**INSECT PEST CONTROL METHODS AMONG COWPEA FARMERS IN SELECTED STATES IN NORTH CENTRAL NIGERIA**

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**(19PGAB000045)**

# TITLE PAGE

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**AUGUST 2022**

# DECLARATION

I, Oluwasanjo, Biodun OWOJAIYE, a Doctor of Philosophy candidate in Agricultural Extension and Rural Development in the Department of Agricultural Economics and Extension, Landmark University, Omu-Aran, hereby affirm that this thesis titled Insect Pest Control Methods among Cowpea Farmers in Selected States in North Central Nigeria is based on my original work. Any material(s) obtained from other sources or work done by any other persons or institutions have been duly acknowledged.

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# CERTIFICATION

This is to certify that this thesis has been read and approved as meeting the requirements of the Department of Agricultural Economics and Extension, Landmark University, Omu-Aran, Nigeria, for the Award of a Doctor of Philosophy Degree in Agricultural Extension and Rural Development.

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External Examiner Date

# DEDICATION

For the gift of life, the privilege of advancement and the countless kindnesses, I dedicate this thesis to God, the Father of our Lord Jesus Christ.

It is also dedicated to my parents, High Chief Engr. & Mrs B. I. Owojaiye, for their unflinching and immeasurable support over time.

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# LIST OF ACRONYMS

ADP: Agricultural Development Project/Agricultural Development Programme

DOI: Diffusion of Innovation

FAO: Food and Agriculture Organization

FAOSTAT: Food and Agriculture Statistics

IITA: International Institute of Tropical Agriculture

IPM: Integrated Pest Management

OECD: Organization for Economic Cooperation and Development

LGA: Local Government Area

NBS: National Bureau of Statistics

NPC: National Population Commission

NSPRI: Nigerian Stored Products Research Institute

OLS: Ordinary Least Square Regression

PICS: Purdue Improved Crop Storage

SDG: Sustainable Development Goals

SON: Standards Organization of Nigeria

TPB: Theory of Planned Behaviour

TRA: Theory of Reasoned Action

WHO: World Health Organization

# ABSTRACT

The adoption of alternative pest control methods that are safe and ecofriendly may not be achieved without a comprehensive understanding of farmers’ current insect control practices, knowledge, preferences and perceptions. This study sought to understand factors influencing the use of indigenous, conventional and alternative insect pest control methods among cowpea farmers in Kwara and Niger states, Nigeria. The study described socioeconomic characteristics, assessed the awareness level, availability and use of the methods, examined preferences for these methods, investigated factors influencing insect pest control decisions, identified sources of information utilized; examined perceptions and knowledge of insect pest control; and identified constraints limiting choice of insect pest control methods.

Data were collected from 384 cowpea farmers using a structured interview schedule to elicit information while a multi-stage sampling technique was used to select respondents. Kwara and Niger States were purposively selected based on the preponderance of cowpea production in stage I. In stage II, two of the four agricultural zones in Kwara State and one of three in Niger State were purposively selected. Stage III involved the random selection of three blocks from the two zones in Kwara State and two from one zone in Niger State to give a total of eight sampled blocks. Thereafter four cells were randomly selected from each of the eight blocks selected in stage II; this gave a total of thirty-two cells. At the last stage, proportionate sampling method was used to select 384 farmers for the study. Data were analyzed with both descriptive (percentages, frequency counts, means and ranks) and inferential (Probit and Ordinary Least Square Regression, analysis of variance and chi-square) statistics.

Majority (80.2%) of cowpea farmers are male, 85.4% are married with a mean age of 48.9 years and average household size of 7 persons. The mean farm size and quantity of cowpea stored is 3.6 hectares and 4.1 tonnes respectively. The findings revealed that farmers were most aware of the conventional method (93.4%) while 59.0, 83.0 and 40.0% of the respondents used indigenous, conventional and alternative methods respectively. Findings also indicate effectiveness, availability, quantity required, intended time of sale, time required to apply method, and time of application as the main factors for pest control. Extension Agents, input dealers, agricultural research institutes were the most utilized sources of information. Majority (90.4%) of respondents had knowledge of insect pest control methods while the risk of failure, uncertain outcome and inadequate capital were the major constraints. Probit regression revealed that age (t=0.21, p<0.01), farm size (t=0.41, p<0.01), group membership (t=0.193, p<0.01) and quantity stored (t=0.003, p<0.01) significantly influenced the use of insect pest control methods. Ordinary Least Square regression showed significant relationship between farm size (t=4.681), group membership (t=4.688), quantity stored (t=2.312), education (t=-2.196), cowpea farming experience (t=-3.419), frequency of extension contact (t=-.534) and intensity of use.

This study has showcased awareness and use of indigenous and alternative methods which is useful as input into extension programme planning. The study concludes that use of the conventional method remains high despite awareness and knowledge of indigenous and alternative methods and recommends enforcement and sanctions by government. Training and licensing of input dealers is also recommended since results show that farmers are reliant on them for information. Extension linkage with research should be strengthened so extension staff can better address issues of risk of failure and uncertainty of outcome constitute barriers to use of alternative methods. Finally, the uptake and use of alternative methods should be incentivized as it is sustainable.

**Keywords**: alternative methods, indigenous control, pest control decisions, synthetic pesticides, use intensity.

# CHAPTER ONE

# INTRODUCTION

# 1.1 Background to the Study

Nigeria relies on its agricultural sector for the supply of food, raw materials and foreign exchange as it contributes about 24% to the GDP (National Bureau of Statistics, 2020). Along with its multifacetedroles of improving nutrition, food access and income security at the household, community and national levels (Owach, Bahiigwa & Elepu, 2017), agriculture, either on a large or small scale, is estimated to provide employment to about 36% of the labour force (Food & Agriculture Organization, 2019). About 70% of the farming community are smallholders who reside and operate in rural areas (Ikuemonisan and Ajibefun, 2021).

The production and storage of food and cash crops is a cardinal feature of the agricultural sector in Nigeria. It remains the largest in the sector accounting for 87.6% of the agricultural sector’s total output (Oyaniran, 2020). This is reflected in Nigeria being ranked 1st, 4th, 11th and 14th largest producer in the world of cowpea (3.4 million tonnes), palm oil (3.9 million tonnes), maize (10.4 million tonnes) and rice (8 million tonnes) respectively (FAO, 2019). In contrast, forestry, fishing and livestock contribute 1.1%, 3.2% and 8.1% respectively of the sector’s output (Oyaniran, 2020). Safe food production systems in the country is therefore of national and global importance.

Legumes constitute an affordable and important class of food in the diet of humans, supplying 20–45% protein, about 60% carbohydrates, 5–37% dietary fibre and appreciable quantities of minerals and vitamins (Kouris-Blazos and Belski, 2016). Also, Ene-Obong *et al.* (2013) reported that legumes are the most consumed group of food after roots and tubers in Nigeria. Similarly, Odogwu, Uzogara, Worlu & Agbagwa (2021) reported that since 1988 the production of cowpea compared to other legumes has increased. The increase is due to improved cowpea varieties for planting and good management practices now available to farmers through extension agents.

In Nigeria, the most commonly cultivated legumes for human consumption include cowpea, soybeans and groundnut, collectively referred to as food or grain legumes (Sindhu *et al.,* 2019). Cowpea, commonly referred to as poor man’s meat, contains about 25% protein and holds high potential for consolidation of livelihoods and in alleviating the challenge of food insecurity in Sub-Saharan Africa (Abdullahi, 2016; Grivetti and Ogle, 2017; Gondwe, Alamu, Mdziniso & Maziya-Dixon, 2019). In the same vein, Dugje, Omoigui, Ekeleme, Kamara & Ajeigbe (2009) revealed that farmers by storing and selling cowpea fodder during the dry season were able to raise their yearly income by 25 percent.

