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# Analytical study of Farm Management Practices among Maize Farmers in Benue valley of Adamawa state, Nigeria

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***Abstract:*** *This study investigates factors that influences farm management practices among maize farmers around Benue valley of Adamawa state with a particular notion on pesticide usage in controlling both predominant weeds and pests found in the study areas. Maize is among the most essential cereal crops that is widely cultivated in North Eastern Nigeria, it is cultivated and consumed as a staple food and is regarded as the second most cultivated crop after rice. However, the most common pesticides used are Organochlorine, Organophosphates and Pyrethroids. Hence, these pesticides are used to avert damages and loss of crops so as to increase yield and create food security for the nation for sustainable development in all life ramifications. However, lack of appropriate knowledge on good farm practices on pesticide management practices (GPMP) by the farmers in these areas of study was alarming. Therefore, a survey was conducted using structured questionnaire which was validated through Principal Component Analysis (PCA) was employed. The adequacy or reliability was measured by Kaiser-Mayer-Olkin. Which the value of KMO is greater than 0.5 or 0.6 the sampling is considered adequate. The sample respondents are 292 maize farmers in four areas of the study which comprises Chigari, Dasin-Hausa, Gurin and Lake-Gerio all along Benue valley in order to access primary information on their pest management practices in maize. The analytical results indicated that 84.9%of the farmers generally lack adequate knowledge of good pest management practices and risk involved in misusing deleterious chemicals, it has been recommended that there is need for the government (state or local) to engage into campaign through promotion of a sustainable platform hazardous-free agricultural practices for all to reduce if not eliminate all life threatening chemicals (pesticides) that causes both acute and chronic diseases among farmers and consumers. Therefore, the aim of this study was to harness a better understanding on the level of correct and safe pesticide usage among maize farmers in North Eastern Nigeria so as to create a sustainable agriculture and ensure food security.*

**Keywords:** Maize farmers, Adamawa state, farm and Pest management practices

## Introduction

There is no doubt that new agricultural technology and attractive prices in both local and modern markets generate huge farm investments and income streams that simultaneously tend to increases agricultural productivity in order to meet-up with the increasing demand of the increasing population of the world. The farmers through intensive cultivation of crops using pesticides for pest and weeds control to reduce damages and to obtain high yield, even though it has toxicological effects which could be acute or chronic. Report indicated that global application of pesticide have been in increase significantly during the last three decades. Maize is among the most essential cereal crops that is widely cultivated globally. In Nigeria, it is cultivated and consumed as a staple food and is regarded as the second most cultivated crop after rice. However, more than 5.56 million hectares (ha) of land has been cultivated for maize

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production in 2013, (Tsedeke *et al;* 2014). The country's demand for energy producing food cannot be overemphasised due to high increasing population density and Africa in particular. The pest management practices on maize by farmers commonly being practiced in Nigeria and particularly in Adamawa state are both cultural as well as chemical control measures that majority of farmers employed in order to reduce the impacts of damages and disease transmissions which obviously tend to decline the yield and price of the commodity. However, effective pest management is directly inclined to usage of chemical pesticides that control both predominant pests, weeds and diseases in the study areas which influences high yield and reduce losses. The commonly used pesticide chemicals by farmers in the state are both Organochlorine, Organophosphate and Pyrethroids, despite high yield obtained from using pesticides in agricultural production in the state, the human and animals health with environmental consequences are in great danger(Aderonke et al, 2013; Joseph et al, 2014; Obidah et al, 2012). Many studies of pesticide residue and its impacts have been conducted in various fields especially on vegetables (Mazlan et al, 2005; Berne's-Perez et al, 2006; Grzywacz et al, 2010). and other tree crops, (Katja et al, 2014) but little or no pesticide residues studies on cereal crops in North Eastern states of Nigeria particularly in Adamawa state.

**The purpose of the study**

The purpose of this study is to provide comprehensive information on farm practices and pest management practices of maize among farmers around Benue valley in Adamawa state, Nigeria.

