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UTILIZATION OF AGRICULTURAL CHEMICALS FOR SORGHUM PRODUCTION BY SOME FARMERS IN BENUE STATE

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Abstract
This study was designed to assess the utilization of agro-chemicals in the production of sorghum by farmers in Benue State. Specifically, the objectives were to assess the types of agro-chemicals used in the sorghum production chain among farmers and evaluates the methods of agro-chemicals application by farmers on sorghum production. The study used a mixed method design while cluster sampling was used to select 400 samples. Data was collected using questionnaire and Key Informant Interview while quantitative data was analyzed using percentages, qualitative data was analyzed using explanatory, interpretative and analytical approaches. The study found that the types of agro-chemicals used by the sorghum farmers were Butachlor (50.8%), Pendimathrin (20.6%) and Atrazine (17.5%) as pre-emergent pesticides. Glyphosates (56.1%), Paraquat (9.6%), 2,4-D, (8.9%) Cypermethrin (6.1%) and Lamda-cylahothrine as post-emergent pesticide. DDforc (25.1%), Crush (18.8%) and Phostoxin (10.9%) for sorghum preservation. It was also found that sorghum farmers predominantly used direct surface application (71.8%) and basal application methods (12.2%). The type of equipment used for pesticides application was knapsack sprayers. In order to preserve sorghum, farmers predominantly spray raw liquid on the sorghum mixed and package type (33.2%), tied tablets in a polythene and drop in the stored bags and mix insecticide with water and spray outside the packaged bags (19.3%) while others mix pesticides with water and spray directly on the seed and packaged (16.0%). The study therefore recommends for aggressive campaign and programmes to sensitized farmers on the need for seed treatment and the negative effects of using paraquat for sorghum production, use of more extension workers in rural areas to train farmers on pesticides use and prohibition the sale of fake and adulterated pesticides in the State.
Keywords: Utilization, pesticides, herbicides, sorghum, farmers, Benue state

INTRODUCTION

Sorghum (Guinea corn) is a cultivated cereal crop that is generally believed to have originated in North-Africa amongst countries along the Nile within the Ethiopian region in 1,000 B.C and is today one of the five most important cereal crops after rice, wheat, corn and barley largely grown in Africa, Asia, North America and South America (Adegbola, *et al*., 2013). The global annual sorghum production released in 2017 among top ten producing nations, showed United States of America as the leading producer with an annual production figure of 13.38 Million tons; India is second with a production figure of 8.23 Million tons, Nigeria is third accounting for 7.65 Million tons, Mexico produced 6.09 Million tons. In West Africa, Nigeria accounts for about 71% of the total regional sorghum output (FAO, 2012).

Sorghum is largely consumed in Nigeria and it is believed to have a lot of nutritional benefits due to its high anti-oxidant properties, and it contains the following vitamins B1, B2, B3, calcium, potassium, iron, phosphorous and sodium (Organic facts, 2017). Therefore, the importance of sorghum to national and human development cannot be over emphasized, as the grains provide ingredient for many indigenous foods and beverages companies in Nigeria. In view of its importance for human, economic and national development, sorghum production in Nigeria generally is severely constrained by pest and diseases which in turn, have adverse effects on the livelihood of farmers and other stakeholders across the value chain by reducing valuable income and profitability, thereby creating poverty among farmers (Ugwu, *et al*., 2015).

Sorghum production in Nigeria and indeed Benue State is severely constrained by weeds, pests, diseases and inappropriate pesticides application, which hitherto have adverse effects on yield, the livelihood of farmers and other stakeholders. Despites its enormous importance to human, economic and national development, there has been an unstable growth of sorghum production in Benue State particularly, when compared to other staple crops like cassava, rice, yam, and groundnut. Consequently, most farmers have resorted to the use of herbicides for the control of weeds and insecticides for the control of insect pests and disease (Okrikata and Anaso, 2008; FAO, 2011). At various stages along the sorghum production chain, pesticides are used in Nigeria. According to a study by NBS (2020) there is high proportions of import of pesticides in Nigeria while and World Bank, FAOSTAT (2020) study also revealed high massive use of pesticides by farmers in Nigeria. This made agricultural experts to argue that pesticides use is indispensable to agricultural production as medium and large–scale farmers depend almost entirely on pesticides for the control of weeds and pests hence one-third of agricultural products are produced using pesticides. There are approved scientific methods for pesticides application prescribed by agricultural experts worldwide. However, lack of adequate knowledge of pesticides used by most small-holder farmers in Nigeria and information concerning the type and dosage of pesticides to be applied as the only source of information is usually the product label. This is why Ugwu, *et al* (2015) argued that a good number of farmers do not have access to information on safety tips about pesticides handling or training in pesticides management.