In Nigeria and other tropical countries, cowpea is a preferred multifunctional staple occupying an important place in the diet, economy and farming systems of many smallholder households (Molosiwa, Chiyapo, Joshuah & Stephen, 2016). Furthermore, Goncalves *et al.* (2016), affirmed that cowpea is the most widely cultivated and suitable legume crop across Asia, South America and Africa because of its environmental, agronomic and economic advantage over other crops. It is resistant to droughts with the ability to produce significant grain than other cultivated crops including the drought-resistant crops peanut, pearl millet and sorghum (Organization for Economic Co-operation and Development [OECD], 2016). Also, cowpea plays a particularly useful role in fixing nitrogen, providing ground cover, suppressing weeds, augmenting soil fertility and aiding sustainability of cropping systems (Beshir *et al,* 2019).

The country accounts for 40-60% of global cowpea production (FAOSTAT, 2014; IITA, 2017) and as such, possesses huge potential in the production of the legume. Cowpea is indeed a major source of livelihood for rural dwellers and recent studies have continued to document the country’s consistent high ranking in its production and consumption (FAOSTAT, 2021; Horn, Nghituwamhata & Isabella, 2022). However, the social and economic benefits that would have been derived from the high level of production have been stymied by widespread losses as a consequence of the activities of insect pests. The menace of insect pests among other challenges continues to be formidable at every stage of any agricultural enterprise.

A pest is any organism that spreads disease, causes destruction or is otherwise a nuisance including unwanted species of animals or plants and vectors of animal and human disease.  Pest control is therefore critical to any agricultural production venture, particularly in cowpea production. This is because cowpea is vulnerable to a wide array of pests and diseases throughout its lifecycle from field to store (IITA, 2017). As the seedling stage, juice from its leaves and stems are extracted by aphids such as *Aphis craccivora* which also spread the cowpea mosaic virus. During flowering, thrips such as *Megalurothrips sjostedti* feeds on the plant, while pod borers including but not limited to *Maruca vitrata* attack its pods at some stage in pod formation. After harvest and in storage, bruchid weevils especially *Callosobruchus maculatus* attack the seeds.

Adebayo and Anjorin (2018) noted that losses of cowpea grain across the value chain are a severe recurring problem, and in Nigeria, as much as 20-50% of grain is lost because of infestation by insect pests (Anyim, 2016; Indahgiju, Samson, Bako & Suleman, 2022). The maximization of this important crop is therefore greatly reduced by the activities of insect pests among other biotic factors. Limiting abiotic factors include inadequate improved varieties, poor management systems, poor popularization of improved technologies and weak agricultural information dissemination. The effect of the loss of cowpea crop is therefore far-reaching besides the wastage of scarce inputs such as land, labour, money and time spent in cultivating or acquiring the crop.

The nexus between the importance of cowpea and the equally significant detrimental activities of insect pests results in cowpea production practice in Nigeria being signposted by the increasing intensive use of different agricultural pest control methods permeating activities from production through storage. Since protecting crops on the field and in storage represents a logical attempt to guarantee the availability of food and safeguard investments, farmers and traders hoping to improve their yields and crops therefore find the use of pest control methods appealing and desirable. Consequently, pest control is important for the maintenance of crop quality and quantity, assurance of food availability, increase in yield, protection of crops, and maximization of productivity and profitability. These methods are diverse with farmers embracing perceived proven and effective methods that span the indigenous, conventional and alternative. While the conventional method has been more widely used, in recent times and indeed over the past decade, there has been increased awareness of the advantages of indigenous and alternative pest control methods because of the human and environmental hazards connected with the use of synthetic chemicals. Underpinning this drive is the quest for responsible production and consumption which is the crux of the 12th Sustainable Development Goal of the United Nations.

At the production stage, indigenous methods which are rooted in simple practices developed and acquired by a farmer through long and close association with pests and have been passed down over generations include an array of physical measures that may involve ploughing, handpicking of insects, and the application of neem or pepper fruit extracts. Alternative pest control methods at this stage aim at enhancing pest management systems that are eco-friendly, do not deplete natural resources and do not threaten agricultural production and farmers’ incomes nor pose danger to the environment or human health. They include the rearing and release of predators, climate adapted push-pull systems, use of pheromone and cultivation of early maturing varieties.

The conventional method both on field and in store centers on the application of synthetic pesticides. Pesticides are substances or blend of substances projected to prohibit, control, destroy, repel, prevent, alleviate or mitigate pests that interfere or cause harm in production, processing, transporting, marketing and storage of agricultural commodities and wood and wood products (Babarinsa, Ayoola, Fayinminnu & Adedapo, 2018). The use of pesticides has had a significant impact on agriculture. Akinneye, Adeleye, Adesina & Akinyemi, (2018) asserted that the advantages are multifarious and pesticides have made a significant contribution to the food security of the globe for the control and destruction of various types of pests. Olabode, Adeshina & Olapeju, (2011) reported that as far as management tools in agricultural ventures go, pesticides are a crucial bedrock as they offer increased yields in fields, increased protection against insects and general enhancement of shelf-life of agricultural commodities in storage. They are perceived as labour-saving, economic and efficient damage control input against insects and other pests (Damalas, 2011).

At the postharvest level, alternative pest control methods include admixture with botanicals, the use of plastic drums, jerry cans, NSPRIDUST®, ZeroFly® hermetic bag, cold treatment, Purdue Improved Crop Storage (PICS) Bag, NSPRI hermetic steel drum and Improved Inert atmosphere silo®. This study rests on the assumption that the level of use of different pest control methods and an investigation of the farmers’ perceptions of these methods is crucial to understanding their insect pest control decision processes. The study also aims to make available a clear depiction of ongoing realities as to the use of indigenous and alternative insect pest control methods. A good understanding the farmers’ perceptions of insect pest control methods will help with better design of intervention steps to promote indigenous and alternative pest control methods which include Integrated Insect Pest Management and other limited pesticide use practices. Although socioeconomic factors remain one of the most central factors because they affect and shape decision pattern (Tomul and Savasci, 2012), this study considered other related factors influencing use of different insect pest control methods including constraints limiting choice and information sources.

This study also investigated perception of pest control methods; extricating factors that engender or hinder improved utilization of insect pest control methods among farmers requires identifying factors that impact their perception of the methods. For this reason, this study investigated the use, preference, perceptions and knowledge of indigenous, conventional and alternative insect pest control methods in Kwara and Niger States, Nigeria. Both states are renowned for high production of cowpea (Bolarinwa, Ogunkanmi & Ogundipe, 2021).

# 1.2 Statement of the Problem

The practice of using synthetic pest control methods with its attendant problems have long been the practice among cowpea farmers in spite of availability of indigenous and alternative methods which has been adjudged safe and eco-friendly. Although the conventional methods are more popular among farmers nevertheless the resultant problem borne out of its poor or inappropriate use have been a thing of concern to producers, consumers, policy makers and other stakeholders.. Prime among them is the incessant cases of food poisoning (Olurominiyi and Emily, 2011; Gwary, Hati, Dimari & Ogugbuaja, 2012) borne out of indiscriminate use of chemicals, lethal residues, development of resistant strains and increased production costs and destruction of wildlife and beneficial insects. These problems of insect pest control among cowpea farmers continue to plague many Nigerian farm households despite public and private efforts to stem the tide. Evidence abounds in literature that a number of alternatives already exist in the marketplace at varying stages of adoption. For example, along the postharvest value chain, the Nigerian Stored Products Research Institute (NSPRI) has developed and registered a number of safe grain storage and pest control protocols and methods that are scientifically proven to be safe and which do not deplete the environment. Such methods include NSPRIDUST®, the Improved Inert Atmosphere Silo® and NSPRI hermetic steel drums. However, a lot of factors come to play in the choice of pest control methods used by cowpea farmers. Some of these consist of socioeconomic characteristics such as age, size of farm and education; and other factors including cost of method, time and quantity required and method of application, farmers’ knowledge and perception of methods.