The specific objectives is to determine

1. The basic farm management practices of maize among farmers in the study areas
2. The basic pest management practices of maize among farmers in the study areas
3. The most common pesticides of maize used by farmers in the study areas

## Materials and Methods

The study was conducted in four areas of studies including Chigari, Dasin-Hausa, Gurin and Lake-Gerio all along river Benue in Adamawa state. A structured questionnaires and samples of both maize and water was obtained. A total of 292 farmers was targeted from these study areas base on their experienced in maize production and pesticide usage. The structured questionnaire was validated through Principal Component Analysis (PCA) and the reliability was measured by Kaiser-Mayer-Olkin. Which the value of KMO is greater than 0.5 or 0.6 the sampling is considered adequate. However, the structured questionnaire was designed as closed ended and five point Likert scale. The quantitative data collection of the study relied on structured questionnaire as a tool. The data was generated from the structured questionnaire which contained four different sections that comprised of (a) Personal data (demographic information of the farmers) excluding names of respondents, (b) Pest management practices, (c) Maize and water consumption related issues (d) Health related issues. The instrument comprised total of thirty seven (37) items. The data were analysed using Statistical Package for Social Sciences (SPSS®). However, several statistical tools such as descriptive analysis was used to describe farmer's socio-demographic background and general pest management practices. Pearson correlation analysis was carried out to investigate the pesticide frequency application and the knowledge of farmers on correct pesticide application practice in the study areas. Factor analysis was conducted on factors that influences farmers pest management practices was analysed. Hence, factor analysis was employed in order to reduce the number of variables and group them under common underlying characters. The Kaiser-Meyer-Olkin (KMO) statistic with value equal to 0.730 or higher was used to determine whether the variables accepted to be conducted in factor analysis. Apart from descriptive and chi-square analysis, also factor analysis was conducted in analysing those factors that tend to influences farmers pest management practices in those areas of the study. The KMO statistics with a value equal

to 0.730 or higher was used in determination of acceptability of variables in conducting factor analysis. Factors with eigenvalues greater than 1 were considered significant for factor analysis. However, factor loading used was greater than 0.05. Each factors extracted in factor analysis were tested by reliability.

## Results and Discussion

### Demographic information of Farmer's

Table 1 on page 12 shows demographic profile of farmers in the study. A total of 292 maize farmers were contacted, the results showed that most of the farmers who dominated maize farming were at the age range between 20-35years of age 38.4%. The lowest percentage in farming involvement among the farmers was found 4.8% at age range of 66-80 years old. Farmers with age range of 55-65 years was 6.8% and 36-45 years with 30.5% respectively. Analytically, the results indicated that youths are desired to take up the farming generation. For farmer's experience, 11-20 years have the highest percentage 37.7% and the lowest 4.1% are with above 40 years of age. The rest were having experience ranging from less than 10 years, 29.5%, 21-30 years 21.6%, 31-40 years 7.2%. For the educational attainment, most of the farmers had informal education 43.2%, followed by primary education 31.2%. The practice of land ownership in the study areas is generally free-hold titled, which significant members of the farming families 55.5% owned their farms. While 44.5% hired their farmlands for agricultural production. The highest number of farmers with highest experience of farming practices are within the range of 11-20yrs of experience with 37.7%. However, the farmers with more than 40yrs experience are 4.1%. Those farmers that have the lager farm size 21-25ha are 3% while those with small farm sizes 1-5ha are 88%. Subsistence farmers with small holdings are the majority as active farmers. The farmers with lower output (<100 tons) are the most significant members of the farmers and are subsistence farmers while those with higher output (>100 tons) and above are very insignificant and are mechanized farmers

**Table: 1. Socio-demographic and farm profiles of respondents (n=292)**

| Variables | Frequency | Percentage (%) |
|---|---|---|
| **Gender** | | |
| Male | 279 | 95.5 |
| Female | 13 | 4.5 |
| **Age Distribution** | | |
| 20-35 years | 112 | 38.4 |
| 36-45 years | 89 | 30.5 |
| 46-55 years | 57 | 19.5 |
| 55-65 years | 20 | 6.8 |
| 66-80 years | 14 | 4.8 |
| **Education Level** | | |
| Primary | 91 | 31.2 |
| Secondary | 54 | 18.5 |
| Tertiary | 21 | 7.2 |
| Informal | 126 | 43.2 |
| **Land ownership status** | | |
| Own | 162 | 55.5 |
| Lease | 130 | 44.5 |
| **Farming Experience** | | |
| ≤ 10 years | 86 | 29.5 |
| 11-20 years | 110 | 37.7 |
| 21-30 years | 63 | 21.6 |
| 31-40 years | 21 | 7.2 |