The objective of the study therefore, was to assess the utilization of agro-chemicals in the production of sorghum by farmers in Benue State.

Methodology

Research Design

This study adopted a mixed method research design. This design enables the researcher select samples from large population as it offers the benefit of getting opinions and views from wide range of respondents. The design is also adopted because it enables generalization of findings or inference. It also allows the researcher to probe opinions and views in-depth from people who are custodians of knowledge.

Study Area

The study area was Benue State of Nigeria which was created on the 3rd February, 1976 with a projected population of about 4,293,300 people based on annual average growth of 0.3 (NBS 2017; Our Collective Vision 2015). Benue State is bordered in the North by Nasarawa and Taraba States. In the East, the State shares boundaries with Cross-River State and Cameroon. In the South the State is bordered by Ebonyi and Enugu States while in the West it is bordered by Kogi State.

The topography of Benue State is composed riverine areas and undulating plain with sporadic hills scattered across the area. The drainage system in the area is essentially made up of one of the largest rivers in Nigeria, the River Benue and several tributaries that transverse the area. Generally, based on Koppen's Scheme of Classification, Benue State lies within the AW Climate and experiences two distinct seasons, the wet/rainy season and the dry/summer season. The rainy season lasts from April to October with annual rainfall in the range of 100-200mm (BNARDA, 2019). The dry season starts in November and ends in March with the temperatures fluctuating between 23 – 37 degrees Celsius in the year. The south-eastern part of the State adjoining the Obudu-Cameroun Mountain range, however, has a cooler climate similar to that of the Jos Plateau (BNARDA, 2006; Our Benue Our Future, 2009). The vegetation of the area is made up of rain forests which have tall trees and tall grasses that occupy both the western and southern fringes while the Guinea savannah is found in the eastern and northern parts with mixed grasses and trees that are generally of average height (BNARDA, 2006; Our Benue Our Future, 2009).

The People are predominantly Small-Scale farmers who cultivate a wide varieties of agricultural products such as sorghum, millet, sesame, mango, oranges, beans, rice, sweet-potato, maize, yam, cassava, cocoyam, palm oil, African pear, tomatoes, chili-pepper and peanuts. (Our Benue, Our Future, 2009). The State is one of the major sorghum producing States in Nigeria (Nyishir, 2004; Ajayi and Nyishir, 2006). In Benue State, modern techniques of farming are not yet popular with farmers as most of them are not educated and farm majorly on subsistence level. Use of scientific methods of farming such as fertilizers, improved seed, herbicides, insecticides and other foreign methods appear to be on the increase. However, affordability, accessibility and availability of these scientific techniques are still a challenge; hence most of the farmers are uneducated and are seriously constrained by their poverty situations.

Population

The population of documented sorghum farmers in Benue State is 2,244 (BNARDA, 2019). The population of the study consists of sorghum farmers in Benue State. They include small- and large-scale sorghum farmers who reside essentially in rural communities in the sampled Local Government Areas, and comprised of both male and female sorghum farmers.

Sample Size Determination

The sample size of this study was determined using Yamane, (1967) formula for known population. The formula is stated below;

$$\frac{N}{1+N(e)^2}$$

n= Sample Size

N= population Size

e = Level of significance

$$\frac{2244}{1+2244\,(0.05)^2}$$

$$= 3.998$$

$$N = 400$$

Sampling Technique and Procedure

The study utilized cluster sampling procedure to sample responses. In the first stage, cluster sampling was used to cluster the study area into existing agricultural zones in the state such as Zones A, B and C. After the area was clustered, purposive sampling was used to select two local government areas in each of the clustered agricultural zones. Consequently, Kwande and Ukum Local Government Areas were selected from Agricultural Zone A, Guma and Makurdi Local Government Areas were selected from Agricultural Zone B, while Apa and Otukpo Local Governments were selected from Agricultural Zone C.