The farmer’s perception of insect pest control methods is a crucial factor that should be taken into consideration but is usually ignored. The way people see and understand things around them differ from one individual to the other and could be the difference between reinforcement of old habits and adoption of new methods. Until these issues are adequately understood, designing suitable approaches for the desired behavioural change will be difficult while the problems associated with cowpea contamination would continue.

Several aspects of the decision making process among farmers on selection of pest control methods are not well understood despite being seen as a problem in agricultural practice in most developing countries. While there have been previous attempts to understand pest control dynamics in the country, many of these inquiries have concentrated exclusively on use of synthetic pesticides, use and safety practices (Ogunjimi and Farinde 2012). Also, literature on attempts to empirically investigate the pest control behaviour of farmers on indigenous, conventional and alternative methods at the same time is scarce. The available studies have explored the different methods in isolation and also have knowledge gaps which this study seeks to fill. For example, Omolehin, Adeola, Ahmed, Ebukiba & Adeniji (2011) studied economics of pesticides application amongst cowpea farmers in Kaduna State, Nigeria but did not provide data on other insect pest control methods employed by farmers on the field and in store. This gap is addressed in this study through the investigation of two key stages of the value chain, that is, production and storage.

Similar to Adeniyi, Oguntokun & Ibiyinka (2017) **in their study of the determinants of the extent of pesticide use in Nigerian farms**, Rahman and Chima (2018) investigated the predictors of pesticide use in agricultural production in southern Nigeria. Both studies, however, did not factor in other considerations beyond the socioeconomic determinants and predictors. What’s more, there are currently few studies that have attempted to probe the determining factors of farmers’ usage of pest control methods in general with a view to providing clearer understanding of farmers’ pest control decision and adoption. This has weightier implications and necessitates studying the determinants of use simultaneously with their perceptions since pest control is strictly results oriented and may spell the difference between a good or bad farming year for many resource poor farmers. It is expedient to probe the factors which determine the perceptions of pest control methods and the constraints limiting choice of methods among cowpea farmers. This investigation makes an effort along this course.

Along the same line, in the bid to understand pest control behaviour, little consideration has been given to the importance of cowpea farmers’ sources of information on pest control in Nigeria. Studies by Jamali, Solangi, Najma & Nizamani (2014), and Tarla, Manu, Tamedjouong, Kamga & Fontem (2015) highlighted the importance of information sources in the selection of pest control methods in Cameroon and Pakistan respectively. Therefore, this study aims at investigating the use, intensity of use, preferences, knowledge and perceptions of pest control methods amongst cowpea farmers in Kwara and Niger States.

# 1.3 Research Questions

The investigation addresses the following research questions:

1. What are insect pest control methods used by cowpea farmers in Kwara and Niger States?
2. What are cowpea farmers’ preferences in insect pest control methods in Kwara and Niger States?
3. What are the factors influencing cowpea farmers’ insect pest control decisions in Kwara and Niger States?
4. What are cowpea farmers’ sources of information on insect pest control methods in Kwara and Niger States?
5. What are cowpea farmers’ perception of insect pest control methods in Kwara and Niger States?
6. How knowledgeable are cowpea farmers on insect pest control methods in Kwara and Niger States?
7. What are the constraints to cowpea farmers’ choice of insect pest control methods in Kwara and Niger States?

# 1.4 Objectives of the Study

The general objective of this study was to study the use of indigenous, conventional and alternative pest control methods among cowpea farmers. The specific objectives of the investigation were to:

1. investigate insect pest control methods used by cowpea farmers in Kwara and Niger States.
2. determine cowpea farmers’ preferences for insect pest control methods in Kwara and Niger States.
3. investigate factors influencing cowpea farmers’ insect pest control decisions in Kwara and Niger States.
4. examine cowpea farmers’ sources of information on insect pest control methods in Kwara and Niger States
5. examine cowpea farmers’ perceptions of insect pest control methods in Kwara and Niger States.
6. examine cowpea farmers’ knowledge on insect pest control methods in Kwara and Niger States, and,
7. investigate constraints to the choice of insect pest control methods among cowpea farmers in Kwara and Niger States.

# 1.5 Research Hypotheses

Based on the objectives, the following hypotheses were tested (stated in the null form):

**Hypothesis 1**

H0: There exists no significant relationship between selected socio-economic characteristics of cowpea farmers and use of conventional insect pest control method.

**Hypothesis 2**

H0: There exists no significant relationship between selected socio-economic characteristics of cowpea farmers and intensity of use of conventional insect pest control method.

**Hypothesis 3**

H0: There exists no significant difference in use of indigenous, conventional and alternative insect pest control methods among cowpea farmers.

**Hypothesis 4**

H0: There exists no significant association between knowledge and use of insect pest control methods among cowpea farmers.

# 1.6 Significance of the Study

The study is of consequence because it seeks to satisfy the growing desire to have a more solid understanding of farmers’ pest control behaviour in terms of factors which influence use of synthetic pesticides as a conventional method and indigenous as well as alternative methods. It would engender ample understanding of farmers’ decision-making and use patterns of different methods. Understanding these factors is crucial to developing a policy document for sustained promotion of indigenous and alternative methods. The development of regulations and policies demands information about prevalent insect pest control practices and the manner in which they are perceived by practitioners, in this case, farmers. This investigation will make available these data for appropriate programme formulation by policy makers and provide recommendations on implementation strategies.

It would enhance the dissemination of alternative pest control methods which contributes to realization of the Sustainable Development Goals (SDGs) since it is essential to comprehend elements that exerts stimulus on level of use and perceptions as well as the knowledge systems that reinforce insect pest control habits. It would aid in the identification of opportunities and barriers to increase the uptake of Integrated Pest Management (IPM) and low pesticide-input pest management. Understanding these dynamics and intricacies will help researchers and agricultural extension workers design and select appropriate approaches and outreach strategies for a sustained change in behaviour.

The usage of indigenous and alternative control methods are of significant concern in Nigeria even though the subject lacks precise empirical data and continues to be largely under-researched. Baseline data are absent and previous studies have not attempted to coherently document farmers’ use, knowledge and perception of the different insect pest control methods on field and in store. This study adds to the extant body of knowledge by supplying data and perspectives required by extension agents, policy makers and technology generators for the formulation and revision of strategies and policies.

This study is intended to generate awareness and document the availability and use of alternativemethods for cowpea production and storage in Nigeria. It is anticipated that the outcome would pilot policy recommendation which if adopted would lead to increased adoption of alternative pest control methods in the country. Finally, it would make a contribution to the sustainability challenge by promoting practices that are not inimical to the fragile ecosystem.

# 1.7 Scope and Limitation of the Study

This investigation limited itself to analysis of use of indigenous, conventional and alternative control methods in production and storage of cowpea. The study was conducted in North Central Nigeria, specifically, Kwara and Niger States. Both two states are renowned for high production and storage of cowpea. The respondents were cowpea farmers who provided responses on both production and storage activities. The study is thus limited to North Central Nigeria. Two (2) of four ADP Zones in Kwara State and One (1) of three in Niger State were selected with the state of insecurity, banditry and high level of kidnappings being the key consideration for the choice of one zone in Niger State. There is high concentration of cowpea farmers in the selected Local Government Areas across both states. The study is limited by the assumption that extant literature is significantly dependable and responses provided by respondents are accurate. Data analysis was therefore restricted to primary data obtained from respondents.