| | | |
|---|---|---|
| > 40 years | 12 | 4.1 |
| **Farm Size** | | |
| 1-5 hectares | 257 | 88.0 |
| 6-10 hectares | 22 | 7.5 |
| 11-15 hectares | 7 | 2.4 |
| 16-20 hectares | 5 | 1.7 |
| 21-25 hectares | 1 | .3 |
| **Farm Workers** | | |
| ≤ 10 | 227 | 77.7 |
| 11-20 | 53 | 18.2 |
| 21-30 | 7 | 2.4 |
| 31-40 | 3 | 1.0 |
| > 50 | 2 | .7 |
| **Farm Output** | | |
| ≤ 100 tons | 246 | 84.2 |
| 101-200 tons | 31 | 10.6 |
| 201-300 tons | 8 | 2.7 |
| 301-400 tons | 2 | .7 |
| 401-500 tons | 4 | 1.4 |
| > 500 tons | 1 | .3 |

**Insect pest and weeds management**

Farmers were asked on their pest management strategies (methods). As indicated that about (86.6%) of the respondents used chemical control for both weeds and the pests that are predominantly found in the study areas. While 6.9% and 6.6% of the respondents respectively used cultural control and ashes as a means of control. However, this may be attributed to poverty level and lack of government will to provide adequate soft loans as a credit facilities (inputs) to the subsistence farmers for uplifting and enhancing their productivity to meet up the demand of ever increasing population of the communities.

**Pest management control**

Hence, from the data in Table 2 below indicated that chemical control method was extensively used by the farmers as a major means of protecting cultivated crops from predominant pests and weeds in those study areas.

**Table: 2. Pest management control**

| Types of pest control | Frequency | Percentage % |
|---|---|---|
| **Cultural control** | **20** | **6.9** |
| **Chemical (pesticides)** | **253** | **86.6** |
| **Control** | **19** | **6.5** |
| **Others** | | |

**Mixing pesticides for application in the study areas**

Farmers were also asked on who mixed and applied pesticides, as indicated on table 3 page 13 that about 60.6% of the respondents mixed the pesticide themselves whereas only few respondents either hired for labour or their family members mixed the chemicals for onward application. Since most of the farmers were not adequately trained by either extension workers or through any effort of non-governmental organizations, such behaviour may result in wrong handling and disposal of pesticides which may results in direct contact and can lead to accident that may be injurious to both the health of the farmers and the environment. However, the

results clearly indicated that 55.8% of the respondents applied pesticides on their farms while significant number of the farmers 24.0% hired labour for that purpose. However, lack of training and adequate knowledge on pesticide management practices can lead to wrong or bad practices which may results to direct contamination of either water, soil and health risk of the farmers that involved in the action and neighbours through drift. Obviously, wrong or bad application procedure may result to over accumulation of pesticide residues in all the edaphic factors of the environment which may tantamount to environmental degradation and pollution which may have direct impact on the life of both animals and man inhabiting the environment, as attested many researchers that; chemical substances such as phthalates, bisphenols and parabens are released from pesticides during mixing and application into foods, water and to which both farmers and consumers are subjected to, may interfere with production and function of endocrine system, (Giulivo et al, 2016). A lot of inherent cases that are directly associated with the use of pesticides such as exposure and incidences of certain diseases which the farming families may have genetic susceptibility to pesticides associated diseases and are likely more at risk than consumers, (Kim et al, 2016). However, associated pesticide exposure to end users is as a results of poor training, poor understanding and poor delivery modes, ((Macfarlane et al, 2013). The most important channel for pesticide exposure to farming families and neighbours is inhalation of atmospheric pesticides either during mixing or spray, (lopez et al., 2016).

**Table: 3. mixing pesticides for application in the study areas**

| Who mix pesticides | Frequency | Percentage (%) |
|---|---|---|
| Labourer | 55 | 18.8 |
| My self (Farmer) | 177 | 60.6 |
| Family Members | 60 | 20.6 |

**Change of pesticides by farmers in the study areas**

For pesticide change in application as indicated on table 4 on page 13 however, majority of the respondents 84.9% are those that do not change their pesticides while those that frequently change pesticides do so at different variation of time which include from every 2 days to 5 days as indicated. Thus, those that frequently change after every 3 days occupied the highest number of respondents 4.8% while those respondents that frequently change in every 4 days are the lowest 2.7%. Technically, this indicated that only a portion of the total respondents seems to be totally ignorant of specific pesticides that are mean for a specific practice in agricultural production. However, as a results of this behaviour the applied pesticide residue can obviously contaminate the environment and lead to environmental pollution and degradation of edaphic factors that can lead to spread of diseases either through direct contamination or leaching and erosion (drift), as stated by Lopez et al, (2016) that major channel for pesticide exposure to farming families and neighbours is inhalation of atmospheric pesticide.