The next stage, 4 council wards were purposefully selected from local government areas. These include Usar, Mbadura, Mbaikyor and Tondov I council Wards (Kwande), Borikyo, Ugban, Kendev and Kundav Council Wards (Ukum), Mbawa, Uvir, Nzorov and Nyiev council Wards (Guma), Fiidi, Mbalagh, Agan and Modern Market wards (Makurdi). Auke, Igah-Okpaya, Oba and Ofoke council wards (Apa), Adoka- Ahaje, Adoka central, Entekpe and Ugboju Icho Council Wards (Otukpo), totaling twenty-four council Wards in the six Local Government Areas of the three Agricultural Zones of Benue State.

The last stage was selection of samples in the council wards. In Kwande Local Government, 75 respondents were selected, Ukum Local Government area (87 respondents) while in Guma Local Government area, a total of 63 respondents were selected. In Makurdi Local Government Area, 65 respondents, Apa Local Government area (56 respondents) and in Oturkpo Local Government area, 54 respondents were selected, totaling 400 respondents.

For the purpose of Key Informant Interview, purposive sampling was used to select sorghum farmers who have B.Sc., HND and those working in Crop Production Department of BNARDA. In each of the council ward in the selected Local Government areas, one key informant was selected.

Method of Data Collection

Questionnaire

A questionnaire was developed and administered to the 400 respondents. In the administration of the questionnaire, two research assistants were employed in the study areas and trained. Moreover, some of the literate respondents were asked to fill the questionnaire by themselves since they are literate enough to understand the questionnaire items, while the majority (non-literate) were assisted by the researchers. Therefore, face-face method was used for administration of questionnaire to respondents in the sampled areas. The duration for the exercise was one month and two weeks.

It can be inferred from Table 1 that 394 questionnaires were retrieved out of the initial 400. This because the respondents reported to have lost the questionnaires before retrieval. This represents 98.5 % retrieval rate which is so high and the non-response rate of 1.5%.

Key Informant Interview

Interviews were conducted with selected crop production experts at BNARDA officers at the Headquarters who have the requisite knowledge that was of significant value to the researcher in particular and the research in general for the study. Therefore, twenty-four council wards were selected for the key Informant Interview and the interviewees for KII were selected based on recommendations of research assistant in the sampled areas. In each selected council ward, one key informant was interviewed, totaling twenty-four interviewees.

Technique of Data Analysis

Data gathered was triangulated as findings from the questionnaire and KII were compared to ascertain areas of agreements and disagreements. Under quantitative technique, data obtained through the use of questionnaire was analyzed through descriptive statistics such as frequencies and percentages. Qualitative data collected using key informant interview was analyzed using explanatory, interpretative and analytical approaches.

Table 1 shows that the respondents in this study were 69.5% (274) male and 30.5% (120) females. This result agrees with Ndagana *et al*. (2020) study which revealed that male involved in sorghum farming in Niger state compared with the women.

In terms of age, majority of the respondents falls within the age range of 36-55 years comprising 43.7% (172) followed closely by those between 18-35 years 43.4% (171), only 8.1% (32) of the respondents were 56 years and above. This implies that sorghum farming is mostly practiced by youths and the middle-aged who are able bodied with strength to engage in all the rigorous farming activities involved in sorghum production. This is consistent with Yahaya *et al.* (2022) studies which showed that sorghum farming in Nigeria is dominated by middles aged adults.

With regards to marital status, the majority 82.7% (326) of the respondents were married, while 14.5% (57) were single. A negligible percentage 2.5% (10) of them were either divorced or widowed. This implies that it is married people who have more hands that are better able to cope with sorghum production which is labour intensive. This is consistent with Ndagana *et al*. (2020) finding which showed that married people were more involved in sorghum farming in Niger state, Nigeria.