# 1.8 Definition of Terms

These terms are defined in the way they are used and operationalized in this study.

**Pest:** Any organism that possess noxious attributes, causes damage or is otherwise a nuisance including unwanted species of animals or plants and vectors of animal and human disease.

**Insect Pest**: This refers to insects with segmented bodies, jointed legs, and external skeletons belonging to class insecta and phylum arthropoda that spreads disease, causes destruction or is otherwise a nuisance. Examples include thrips,aphids, bruchids.

**Pest control:** This is the elimination of insect pests or the inhibition of their reproduction, development or migration. In this study, pest control refers to the control of insect pests.

**Indigenous insect pest control methods:** these refers to insights, methods and adaptive skills based on accumulated years of experience in a local environment and in one’s professional career, in this case, cowpea production and storage.

**Conventional insect pest control methods:** The conventional method as operationalized in this study, both on the field and in store, centres on use of synthetic pesticides for controlling the activities of insect pests.

**Alternative insect pest control methods:** Pest management systems that are eco-friendly, do not deplete natural resources nor pose danger to human health or the environment.

**Perception:** This refers to opinions and beliefs held by the respondents on the differentpest control methods on cowpea production and storage.

**Knowledge**: this refers to the level of factual comprehension and understanding of a subject matter and associated issues.

**Evaluation**: simultaneous appraisal of the usage of different insect pest control methods.

# CHAPTER TWO

# LITERATURE REVIEW

# 2.1 Conceptual Clarifications

This section reviews concepts relevant to the study. It discusses existing knowledge and past research pertinent to the subject. It provides a detailed conceptual framework, explains the major concepts used and the underlying theories and assumptions of the study.

# 2.2 Knowledge and Perception Studies

A knowledge and perception study is a quantitative method of gathering quantitative and qualitative data. In the majority of these studies, data gathering is usually done orally by an interviewer using standardized interview schedules with predefined questions to elucidate responses. The data obtained, which may be quantitative or qualitative is then analysed in line with the objectives of the survey. This survey studies and collects data on what is known, believed and done as it concerns a specific subject (Wood and Tsu, 2008) using a representative sample of a particular population. It reveals what people know, feel and also how they behave. They provide a mechanism for measuring the extent of a given situation by helping to disprove or confirm a hypothesis. They provide fresh perspectives and help to establish a baseline for use as reference in future assessments. Designing effective control strategies and undertaking modifications to existing control strategies require a comprehensive grasp of the factors influencing farmer’s knowledge, perception and decisions and in this regard these surveys are useful in measuring and evaluating the effectiveness of extension education (Van damme, 2009). The desire to provide solutions to farmers’ agricultural problems in sub-Saharan Africa through the incorporation of their perception is enhanced as they bring to the fore misunderstandings and misconceptions that have become barriers to behaviour change which also reinforce practices extension aims to change. A thorough appraisal of farmers’ existing knowledge and perception is therefore an indispensable condition to enhancing their roles as independent decision makers. In summary, it is an educational diagnosis of a specific population, in this case, cowpea farmers in North Central Nigeria. This study is an attempt to study the farmers’ knowledge, perception, preference and use of pest control methods in cowpea production and storage.

An evaluation of knowledge, perceptions and practices in insect pest control is of the utmost importance in setting accurate research agendas that address recognized problems in agriculture and correctly decipher gaps between scientists’ knowledge and farmers’ knowledge; the inclusion of such evaluation would make for the development of widely acceptable innovation communication of research output. These surveys are also indispensable to planning awareness campaign strategies and creating messages for mass communication, as they also assist in the design of programmes that are appropriately tailored to the needs of the community. They are highly effective in evaluating changes that occur in knowledge, perception and practice as a result of extension education and intervention as they help in aggregating key data related to the problem and its influencing factors, in this case pest control.

Meijer, Catacutan, Ajayi, Sileshi & Nieuwenhuis (2015) stated that farmers’ attitudes as whether to adopt a technology or not is the sum of the knowledge such farmers have about the technology and their perception towards the technology. The selection of a pest control method is dependent on the individual farmer’s goals which are intricately interwoven with his knowledge, perception, attitude to pest control and its effects. Thus, practice and adoption of innovations is highly dependent on what the farmer believes, that is, perception towards adoption is largely framed by farmers’ individual characteristics including age and education. An intensified focus on knowledge and perception of use of pest control among cowpea farmers combined with basic research is imperative for the reason that a similar approach in rice pest management has led to the advancement of successful advisory services intervention (Van Mele, 2000).

# 2.3 Concept of Knowledge

This is the level of factual comprehension and understanding of the subject matter and associated issues. Roska, (2003) defined knowledge as structured facts about a phenomenon in a definite arena of human life, entrenched in a certain thought-framework. Knowledge is specific to a social or agro-ecological context within which it is shared and transmitted. Farmers’ knowledge is generally a product of the interaction between scientific and indigenous knowledge adapted to their individual social, political and economic environment. It encompasses decisions and practices built on experience over time. It varies among individuals and is distinctive with age, wealth and gender as some of the differentiating factors. In any social, economic and environmental milieu, farmers’ knowledge provides a structure for decision making. Farmers’ access to information and the social network within which they interact greatly influences their knowledge about any technology, increases awareness and enhances their capacity to evaluate extant pest control methods (Lambrecht, Vanlauwe, Merckx & Maertens, 2014). While this knowledge evolves and is dynamic and often rarely systematized (Boven and Morohashi, 2002), it is essential to make a distinction between indigenous knowledge and farmers’ knowledge. Indigenous knowledge pertains to insights and adaptive skills based on many years of experience in a local environment (Thompson, Lantz & Ban, 2020) while farmers’ knowledge is broader in dimension as it encompasses indigenous knowledge and variables influencing the present set of knowledge on a particular subject.

For this study, the knowledge by study population refers to their understanding of pest control methods. Knowledge as a variable may moderate the choice of pest control methods by farmers. Suklim, Raksanam & Songthap (2013) asserted that risky behavioural tendencies in pesticide use are prevented by superior knowledge of the pesticide type and health effects of pesticides. Mohanty *et al.* (2013) found that knowledge was connected to pesticide safety behaviour. Karunamoorthi, Mohammed, & Wassie (2012) asserted that a great majority of farmers are fairly knowledgeable of pesticides impact on human health. An investigation of cowpea farmers’ knowledge of indigenous and alternative pest control methods is therefore indispensable.

# 2.4 Concept of Perception

The Cambridge Dictionary of the English Language defines perception as a [belief](https://dictionary.cambridge.org/dictionary/english/belief) or [opinion](https://dictionary.cambridge.org/dictionary/english/opinion), [held](https://dictionary.cambridge.org/dictionary/english/held) by a lot of [people](https://dictionary.cambridge.org/dictionary/english/people) and [built](https://dictionary.cambridge.org/dictionary/english/based) on how things seem. Webster's New World dictionary (2021) defines perception as understanding or knowledge acquired by perceiving a concept or idea, so formed even as it defines attitude as a style of acting, feeling or thinking that shows one's outlook or opinion. In literature, however, despite the distinction between their meanings, they have often been used interchangeably.

