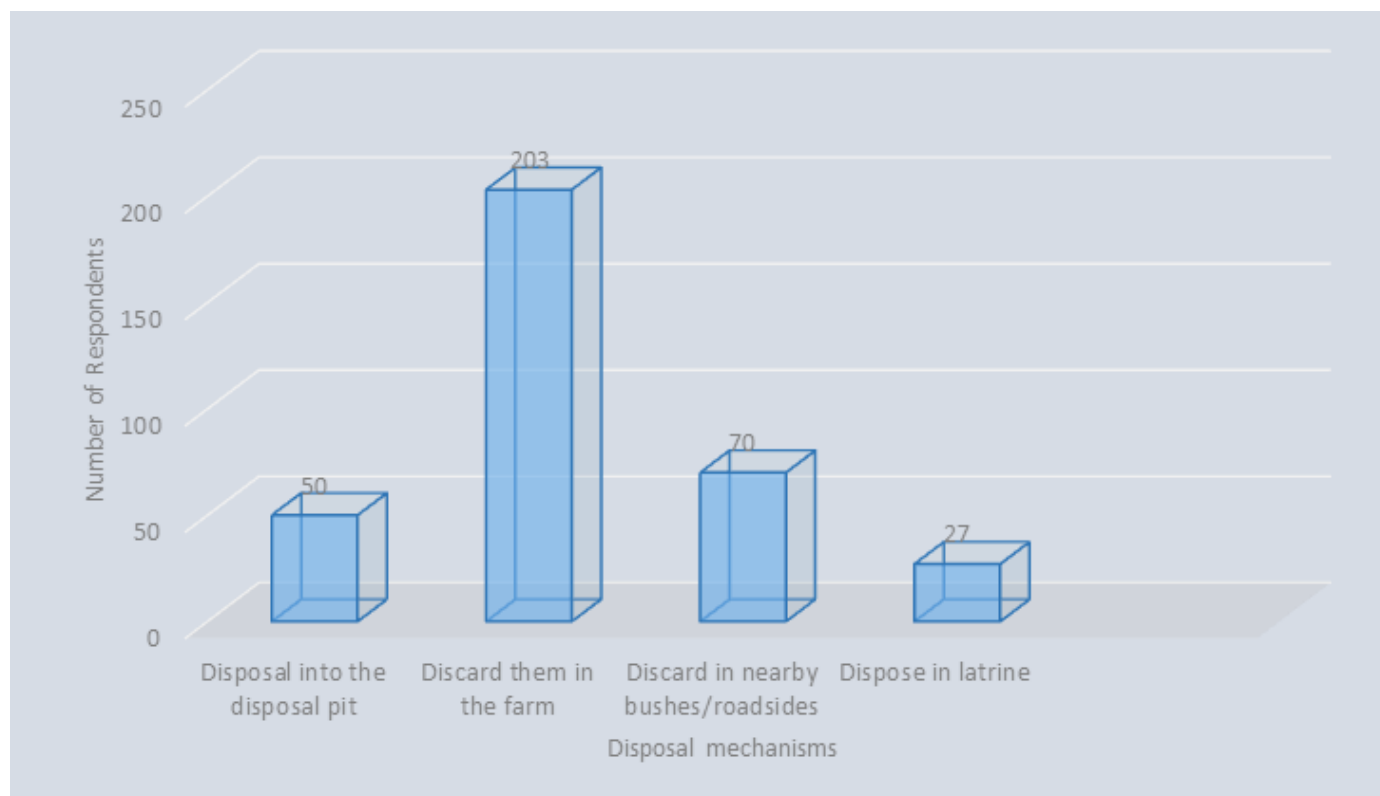


Figure-4. Shows disposal mechanism of empty pesticides containers/bottles in parts of Rivers Niger and Kaduna Catchment, North Central, Nigeria.

Similar situation has been reported previously in developing countries [19]. Also leftover spray mixture was often emptied into streams or near a near water bodies in the study location. This finding is in line with discovery in a number of studies in Nigeria [20];[21].

5. Conclusion and Recommendations

It was established that the farmers in the study area uses various compounds of synthetic pesticide and fertilizers in their farming activities. The types of pesticides compounds identified in used in the study area include: organochlorine and organophosphorus based which are known to present serious negative socio-economic effects. Organochlorine based pesticides identified in used in the study area constitutes highest percentage at 34.78% while organophosphorus based pesticides constitutes 8.69%. Nitrate, nitrite and phosphate based fertilizers were also identified in use in the study area. It was also established that farmers in the study area have not adopted environmental sustainable measures in pesticides and fertilizers use in farming activities. This conduct by farmers in the area can lead to contamination of water and biota. More so, potential negative effects on socio-economic wellbeing of communities in the study area can be expected. In view, of the aforementioned, it is recommended that visible and effective environmental management policies in respect of agrochemical use in the study area be put in place. Also, government dedication, political wills, and collective responsibility of all stakeholders toward agrochemical management and ensuring sustainable farming practices involving the use of pesticides and fertilizers in the study area to guarantee cleaner and healthier environment for all.

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