Results and Discusion

Table 1: Socio-Demographic Attributes of the Respondents

Demographic Attributes	Frequency (N=394)	Percentage (%=100.0)
Sex		
Male	274	69.5
Female	120	30.5
Age of the Respondent (in years)		
18-35	171	43.4
36-55	172	43.7
56 and above	32	8.1
No response	19	4.8
Marital Status		
Single	57	14.5
Married	326	82.7
Divorced/Widowed	10	2.5
No response	1	0.3
Educational Qualification		
Non-formal education	40	10.2
FSLC	89	22.6
SSCE	98	24.9
National Diploma	36	9.1
NCE	83	21.1
Degree/HND	40	10.2
PhD	1	0.3
No response	7	1.0
Years of Sorghum Farming		
1-10 years	13	3.3
11-20 years	39	9.9
21-30 years	156	39.6
31 years and above	180	45.7
No response	6	1.5

Source: Field Survey, 2019.

The educational qualification of the respondents showed that a clear majority of 65.8% attained one form of tertiary qualification or the other, and acquired a certificate such as National Diploma, National Certificate of Education, degree in addition to Senior School Certificates representing 24.9% (98). Respondents with First School Living Certificate were 22.6% (89), while those with non-formal education were 10.2% (40). This result agrees with Yahaya *et al* (2022) which found that most of the sorghum farmers in Nigeria have formal education. It however disagrees with Yahaya *et al.* (2022) study which showed that sorghum farming in Nigeria is predominantly undertaken by people with secondary education instead of tertiary education as found in this study.

As for the years of experience in sorghum farming, table 1 clearly shows that a great majority 45.7% (180) of the respondents have been in sorghum farming for over 31 years and 39.6% (156) of the respondents have been in sorghum farming between 21 and 30 years. Those with 11-20 years of experience constituted 9.9% (39), while 3.3% (13) of the respondents had 1-10 years of sorghum farming experience. This result is consistent with Ndagana *et al*. (2020) study which found that sorghum farming was predominantly undertaken by experienced farmers.

Table 2: Types of Agro-Chemicals Used By Sorghum Farmers in Benue State

Type of pesticide	Frequency	Percentage
Herbicide	326	82.7
Insecticide	48	12.2
Fungicide	5	1.3
Others	1	0.3
No response	14	3.6
Total	**394**	**100.0**

Source: Field Survey, 2019

Table 2 shows that majority 82.7% (326) of the respondents use herbicide in sorghum production. Other agro-chemicals used by respondents for sorghum production were insecticide 12.2% (48) to prevent insects fungicide 1.3% (5) and others, 0.3% (1). This implies that herbicides and insecticides are the major agro-chemicals used by farmers for sorghum production in Benue State.
This finding is in line with Guillaume (2017), who noted that pesticides are in different forms or types, and its usage by the farmers is based on target organisms, pests or weed. Pesticides are also selective and non-selective. Selective pesticides kill only selected pests with little or no injury to crops, while non-selective pesticides are toxic to all plants. Similarly, the findings of the study are in line with the previous study by Gilden *et al.* (2010) who posited that chemicals are used for the control of pests in crops like yam, sorghum, maize, sugarcane, cassava among others.

Table 3: Type of Insecticide Used For Sorghum Seed Treatment by the Respondents

Type of insecticide	Frequency	Percentage
Fasadan D	50	12.7
Andre dust	42	10.7
Apron plus	18	4.6
Apron star	71	18.0
Don't use	213	54.1
Total	**394**	**100.0**

Source: Field Survey, 2019.

Data presented in Table 3 shows that the majority 54.1% (213) do not use insecticides for treatment of seeds. 18.0 % (71) of the respondents used apron plus for seed treatment. While 12.7% (50) of the respondents used Fasadan D for sorghum seeds treatment, 10.7% (42) of them used Andre dust while 4.6% (18) respondents preferred Apron plus for seeds treatment.
Majority of the respondents 54.1% (213) who do not use insecticides for seeds treatment said they are afraid that it could inhibits the sorghum seeds from germinating effectively, while some of them said they were not aware that insecticides are used for seed treatment. This could be attributed to lack of money and information on the use of insecticides for sorghum seeds treatment.
A 52-year-old male key informant was asked about the advantage of sorghum seeds treatment and why majority of farmers do not treat their sorghum seeds before planting and he has this to say:

…the starting point for the production of sorghum is seed treatment. This is because any untreated seeds can be infected and when planted, will not give good yield. So, Apron plus, apron star, fansadan D and Andre dust can be used. However, he said that most farmers fear that the use of insecticides could prevent the seed from germinating well.