Similarly, Robbins and Judge (2013) defined perception as the organization, construction and interpretation of sensory impressions in the environment by a person or group to arrive at a meaning. This is related to feelings toward the subject matter, including view and judgment of its importance. In other words, perception is the belief, opinion and points of view an individual or group of persons hold about a phenomenon. A farmer’s behaviour in pest control is the outcome of his own individual perception or of the group to which he belongs. Various scholars have documented different farmers’ perceptions of pesticides and the dangers of agrochemicals (Marquis, 2013) but not the perceptions around the use of other pest control methods, in this case, indigenous and pest control methods.

According to Meijer *et al.,* (2015) a farmer’s perception is his view of a given technology in terms of previous experiences and felt needs. Mumford (1982) opines that perception is a consistent view on a subject which is a product of direct experience and indirect information on the subject matter and suggested a model in which choice of control method depends on the perceptions of the dangers of pests and the sum total of the controls that a farmer is aware of and is able to use. Thus, the selection of a control method is related to its perceived ability to satisfy the farmer's objectives and farmers’ perceived characteristics of a practice are a powerful predictor of adoption. A farmer’s experience of pest problem and his estimation of losses are direct experiences. However, an overestimation of the losses sustained may lead to a need to protect the crop in all circumstances at all cost.

For this study, perception refers to farmers’ feelings and preconceived notions they have towards pest control methods and their effects. Farmers’ perceptions are crucial to figuring out their decision procedure in the practices they select. Kambewa, Changadeya, & Aggrey (2012) posited that individuals’ perception about effectiveness of technologies considerably influences their decision to use. Farmers who perceive a pest control method or technology as being the solution to their problems in their particular environment are likely to adopt and use them. The decision of farmers to use pest control methods begins with the perception of insect pests as a challenge. Raksanam, Surasak, Siriwong & Robson (2012) and Kakaei *et al.* (2014) maintain that farmers’ perception of pest control methods is related to their pest control behaviour. Bagheri, Fami, Rezvanfar, Asadi & Yazdani (2008) reported that farmers’ believed the use of pesticides as the best mode of action against pests. Dasgupta, Meisner & Huq (2007) opined that a lucid understanding of farmers’ perceptions is required for the formulation of policy intervention*.*

# 2.5 Human Behaviour and Perception

The behaviour of humans as it concerns perception supplies the theoretical underpinning for this study. Though highly individualized, it is a multifarious psychological process which coagualutes as a process over time. It is the way we see things, the way they look to us or the way they feel, taste, sound or smell. It is also related to awareness and understanding of a phenomenon and perceptions are formed by our motivations and our experiences, and any two people rarely have the same previous memories and emotional experiences. The similarity in perception is essentially a product of similarity of motivational objectives.

Allport (1955), one of the earliest studies on perception, provided the following particulars on perception:

1. Perceptions are always precise and explicit, even when related to general meanings.
2. They are directly linked to their stimulus objectives.
3. An individual’s longstanding experience determines the attributes of perception. On their own part, Albrecht, Klapötke & Mattler (2010) opined that perceptions are developed in terms of subjective experience with a stimulus having different cognitive stages rather than an immediate response to external stimuli, that is, not to the instantaneous objective-physical stimulus pattern.

Review of this theoretical foundation of the study reveals the complex nature of perception and its relationship with other qualities such as experience, and motivational objectives. In this study therefore; it is assumed that perceptions echo an individual’s world-view, based on experience and motivation. Consequently, with this assumption as a premise, it is possible to study cowpea famers’ experience and motivation about insect pest control by studying their perceptions of these methods. An assessment of farmers’ perceptions is predicated on the conviction that comprehending the farmers’ worldview is essential to the discovery of knowledge gaps influencing their pest control practices. Perceptions always entail acknowledgment of information and as a process it involves the farmer comparing information received from an external source (for example, an extension agent) against information stored in his memory based on his experience. This view emphasizes the importance of factors in the farmer’s learning history. In relation to this study, it is assumed that a relationship exists between farmers' perceptions of pest control and their socioeconomic characteristics such as age, education and experience.

# 2.6 Cowpea Production

Grains are perhaps the most important family of agricultural crop species in the world (Kebede and Bekeko, 2020). The genus *Vigna,* extensively found in the tropical and sub-tropical areas, possesses considerable morphological and ecological diversity (Oyewale and Bamaiyi, 2013; Singh, 2014) and consists of not less than one hundred different species. Indigenous to Africa, cowpea is an annual versatile warmth-loving legume and it is cultivated under an extensive scope of soil and climate conditions (Singh, 2014). All cowpea varieties being currently cultivated in the world originated from East and West Africa (Xiong *et al,* 2016). They vary in the appearance of their grain including the seed size, colour of the seed coat and eye colour (Gerrano, Jansen van Rensburg & Adebola, 2017).

Most cowpea cultivated in Sub-Saharan Africa is intensively intercropped with maize (*Zea mays*), sorghum (*Sorghum bicolor*) (Oyewale and Bamaiyi, 2013; Beshir *et al*, 2019) and intermittently with other crops such as pearl millet (*Pennisetum glaucum)*, cassava (*Manihot esculenta*) and cotton (*Gossypium* spp*.*). Its high tolerance to drought means that, under very hot and dry conditions, many cowpea lines can survive for more than 40 days (Cui, 2019). They are mostly farmed for grain but a small fraction are grown for fresh pods in eastern Asia or green leafy vegetables and fodder in Africa (Alemu, Asfaw, Woldu, Fenta & Medvecky, 2016).

The cowpea grain is the most important part of the crop consumed in different forms (mashed, fried, boiled, sauce and paste) as it is a foremost supplier of affordable vegetable protein (Muranaka *et al*, 2016) An approximated 38 million households (194 million people) in the Sub-Saharan Africa rely on the crop as a major dietary protein source nutritionally complementing tuber crop staples and low-protein cereal (Carneiro da Silva *et al*., 2018). The cowpea grain contains 22–23 % protein, 50%-60% starch and 63.6% carbohydrate and a appreciable quantity of thiamine, riboflavin and niacin (vitamin B1, B2 and B3 respectively), and is richer in calcium and iron content than cereals (Akyaw, Baidoo & Mochiah, 2014; Ngalamu, Odra & Tongun, 2015). The leaves represent a good source of ascorbic acid (vitamin C) and β-carotene (Okonya and Maass, 2014). Cowpea is frequently regarded as the meat of the poor man because of the high protein it contains (Abdullahi, Usman, Girei & Isma’il, 2016). Also, its hay plays a principally useful function for feeding animals for the period of the dry season as an important source of forage for livestock in many parts of West Africa.

# 2.7 Cowpea Production in Nigeria

An enormous bulk of global total cowpea production occurs place in sub- Africa, with an estimated 14.5 million hectares of land cultivated and a total annual production of 6.2 million metric tons (Kebede and Bekeko, 2020). Nigeria is by far the leading producer and consumer accounting for 48% of production in Africa and 46% globally (IITA, 2017) while overall amounts imported into the country are insignificant. Niger, Northern Brazil, Peru, southwest North America and parts of India are other areas with significant amount of cowpea production.

In Nigeria, cowpea is consumed nationwide (Awosanmi, Ajayi & Baffoe, 2020) and the major producing states include Niger, Nassarawa, Borno, Bauchi, Benue, Kano, Kaduna, Katsina, Kebbi, Sokoto, Zamfara, Plateau, Yobe, Kwara and Jigawa. The production and storage of cowpea serves multiple purposes including helping to stabilize prices, preserving quality for future use, maintenance of regular supply throughout the year as well as being a profitable commercial venture. Storage of cowpea is also an important activity and is carried out during glut in a bid to obtain higher prices later in the year. Many producers sell at low prices during the harvest period rather than risk loss in storage. Efficient and effective short, medium or long term crop protection systems and structures, both on field and in store, therefore becomes a necessity because the production and consumption of cowpea does not always occur concurrently.