**Table: 4. Change of pesticides by farmers in the study area**

| Change of Pesticides | | Frequency | Percent (%) |
|---|---|---|---|
| | Yes | 44 | 15.1 |
| | No | 248 | 84.9 |
| | | | |

**Pesticide frequency application in the study areas**

Furthermore, on frequency application of pesticides, most respondents 76.7% indicated in table 5 on page 13 that they tend to maintained first application and the last before harvest. But other respondents 5.5% and 17.8% respectively tend to apply at frequency of every after 4 -5 days and doesn't know the specified frequency of application that is required of them and keep applying at will, this indicated the total ignorant of the frequency as stipulated which has direct

bearing on their crops and management practices. Inadequate knowledge of safe and judicious uses of pesticide chemicals, influence of behaviour of retailers, and inadequate access to viable non-synthetic chemicals control strategy are the major factors that contributed to pesticide misused and overused, (Jallow et al, 2017).

**Table: 5. Pesticide frequency application in the study areas**

| Number of times | Frequency | Percentage (%) |
|---|---|---|
| Every 4 days | 16 | 5.5 |
| Every 5 days | 52 | 17.8 |
| Others | 224 | 76.7 |

**PPE usage by framers in the study areas**

Farmers were asked on Pesticides Protective Equipment's (PPE) usage the results as indicated in table 6 on page 13 that 41.8% of the respondents uses either one or two of the PPEs that was designed for that purpose. However, significant number of the respondents 58.2% don't use any sort of PPEs which virtually, they are exposed to direct contact with such deleterious chemicals that may have health hazard to their existence and the environment in general. This behaviour may be attributed to lack of adequate knowledge, training and educational back-ground of the respondents. This results collaborate with assertions made by Giulivo et al, (2016), that chemical substances such as phthalates, bisphenols and parabens are released from pesticides during mixing and application without proper adherence to safety measures by the far.

**Table: 6. on PPE usage by framers in the study areas**

***Key = * those that used the PPE type only***

| Types of PPE | Frequency | Percentage (%) |
|---|---|---|
| **Glove** | *154<br>138 | *52.7<br>47.3 |
| **Masks** | *90<br>202 | *30.8<br>69.2 |
| **Apron** | *114<br>178 | *39.0<br>61.0 |
| **Boot** | *134<br>158 | *45.9<br>54.1 |
| **Others** | *98<br>194 | *33.6<br>66.4 |
| **Total** | 292 | 100 |

**Pre-Harvest Intervals by farmers in the study areas, (PHI)**

Farmers were also asked on pre-harvest interval practices in maize production in the study areas, hence 19.9% operated their pre-harvest pesticide application interval at 60 days. Whereas significant number of farmers 14.0% in the study areas also operated on 70 days interval. However, only few of them 10.3% at 50 days interval as indicated in table 7 on page 14. This practices by the farmers depend solidly on their level of experience of lifecycle of predominant pests and weeds in and around their farm fields. Hence, these practices may depend solely on planting time, types of maize variety, and rate of infestation of the pests and weeds that are predominantly found in that areas, as Anon, (2012) postulated that, pesticides can be applied for either weeds or pests control for enhancing ripening on non-determinate crop so as to reduce damages and losses. He further stressed that though, different countries have different recommendation of pesticide usage even though the general or common regulation is, and the bulk of grain must be dried to a maximum of 30% moisture content.