Similarly, a 48-year-old female informant in an interview affirmed that:
Seed dressing is important to having a productive crop production and noted that it helps to prevent the seeds from insect infestation. So, farmers can use Apron plus, Fasadan D among other products in the market. However, she agreed that most farmers were not aware of the benefits of seeds treatment.

The above findings are inconsistent with Vanin et al (2010) which found that in Brazil, farmers utilized insecticides such as thiodicarb, acephate, thiamethoxam for treatment of sorghum seeds. Shid *et al* (2022) result is also at variance with this finding as it identified thiamethoxam, cyantraniliprole, imidacloprid and fipronil were used for treatment of the seeds. The inconsistency in the findings could be attributed to constant innovations and research in these countries which expose the farmers to different types of pesticides. Furthermore, different operating climates could present different groups of pests that require pesticides peculiar to their treatment.

Table 4: Pre-Emergent Herbicides Used By the Respondents for Sorghum Production

Pre-emergent Herbicide	Frequency	Percentage
Pendimathrin	81	20.6
Butachlor	200	50.8
Atrazine	69	17.5
Others	30	7.6
Don't use	2	0.5
No response	12	3.0
Total	**394**	**100.0**

Source: Field Survey, 2019.

Table 4 show that the majority 50.8% (200) of respondents used Butachlor, 20.6% (81) used Pendimathrin and 17.5% (69) used Atrazine. Other pre-emergent pesticides used are stomp 7.6% (30). Meanwhile, only 0.5% (2) of the respondents did not use any pre-emergent pesticide for sorghum production.

This finding agrees with Dudje *et al* (2008) who out lined the different types of herbicides such as Atrazine, Butachlor, and Pendimathrin were used for weeds control in sorghum and other legumes in Borno state in Nigeria.

Table 5: Post-Emergent Herbicides Used By the Respondents for Sorghum Production

Post-emergent pesticide	Frequency	Percentage
Glyphosate	221	56.1
Paraquat	38	9.6
2,4-D	35	8.9
Cypermethrine	24	6.1
Don't use	2	0.5
Others	74	18.8
Total	**394**	**100.0**

Source: Field Survey, 2019.

Table 5 shows that the majority 56.1% (221) used glyphosate, 18.8% (74) used other forms of post-emergent herbicide such as gluphosinate, sorgumprim etc., 9.6% (38) of the respondents used paraquat and 8.9% (35) of respondent use 2, 4-D and 6.1% (24) of the respondents use cypermethrine. While 0.5% (2) of the respondents do not use post-emergent herbicide on their sorghum farm.

This imply that post-emergent herbicides are the most used pesticides for weed control among farmers in Benue State. They are chosen probably based on the types of weeds that are prevalent in the field. As a result, there has been significant reliance on post-emergent pesticides for weed control by the respondents (farmers) in the study area.

A 52-year-old male key informant also reiterated:

> We normally use pre-emergent herbicides, such as glyphosate, paraquat and 2, 4-D and Karet…Cypermethrin and Lamda-cylohathrine are used mostly against sucking insects…

This finding agrees with that of the study by NBS (2020) which indicated high proportions of import of pesticides in Nigeria while World Bank, FAOSTAT (2020) study revealed high massive use of pesticides by farmers in Nigeria. This is also in line with some studies which affirmed that farmers used different types of post-emergent herbicides as Glyphosate for the control of broadleaf weeds in sorghum production in the US, China, Brazil and Sub-Saharan Africa. In Borno state in Nigeria, different types of herbicides especially Glyphosate and Cypermethrine were found to have been used by farmers (Dudje *et al.* 2008; USEPA 2018).

Table 6: Type of Insecticides Used For Sorghum Preservation by the Respondents

Type of insecticide	Frequency	Percentage
Crush	74	18.8
Ddforc	99	25.1
Sniper	9	2.3
Phostoxine	43	10.9
Others	142	36.0
No response	27	6.9
Total	**394**	**100.0**

Source: Field Survey, 2019.