# 2.8 Economic Importance of Cowpea

The multipurpose use and economic contribution of cowpea to mankind has long been known and it is considered the most economically significant indigenous African legume crop. The crop provides food, cash and animal feed (Ibrahim, Waba, Mohammed & Mustapha, 2016; Bashir, Ndaghu, Nakwe, Abdulazeez & Samuel, 2018) for rural dwellers in addition to benefits to farms by means of ground cover and *in situ* de-cay of root residues (Claudius-Cole, Ekpo & Schilder, 2014). Furthermore, Kebede (2020) reported that cowpea remains the most excellent cover crop in maize-cowpea intercropping system for reduction of soil erosion.

The nutritional composition of cowpea holds high potential for the achievement of food and nutritional security (Gerrano, Jansen van Rensburg & Adebola, 2017) as it can be used to make different types of foods and snacks. It is the cheapest source of proteins for majority of the rural folk and are essential in diets for the high protein content supplying protein to both rural and urban households as a replacement for animal protein (Wakili, 2013). It is rich in phytonutrients and is thus suitable for providing healthy balanced diet while solving problems of malnutrition among resource-poor households in Sub-Saharan Africa (Okonya and Maass, 2014). What's more, a number of varieties have a short growth cycle and mature early and accordingly supply food during the “hungry period” that is, the phase at the closing stages of the wet season when feeding can become exceptionally difficult in smallholder households in semiarid parts of sub-Saharan Africa (Kebe and Sembene, 2011).

In some parts of West and Central Africa, cowpea fodder is remarkably prized since it can be harvested for feeding livestock. Similarly, stored cowpea fodder is used as feed for the duration of the dry season. Its seeds are vital for the reason that the production of cowpea is entirely reliant on seed as propagation matter (Buleti, Mamati & Abukutsa-Onyango, 2019). In all, the adaptability of cowpea to diverse types of soil and climatic conditions including its resistance to drought and suitability for different intercropping combinations, its ability to complement nutritional value of cereals, its fixing of nitrogen to improve soil fertility particularly among resource poor farmers who apply little or no fertilizer (Kyei-Boahen, Savala, Chikoye & Abaidoo, 2017) and prevention of erosion through provision of land cover makes it a crop of great economic consequence in many developing countries.

# 2.9 Cowpea Production and Food Security

An estimated 239 million people suffer from protein calorie undernourishment (Fanzo, 2012) in Africa where food security remains a major challenge. Cowpea is rich in mineral and phytonutrient content which makes it a key crop for improving livelihoods and sustaining food security. Food security and poverty is greatly impacted by reduction in food losses as most residents of Sub-Saharan Africa are employed in agriculture and allied activities with a major chunk of household expenditure being taken up by food. Food security in Nigeria is a challenge resulting from an array of problems (Eme, Onyishi, Uche & Uche*,* 2014) where the cultivation of 32 of the 79 million arable lands is rain-fed. Protein-calorie malnutrition can be combated by the consumption of dairy products and meat but these foods are not affordable to smallholder households in rural Africa. (Dakora and Belane, 2019). Cowpea as an alternative is extensively consumed in many countries, with its first-rate nutritional and nutraceutical characteristics and numerous economic, ecological and agronomic benefits. Its manifold contributions and use as well as its preservation of the environment makes it crucial to the attainment of food security in many respects (Carneiro da Silva *et al.,* 2018). Successful dissemination and adoption of effective insect pest control techniques for cowpea is therefore crucial to the future of the continent.

# 2.10 Pests of Cowpea Production and Storage

The importance of cowpea to human needs notwithstanding, the major problem of cowpea is pest infestation. Pests of cowpea consist of both vertebrate and invertebrate organisms, with the former comprising rodents and birds and the latter insects, mites and microorganisms including bacteria, fungi and yeast respectively. However, efficient production and storage of cowpea is severely limited to the greatest extent by insects which are the focus of this study. All over the world, insect infestation is a major problem of cowpea starting from the field to storage. Cowpea is subject to damage by broad spectrum of insect pests (weevils, thrips, aphids, podborers, leafhoppers, foliage beetles) at all stages of growth and along the postharvest value chain. Kemabonta and Odebiyi (2005) submitted that the pest spectrum of the crop is extensive and virtually every part of cowpea has an adopted pest species. The cowpea is attacked by weevils as a seedling, with aphids such as *Aphis craccivora* acting as carriers of cowpea mosaic virus and extracting juice from its stems and leaves. As it flowers, flower thrips such as *Megalurothrips sjostedti* feast on it; pod borers such as *Maruca vitrata* attack its pods during pod growth (IITA, 2017) while the preeminent postharvest pest in Nigeria is the cowpea weevil (*Callosobruchus maculatus*). On the field, the chief pests of cowpea comprise *Maruca vitrata, Clavigralla tomentosicollis* and *Anoplocnemis curvipes.*

Evidence in literature suggests that most cowpea varieties are susceptible to *C. maculatus* in storage and according to Stejskal, Aulicky & Kucerova (2014) it has long been established that *Callosobruchus* species is the most important pest among all storage insect pests of cowpea because of its capability to plague the grains from the farm. *C. maculatus* stand outs in Nigeria because of the type and level of its destruction and the overall financial losses it causes. Minor pests such as flour mite, *Acarus siro* are significant in some African countries (Bayih, 2014). *Callosobruchus maculatus* are regarded as minor field pests which assume major insect pest status on the crop during storage (Adebayo, 2015). According to Nalini, Usha, Rajavel & Murali (2012), *Callosobruchus maculatus* is cosmopolitan and the most vicious pest of stored cowpea causing brutal postharvest and financial losses to farmers.

Bean beetle, bean weevil, pulse beetle, storage beetle, cowpea bruchid are common names given to the pest in West Africa based on the magnitude of its attack. Its postharvest feeding and reproductive activities cause physical damage while contamination of infested seeds results from contact with its faeces (Musa and Adeboye, 2017). The laying of eggs in the field by the females on ripening pods signals the onset of its attack. Thus, infestation in store is often the result of harvesting field-infested pods and seeds. A small population is often enough to proliferate and effect considerable damage within a short period of time. However, onset of its attack in store is also common.

There is high susceptibility to contamination by microbes in cowpea seeds stored under poor conditions (Etaware and Etaware, 2019). The activities of fungi in reduction of seed quality during storage are substantial (Etaware, 2019). Research on mycotoxins in stored cowpea seeds refer to *Aspergillus* infection and the consequent aflatoxin production. Aspergillus *flavus* and Aspergillus *parasiticus* are molds producing the potent human carcinogen, aflatoxin which is one of the poisonous and deadly mycotoxins present in stored grains (Manafi and Khosravinia, 2013). The onset of its infestation in stored grains leads to damage, making it inappropriate for eating within only a few months of storage (Musa and Adeboye, 2017). This is particularly so in the tropics and subtropics as storage and climate conditions are favourable to the growth of fungi (Salari, Najafi & Boroushaki, 2012) along with cowpea as well as groundnut and maize being major targets for Aspergillus species (Whitlow and Hagler, 2013). Aflatoxins have been detected in cowpea samples in Nigeria owing to inappropriate handling at some stage in harvest and poor storage conditions at levels higher than the limits stipulated by Standard Organization of Nigeria (SON) (Ogungbemile, Etaware & Odebode, 2020). When ingested in large amounts, secondary metabolites such as mycotoxins which are secreted by fungi can cause diseases and death in humans and animals. Tiffany (2013) provided evidence that aflatoxin contamination in the diets of West Africans is related to the incidence of Kwashiorkor.