**Table: 7. No of Days practices Pre-Harvest Intervals by farmers in the study areas, (PHI)**

| Days | Frequency | Percentage (%) |
|---|---|---|
| 50 | 30 | 10.3 |
| 60 | 58 | 19.9 |
| 70 | 41 | 14.0 |
| 80 | 37 | 12.7 |
| 90 | 38 | 13.0 |
| 100 | 47 | 16.1 |
| 110 | 41 | 14.0 |

**Sources of Pesticide procurement in the study areas**

The main source of pesticides to the farmers in the study areas is open market. About 86.0% of the respondents indicated that they bought their pesticide products from the open market which could be as a result of negligence of the government to control and make adequate provision for such products from the genuine manufacturers as credit facility on subsidized rate to boost productivity and avoid adulteration of these products by the middle-men. However, 14.0% of the respondents (farmers) procured their products from registered dealers in the state as indicated in table 8 on page 14. This is along with a wide repots on procurement, distribution and utilization of pesticides in agricultural production within African content. About 30% of all pesticides procured and marketed in Africa (developing countries) with an estimated value of $300 million are of poor quality and are hazardous and potential threat to human, animals and the environment, (Bashir, 2007). Banned and adulterated pesticides which is more than 50,000 tons become obsolete and unsafe for agricultural production nowadays in the entire sub-Saharan African region, (Story, 2013)

**Table: 8. Sources of Pesticide procurement in the study areas**

| Sources | Frequency | Percentage (%) |
|---|---|---|
| Registered dealers | 41 | 14.0 |
| Open market | 251 | 86.0 |

**Sources of Pest Management Information in the Study Area**

The farmers were also asked on their sources of information related to pest management practices, the results indicated in table 9 that 88.4% of the farmers in the study areas got pesticide management information from retailers of the products instead from a trained extension workers. These information comprises of how to measure the quantity of the chemicals per litres of water using the calibrated top of the container, and what the chemicals mean for. However, 10.2% of the respondents indicated that their friends and relatives were the sources of their information on this aspect, while 1.4% of the farmers indicated that the sources of their information is from extension agents that are from the state government agricultural extension service under Agricultural Development Projects (ADPs). However, the results here indicated that majority of farmers may end up with wrongly transformed information from quack educated retailers who may have no adequate knowledge on the related information. This goes along with assertion made by Ecobichon (2001) in Al Zadjali et al, (2014) that effective information transfer on various aspect of scientific breakthrough by experts to farmers and effective means of disseminating new techniques, improved seeds and seedlings with good advice on related use of pesticides can effectively reduce pesticide related risks in developing countries like Nigeria.

**Table: 9. Sources of Pest management Information in the study areas**

| Sources of pest management information | Frequency | Percentages (%) |
|---|---|---|
| Government | 4 | 1.4 |
| Retailers | 258 | 88.4 |
| Farmers friends | 30 | 10.2 |

**Training of pesticide management practices of farmers in the study area**

The farmers were also asked on pesticide management training, from the findings as indicated in table 10 on page 14 that 2.1% of the respondents had training on pest management from their respective friends while 4.1% of the respondents were trained through their respective families. However, the majority of the respondents had no training on the pest management practices and they constituted 93.8% of the total sample population and this can equally affect their pesticide management practices towards agricultural productivity and risk inducement from misused and mishandling of pesticide chemicals, as related by Atreya et al, (2011) that risk that are directly associated with pesticide use in developing countries like Africa are obviously the misuse of handling and disposal which was attributed to lack of education, training and inadequate information on hazards and problems of effective communication from the state extension organizations. Panuwet et al, (2012) reiterated that, most developing countries lack effective enforcement of policy and regulations which led to absence of a clear over-arching strategy on pesticide management.

**Table: 10. Training of pesticide management practices of farmers in the study areas**

| Source of training | Frequency | Percentages (%) |
|---|---|---|
| Friends | 6 | 2.1 |
| Family Members | 12 | 4.1 |
| No training background | 274 | 93.8 |

**Reading label of pesticide product by farmers in the study areas**

Farmers were also asked on reading label**,** from the analytical result Table 11 on page 14 it indicated that significant number of the respondents 75.7% do not read labels on pesticide products which can enhance the effective utilization of the products as stipulated by the manufacturers. Hence, only 24.3% of them can read the label. This shows that majority of the farmers are actually can't read or write and they can only identified a given product by either its colour or size of the product container. Generally, this can be attributed to their poor background on education and awareness towards pesticide management practices by the Government either at local government, state or federal government level. The result of this study linked with other studies which reported that lack of proper education and adequate information channel on pesticides and its recommended safety guide from the manufacturer hampers farmer's ability for effective management, (Matthews, 2008). Dasgupta et al, (2007) propounded that, environmental degradation and health hazards are direct result of deviation from recommendations of application procedures and dosage from the pesticide labels. However, improper and misused of pesticide in developing countries like Nigeria is directly connected to lack of education and inadequate training in pesticide use and lack of information from manufacturers label related hazards of pesticides, (Damalas and Hashemi, 2010); (Khan et al, 2015).