Table 6 shows that the majority 36.0% (142) of respondents use other types of insecticides such as clorpirifos 20 EC, dichlorvos, nipost, for sorghum preservation, 25.1% (99) of them used DDforce, 18.8% (74) of the respondent used crush, 10.9% (43) of the respondents prefer phostoxine and 6.9% (27) gave no response. While 2.3% (9) of the respondents used sniper for sorghum preservation. Key informants were asked about the types of insecticides that are recommended for sorghum preservation. Their responses were contrary to that of the general respondents as presented thus;

A 46-year old male informant in an interview stated,

> Sorghum farmer's use variety of harmful agro-chemicals to preserve sorghum…However we do not encourage farmers to use insecticides for sorghum or any crop preservation. We encourage them to use pepper, hermetic bags or neem extract. But if necessary, atelic dust and Phostoxin can be used. Atelic dust is mixed on the sorghum seed and packaged while Phostoxin tablet is tied in tissue paper put when the seed is half filled in the bag, put in the middle and top of the bag and closed. But the use of such as preservatives in sorghum production, should be from three months and above.

It was observed that crop production experts and extension workers recommend only hermetic bags, neem extracts, pepper, atelic powder and phostoxine for sorghum preservation. However, farmers choose to use insecticides such as DDforce, Crush, Dichlorvos, Nuvan among other insecticides for sorghum preservation. It was discovered that chlorpyrifos 20 EC which comes in trade names like: perfect killer, rocket, clorfos, actforce and chlorview. have been used by farmers for sorghum preservation. This finding agrees with Dahiru *et al* (2014) who discovered that most farmers and marketers in Mubi used Dichlorvos and DDforce for preservation of sorghum grains for the purpose of marketing it at Mubi grain market. It was further revealed that most of the traders who used pesticides had no formal training or supervision at site of pesticides application, and as such, the chances of these pesticides being applied repeatedly on the grains with consequent

possibilities of residues development on grains at level above their Allowable Daily Intake (ADIs) for human are also evident.

Table 7: Methods Used For Herbicides Application on Sorghum Farm by the Respondents

Method	Frequency	Percentage
Basal application	48	12.2
Direct surface application	283	71.8
Spot application	38	9.6
Others	12	3.0
Foliar application	13	3.3
Total	**394**	**100.0**

Source: Field Survey, 2019.

Table 7 show that the majority 71.8 (283) of respondents use direct surface method, 12.2 % (48) of respondents used basal application method to spray herbicides on their sorghum farm, 9.6% (38) of the respondents used spot application method for herbicides application and 3.3% (13) used foliar application method while 3.0% (12) of the respondents preferred other methods.
A 52-year-old male key informant also revealed the following:
Pesticides come in different types and as such, their method of application also differs. For pre-emergent herbicides, direct surface method is recommended while basal method is recommended for post-emergence herbicides such as glyphosate, paraquat and 2, 4-D. But by so doing, a shield must be used on the sprayer to prevent herbicides from having direct contact with the crop. While foliar method is also used by farmers to spray insecticides such as Karet, Cypermethrin and Lamda-cylohathrine against sucking insects...direct surface method is used by sorghum farmers who employ mixed cropping who use pre-emergents once in the cropping season…basal method is used for sole cropping…glyphosates and paraquat post-emergent herbicides are used…users of foliar method utilize cypermathrine or lamda- cylohathrine to repel sucking insects and prevent sorghum disease.

Similarly, a 48-year-old female key informant in Ukum LGA stated:

> Direct surface is used in case of pre-emergence herbicides, basal method also used in case of glyphosate application but caution should be applied to ensure it does not touch the sorghum directly. While foliar method can be used to apply Lamda-cylahothrin, Cypermethrin and other pesticides to control insects.