# 2.11 Developments in Pest Control

Control strategies to mitigate the losses brought about by insects depend mostly on the application of synthetic pesticides which are expensive, incite insect resistance and environmental contamination (Musa and Adeboye, 2017). Pesticides are utilized to control diseases, insects and pests in a bid to guarantee healthy yields and food security. Records indicate that since its introduction in the 1950s and especially with that of Lindane in 1957, there has been a continued rise in pesticide use in Nigeria (Ogunjimi and Farinde 2012). From 1996 to 2016, in tonnes of active ingredient, a 46% increase was recorded in the practice of pesticides application globally (FAO, 2019). The usage of a broad continuum of synthetic pesticides to control pest species in field and in store products has become a norm over a period of many years. Some of these include organophosphate and chlorinated hydrocarbons. Musa, Oyerinde & Owolabi (2009) asserted that these pesticides are not readily accessible to farmers because of their high cost, toxicity, lack of application expertise, and adulteration. Erhunmwunse, Dirisu & Olomukoro (2012) posited that increased pesticide contamination in Nigeria is as a result of its use for other activities than it was produced for. However, problems associated with use of synthetic pesticides which include: high cost, high persistence in the environment after application, non-availability, inadequate knowledge of application methods among resource-constrained farmers, genetic resistance and health and environmental hazards have called for the research intorelatively cheap, environmentally-friendly and sustainable alternative control measures (Akinkurolere, Adedire & Odeyemi*,* 2006). Efforts to lessen the reliance on synthetic pesticides for pest control has been intensified and led to the development of alternatives that are environmentally secure and cheaper compared topoisonous synthetic pesticides.

# 2.12 Losses and Damage in Cowpea Production

Losses, which may be quantitative, qualitative and nutritive, result from the activities of pest on cowpea during production and storage. While the general losses that occur during the production and postharvest stage of food crops in developing countries have been estimated to be between 30 and 40% of all food crops, a number of studies (Anyim, 2016; Adebayo and Hassan, 2017; Adebayo and Anjorin, 2018) have reported varying degrees of loss ranging from 10% to 50% and even a 100% across the cowpea value chain from field to store in the most severe cases. Losses of this magnitude is often debilitating to resource poor farmers. These losses are often estimated in percentage rather than in monetary terms because available precise data are often inadequate. Weight loss and quality decline and the growth of moulds are the foremost results of infestation (Adebayo and Hassan, 2017). These losses in quality translate to loss of economic value to the farmer. Food loss is any change or alteration in the ability, wholesomeness, edibility or quality of food that hinders it from being used or consumed by people (Abdelradi, 2018; FAO, 2018). It may be direct or indirect and generally depend on socioeconomic, environmental, mechanical, chemical, biochemical, biological and microbiological factors (Nicastro and Carillo, 2021). The former encompasses losses of immediate impact on the crop including disappearance of food from spilling, or consumption by birds, rodents or insects. The latter have no direct impact on the crop but serve as entry avenues for other factors that bring about loss involving the lowering of quality to a level where people refuse to consume it. These losses are attributed to distribution of disease causing organisms, increase in cost of storage and loss in motivation for farmers.The pre-harvest, harvest and postharvest periods are three identified periods during which food may be lost with each period having its own peculiar challenge and methods of overcoming it.

Generally, pre-harvest losses occur before harvesting commences, and includes losses in crops due to the influence and activities of weeds and insects. Harvest losses are those that occur between the beginning and conclusion of harvesting such as losses due to shattering during harvesting. Postharvest losses are losses that occur down the value chain between harvest and the point of human consumption. Loss of quality, loss of weight (quantity), reduction in market value (economic), loss of seed viability and loss of nutritional value are some of the dimensions of postharvest losses. They include losses during transportation and storage and on-farm losses resulting from winnowing, threshing, and drying. Postharvest losses have become important considerations in the bid to attain food security in Africa. Losses of between 20 and 50% have been foundin cowpea in storage owing to cowpea weevil, *Callosobruchus maculatus* F. attack and in some cases the loss possibly will be total, resultingin 100% loss (Udo and Harry, 2013). Insect pests may harm stored cowpea by reducing seed viability, dry weight and nutritional value. The degree of pest attack on field and in store and the perceived effects of adopted pest control methods influence subsequent control method decision and the intensity of use of such methods.

# 2.13 Pest Control Practices

This refers to current measures being taken to achieve the elimination of pests or the inhibition of their reproduction, development or migration resulting from the knowledge and perception of the subject matter. Pest control is a concern globally, more so in the developing world, which includes much of Africa, Nigeria inclusive. Doss (2003) reports farmer’s knowledge, farmers’ experience, land tenure status, education level and access to information as factors influencing the adoption of improved agricultural technologies and the ensuing systems utilized by farmers. Rother (2008) describes the indicators of farmers’ relationships with pest control methods especially the use of synthetic pesticides to include sanitation practices, aptitude to identify and interpret labels and pictograms on synthetic pesticide containers and the use of personal protective equipment.

Poor pest control practices among African farmers have been extensively reported. Asante and Ntow (2009) investigated pesticide use practices and observed farmers who exceeded the recommended dosage and sprays for a growing season on the same field. Expired and banned pesticides are still in use while stirring of pesticides with bare hands (Okoffo, Mensah, Yayra & Mensah, 2016); testing of diluted pesticides with the tongue to determine potency (Williamson, Ball, & Pretty, 2008) and use of unapproved mixtures are the norm (Dari, Addo & Dzisi, 2016).

Williamson *et al.,* (2008) also observed the use of inappropriate products, incorrect dosages, the use of non-calibrated and leaking equipment and mixing of different pesticides and pest control methods to form a pesticide and pest control cocktail among farmers in the region. Ackerson and Awuah (2010) also recorded widespread non-use of protective clothing whenapplying pesticides and application of pesticides without regard to harvesting times and dates. Fianko, Donkor, Lowor & Yeboah (2011) reported pesticide application to crops at maturity followed by immediate harvest for sale to consumers.

According to Matthews *et al.,* (2011), poorly equipped laboratories, inadequate storage systems for pesticides and insufficient knowledge are some of the factors responsible for pesticide abuse in Africa while Damalas and Eleftherohorinos (2011) on their part posited that inappropriate spraying equipment, poor application techniques and improper storage techniques were responsible for the high death rates resulting from pesticide use in Third World countries.

El-Wakeil, Shalaby, Abdou & Sallam (2013) recorded lack attention to safety precautions, incorrect beliefs about pesticide toxicity and lack of information as the basics of pesticide abuse. Ibitayo (2006) and Asogwa and Dongo (2009) noted the use of banned toxic chemicals, poorly maintained spraying equipment, incorrect application techniques, inappropriate storage practices and reuse of pesticide containers for domestic purposes as some of the practices exposing farmers to great risk. This agrees with the position of Dinham (2003) that methods for safe handling, harmless storage of pesticides and application are mostly not followed in many parts of Africa.

A lack of information about the pesticides being handled among farmers has been documented. Lekei, Uronu & Mununa, (2004) found retailers who repackaged and sold pesticides in different and unlabelled containers in Tanzania while (Sodavy, Sitha, Nugent & Murphy, 2000) reported sale of pesticides with labels written in foreign language in Cambodia. Kotey, Gbewonyo & Afreh-Nuamah (2008) found farmers who felt that heavy pest infestation required higher pesticide dosages than recommended whereas overuse of pesticide predisposes yield losses rather than gains (Oerke, 2006).