**Table: 11. Reading label of pesticide product by farmers in the study areas.**

| Options | Frequency | Percentage % |
|---|---|---|
| Yes | 71 | 24.3 |
| No | 221 | 75.7 |

**Pest management practices**

Previous findings by Stadlinger et al, (2011) indicated that low level of farmers knowledge and high illiteracy level among Tanzanian maize farmers constituted about more than 50% of them mixed and applied pesticides with bare hands. However, lack of knowledge and ineffective involvement of government and pesticide retailers in educating farmers especially in the rural areas led to improper behavior of pesticide misused which are the main causes of pesticide related poisoning and environmental degradation in China, (Fan et al., 2015). Hence, good agricultural practices (GAP) obtained in China through effective training and educating farmers by trained retailers, (Yang et al, 2014). Therefore, in this related study Chi-Square analysis was carried out to investigate the relationship between farmer's pest management practices with farmer's educational levels, pesticide frequency application and farmer's knowledge on correct application procedures, and pesticide frequency application and farm output in the study area.

**Table: 10. Training of pesticide management practices of farmers in the study areas**

| Source of training | Frequency | Percentages (%) |
|---|---|---|
| Friends | 6 | 2.1 |
| Family Members | 12 | 4.1 |
| No training background | 274 | 93.8 |

*Ho: There is no significant relationship between farmer's educational levels and their pest control methods.

*Ho: There is no significant relationship between pesticide frequency application and correct knowledge of application.

*Ho: There is no significant relationship between pesticide frequency application and farm output. However, The result in Table 11 above shown $x^2$ (5) =93.8, $p \leq 0.05$ base on Phi value (0.016), the inferential statistics indicated that, there is high significant relationship between the educational levels of the farmers and the pesticide management practices in the study area at 0.05 level of significance which confirm the previous findings of Zhang et al, (2015) in their study also found that level of education directly influences pest management practices in China either negatively or positively.

Thus, $x^2$ (2) = 96.7, $p \leq 0.05$. The inferential statistics indicated that, there is high significant relationship between pesticide frequency application and the knowledge of farmers on correct pesticide application practice in the study areas at 0.05 level of significance. However, the findings of this study confirm the previous findings that due to lack of adequate and proper knowledge of correct application procedures by farmers in Kuwait led to pesticide poisoning and un-safe practices (Saeed et al, 2000); (Saeed et al, 2001); (Saeed et al, 2005); ((Hajjar, 2012); ((Abahussain, E.A., Ball, 2010); Furthermore, farmers with correct knowledge of application procedures due to high overuse of pesticides for yield increase contrary to expectation their practices have no positive influence (Damalas et al., 2006; Al-Zadjali et al., 2014). However, $x^2$ (177) = 19,915, $P \geq 0.05$. Base on Cramer V values (1.000), the inferential statistics indicated that, there is highly insignificant relationship between farm output and pesticide frequency application by the farmers in the study areas at 0.05 level of significance. Thus, contrary to the previous findings in China, there is significant relationships between pesticide frequency application of farmers and the effective crop yield by reducing pests effects while other factors remain constant (Zhang et al, 2015).

**Factors that influences pest management practices among farmers in the study areas**

According to Kaiser-Meyer-Olkin (KMO) test, the analytical result indicated that the sampling adequacy was 75.9% and it is acceptable for conducting factor analysis. The Bartlett's test of sphericity revealed that the overall matrix is significant at 0.000 probability level (Approx. Chi-Square =1639.769, df = 55). There were four factors discovered by the principle component analysis (PCA), which explained over 77.02% of the total variance (Table 12). The factor loading represents the correlation coefficients of each item with the factor. Leech et al, (2005)suggested that, strength of correction of every factor is greater when the scoring is nearly to 1.0. However, the four factors were renamed base on similar features in each statement. These are "Farming system and pesticide effects", "Crop, Pests and Pesticide effects", "Pesticide and Productivity", "Pesticide knowledge, Crop and system Utilization" (Table 12).