Also, one of the key informants in Mbalagh council ward of Makurdi Local Government has this to say:
I usually spray my farm with post-emergent pesticides such as sarosate, force up, vinash and any good glyphosate I lay my hands on. I usually used knapsack sprayer to spray under the sorghum when it is up to eight weeks particularly when the stem is strong. However, I tried to ensure that herbicides do not touch sorghum directly but find it very difficult, consequently, most of the sorghum touched by the herbicides experience delayed growth and, in some cases dried off… the timing for the application of pesticides through foliar method, is twelve to fifteen weeks after planting while other methods like direct surface, spot application and Basal are used either immediately as in the case of pre-emergent and between eight to nine weeks after planting in the case of post-emergent application.

The above findings are consistent with Ugwu *et al* (2015) study which pointed to direct surface method of herbicide application by farmers in Oyo state Nigeria as most of the farmers apply

herbicide themselves or used family labour respectively with knapsack sprayers such as CP 15 and CP3.

Table 8: Methods of Insecticide Application Use by Respondents for Sorghum Preservation

Methods of Application	Frequency	Percentage
Mix Pesticides with water and spray directly on the seed and packaged	63	16.0
Spray raw liquid on the sorghum mixed and packaged	131	33.2
Packaged in the bags and spray outside the bags	17	4.3
Tied phostoxin tablets in cotton woo and drop in the stored bag	76	19.3
Drop tablets directly in stored bags	12	3.0
Others	34	8.6
No response	61	15.5
Total	**394**	**100.0**

Source: Field Survey, 2019.

Table 8 shows that 16.0 % (63) of the respondents said they mixed pesticides with water and spray directly on grain sorghum and packaged while 33.2% (131) of respondents spray raw liquid on the sorghum mixed and packaged. Thus, 4.3% (17) of respondents packaged sorghum grains in bags and spray insecticides outside the bags. Furthermore, 19.3% (76) of the respondents tied phostoxine tablets in cotton wool and drop in the stored bags while 3.0% (12) of respondents said they drop phostoxine tablets directly in stored bags. It was observed that 8.6% (34) of the respondents used other methods of application of pesticides while 15.5% (61) did not respond to the question.

This finding is consistent with the report of Dahiru *et al*. (2014) which revealed that methods of pesticide application involved direct ad-mixtures of the liquid formulation with the grain and placing of pesticides in tablet form on the sorghum seed in Mubi, Borno state in Nigeria. Ugwu *et al* (2015) study also revealed that most of the farmers in Oyo state, Nigeria used spraying method for pesticides application, involving apparatuses such as knapsack sprayers, watering can, and buckets. These studies revealed self and manual application of pesticides on sorghum

Conclusion

From the findings, it could be concluded that the types of pesticides used by sorghum farmers in Benue State include: Pre-emergent pesticides used such as Butachlor, Pendimathrin and Atrazine. Post-emergent pesticides used were glyphosates, paraquat, 2,4-D, Cypermethrine and Lamda-cylahothrine among others. The types of pesticides used for sorghum preservation by the respondents in the study area were DDforc, Crush and Phostoxin. It was observed that most of the pesticides have been banned by authorities. The medium of knowledge acquisition on pesticide use by the respondents was from fellow farmers and pesticide sellers. Sorghum farmers predominantly used direct surface application and basal application methods. The type of equipment used for pesticides application in the study area was knapsack sprayers. The common method of application of insecticides for sorghum preservation by the respondents was: spray raw liquid on the sorghum, mixed and package type, tied tablets in a polythene and drop in the stored bags and mix insecticide with water and spray outside the packaged bags. Consequently, aggressive campaign and programmes to sensitized farmers on the need for seed treatment and the negative effects of using paraquat for sorghum production should be embarked upon. This should be done by the State government and Non- Governmental Organizations. More extension workers should be deployed

by state and local government, to rural communities for proper training of famers on pesticides use.
Revive BNARDA and other Agricultural Development Programmes that are moribund, in addition to creating more research and training centres in the state to scale up training and retraining of farmers on best agricultural practices particularly with regard to use of agro-chemicals.
Benue state Government should enact a law to prohibit the sale of fake and adulterated pesticides in the state. Also, an active agency that will be responsible for monitoring the distribution, sale and use of agro-chemicals in the state should be created in Benue state.
Farmers should use neem extract, hermetic bags, pick bags, pepper and air tight containers in order to lessen the health effects of insecticides on the stored sorghum to consumers.

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