In farmers pest management practices, factor 1 (Farming system and pesticide effects) consist of four items with Eigenvalue of 4.027 that described farmers decision on acceptance or rejection of these items concerning farming systems and its effects on pest and weeds control in the study areas. Factor 2 (Crop, Pests and Pesticide effects) which consist of three items with an Eigenvalue of 2.378 that explained farmers decision on the type of maize cultivated and effects of cultural and chemical control methods on predominant pests and weeds in the study areas. Hence, factor 3 (Pesticide and Productivity) that consist of three items with Eigenvalue of 1.042 which indicated the understanding of the farmers regarding best pest control strategy of predominant weeds and pests in the study areas. Factor 4 (Pesticide knowledge, Crop and system Utilization) which consist of three items with an Eigenvalue of 1.025 that explained the farmers technical know-how on maize cultivation and its impact on predominant pests and weeds in the study areas.

However, the Eigenvalues results indicated that, the total variance explained by every factor of the four factors have eigenvalue of greater than 1.0, which shown that the factor explained more information than single items embedded in it can do. For the Cronbach's Alpha, it was analysed by reliability test to indicate the internal consistency of a multiple items scale as shown in Table 12. Alpha for "Farming system and pesticide effects" and "Pesticide and Productivity" (> 0.8) indicated that the items form a scale that has good internal consistency. Hence, factor "Crop, Pests and Pesticide effects" and "Pesticide knowledge, Crop and system Utilization", (> 0.7) indicated that the items form a scale that has fairly internal consistency.

**Table: 11. Chi-Square Tests**

| Variables | Chi-Square | d/f | Significance |
|---|---|---|---|
| Pest management practice/ Educational levels | 5.64[a] | 6 | 0.016 |
| Pesticide frequency application/ Correct knowledge of application | 48.334[a] | 2 | 0.000 |
| Pesticide frequency application/ Farm output | 111.88[a] | 178 | 1.000 |

**Table: 12 summary of factor loading on pest management practices among farmers**

| Items | Factor loading |
|---|---|
| Factor 1: Farming system and pesticide effects | |
| Chemical control is cheaper than other methods. | 0.728 |
| Crop rotation is more effective in pest control than other methods | 0.883 |
| Mixed farming is most effective in pest control than other methods. | 0.825 |
| Factor 2: Crop, Pests and Pesticide effects | |
| The predominant pests in this area is effectively controlled by chemicals than other methods. | 0.658 |
| Cultural method is more effective in controlling predominant pests in this area than other methods. | 0.846 |
| Generally, hybrid maize seeds are used by the farmers in this area for cultivation. | 0.857 |
| Factor 3: Pesticide and Productivity | |
| Pesticide control is more effective in subsistence farming than mechanize farming. | 0.937 |
| Chemical control increase yield than other methods in production. | 0.714 |
| Factor 4: Pesticide knowledge, Crop and system Utilization | |
| Local maize variety seeds are predominantly used for cultivation in this area. | 0.826 |
| Cultural methods are generally being used in controlling pests in this area. | 0.837 |
| Most farmers in this area have knowledge in pest control. | 0.870 |
| Eigen Values | 4.027 2.378 1.042 1.025 |
| % of Variance explained | 36.610 21.619 9.471 9.320 |
| Cumulative % variance explained | 36.610 58.229 67.700 77.020 |
| Cronbach's alpha | 0.811 0.733 0.814 0.793 |

## Conclusion and Recommendations

Pesticide remained the main strategy among maize farmers in Adamawa state for both weeds and pest control, the use of pesticides tend to increase yield and reduce damages and loss of cultivated crops, though few among them used an alternative pest control methods. Thus, many farmers lack adequate information (knowledge) of correct principles of pest management practices that led those neglecting precautionary measures. This might be due to lack of extension services (from extension service workers) on part of the government. However, there is need to educate the farmers on Integrated Pest Management (IPM) system that can be environmentally friendly which tend to improve productivity to create food security for the farmers and the Nation in general. Non-governmental organizations (NGOs), National Agency for Food and Drug Administration and Control (NAFDAC), registered dealers, Retailers, to promote a sustainable plat form of hazardous-free agricultural practices for all so as to reduce if not eliminate all life threatening chemicals (pesticides) through effective and sustainable supervision and monitoring. Therefore, there is need for positive approach by either local government, state government, or federal government towards minimizing usage of artificial pesticides by farmers and emphasise more on organic pesticides for safe-food for all.

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