Lekei, Ngowi & London (2014) and Khan, Mahmood & Damalas, (2015) attributed this worrying trend to not having education and knowledge, inadvertent application errors and erroneous perceptions of pest control and effectiveness. Waichman, Eve & Nina (2007) and Isin and Yildirim (2007) recorded farmers’ solitary reliance on their own experiences as a source of direction on pest control and as a guide for understanding labels (when using synthetic pesticides) in the absence of regular extension contact. Dung *et al.,* (2003) reported reliance on experience of their own practices while disregarding extension advice among farmers. For this study, this was operationalized in the ways farmers’ knowledge and perceptions are demonstrated in the choice and use of pest control methods.

# 2.14 Sources of Information

This relates to the farmers’ information sources and its effects on the pest control behaviour. The importance of source of information cannot be overemphasized. Access to information has manifold channels comprising government extension officers, non-government organizations (NGOs), extension booklets and monographs, fellow farmers, agro-input dealers and retailers etc. Quality information that is specific and appropriate to a farmer’s surroundings is facilitated through government extension agents (Lambrecht *et al.*, 2014). Such information increases farmers’ general awareness about available technologies and protocols and subject to their individual perceptions and characteristics, it influences their agricultural practices. In conservation agriculture studies, farmers’ access to timely information positively impacted adoption behaviour and the decision to use conservation practices (Knowler and Bradshaw, 2007). According to Houbraken, Bauweraerts, Fevery, Van Labeke & Spanoghe, (2016), economies in transition are populated by smallholder farmers with limited knowhow on alternative pest control methods. Adu-Kwateng, Bortey, Aidoo & Adu-Appiah, (2016) asserted that there was widespread ignorance of the effect of synthetic pesticides among farmers and consumers. Similarly, Wumbei, Houbraken and Spanoghe (2019), asserted that agricultural best practices are not usually adhered to in handling these substances. Investigation into the sources of information on insect pest control reveals veritable differences in addition to widespread limitation. Farmers’ knowledge of pest control is closely related to their source of information on pest control. For example, Wasudha, Ori & Ori (2015) reported that vegetable farmers relied on knowledge received from fellow farmers, pesticide shops and relatives for their farming endeavors. With this comes the risk of information gaps as new generation of farmers evolve. Jamali *et al.,* (2014) and Tarla*et al.,* (2015) reported a dependence of farmers on traders and chemical vendors for agricultural pest control knowledge in Cameroon and Pakistan respectively. Given the crucial role pesticide retailers play, Yang *et al.,* (2014) stressed the need for effective educational and extension programs for them.

Some of these may include crucial knowledge as actions before, during and after pesticide sprays, recommended pesticide and dosage, withdrawal and waiting period, precautionary measures, and associated risks from misuse and exposure to pesticides on farmers. Fan *et al.,* (2015) highlighted the importance of authorities in supplying information and providing direction on pest control, awareness and behaviour of farmers. Usually, the input dealer in rural areas is the sole individual who is readily accessible to resource-poor farmers who require information, have low educational levels and negligible extension contact.

It is necessary to study the sources of information because perception process is based on farmer’sexposure to knowledge and information in their milieu (Dermuth, 2013).

# 2.15 Conventional Pest Control

Conventional control of insect pests is heavily reliant on sythetic pesticides (Handford, Elliott & Campbell, 2015) and was operationalized in this study as the use of synthetic pesticides. Nesheim *et al.,* (2014) observed a shift from a general extensive land use to a more concentrated intensive use of land in Nigeria which includes the development of irrigation systems for agricultural lands, ecosystem simplification and pesticide and fertilizer use. This agricultural intensification requires larger quantities and amounts of synthetic pesticides for the maximization of efforts and resources. Conversely, resource-poor rural farmers use the largest proportions of synthetic pesticides (Oluwole and Cheke, 2009). Generally, there is a glaring absence of agricultural produce inspection at the local markets accompanied by an excessive dependence on farmers to guarantee proper use and appropriate dose ratesof pesticides. The persistent use of pesticides among farmers and traders is compounded by inadequate awareness of necessary precautions to be taken in application and the potential short and long-term risks (Damalas and Eleftherohorinos, 2011).

# 2.16 The Importance of the Conventional Method

The bid to guarantee stable supply of food all year round and increase crop yields, preserve the nutrient composition of food and facilitate storage; all common features of modern agriculture is signposted by increased use of pesticides (Wong *et al.,* 2014). The peculiar characteristics of developing countries make pesticides more valuable than ever before as they seek to diversify their revenue base and gain a foothold in the global market through the provision of primary commodities (Ismail, Sameni & Halimah, 2011). The actualization of this goal and the accompanying pressure is further enhanced by agricultural inputs such as herbicides, fungicides, pesticides, which make up the whole gamut collectively referred to as pesticides. According to Lagerkvist, Ngigi, Okello & Karanja (2012) high insect pest and disease incidence being major agricultural production constraints are mitigated by the use of pesticides.

# 2.17 Theoretical Framework

An assortment of theoretical models has been developed in the bid to comprehend the utilization of practices among different socioeconomic groups. These include Theory of Reasoned Action (TRA) (Fishbein & Ajzen (1975), Social Cognitive Theory (SCT) (Bandura, 1986), Technology Acceptance Model (TAM) (Davis, 1989), Theory of Planned Behaviour (TPB) (Ajzen, 1991), Motivational Model (MM) (Davis, Bagozzi, &Warshaw, 1992), Combined-TAM-TPB model (C-TAM-TPB) (Taylor & Todd, 1995) and Innovation Diffusion Theory (IDT) (Rogers, 2008). Venkatesh, Morris, Davis, & Davis (2003) synthesized these theories to develop the Unified Theory of Adoption and Use of Technology (UTAUT).

These theories are significant as they give explanation to the decisions to adopt and use and complexity of perceptions involved at the individual and group level (Ndah, Schuler, Uthes & Zander, 2010). A number of established technology utilization theories have been used to study the determining factors of adoption and use decisions (Leeuwis, 1993).

This section considers some theories of use/adoption relevant to the study: Theory of Reasoned Action, Theory of Planned Behaviour and Diffusion of Innovation Theory. These theories are useful in predicting utilization of innovations in behavioural change programmes while they also explain adoption decisions (Braak, 2001).

# 2.17.1 Theory of Reasoned Action (TRA)

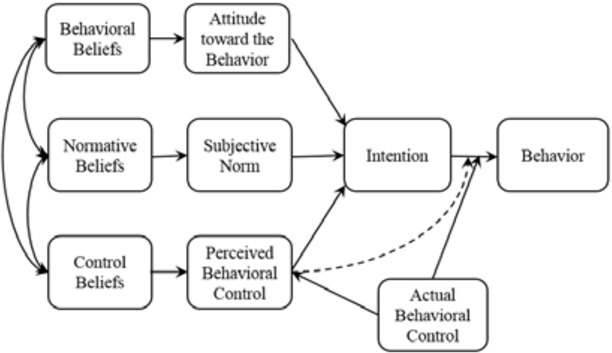
Developed by Ajzen & Fishbein (1980), it is a model that underlines the study of perceptions helping scholars to appreciate the association between perceptions and behaviour. This theory posits that individual behaviour is determined by perception of outcomes of behaviour and the opinion of the environment. The theorists believed that individual behaviour is predicted by the intention which is a plan to either carry out or not carry out a particular behaviour. It explains and predicts beliefs, attitude and intention. Parminter and Wilson (2003) opined that systemic reflection on information about behaviour precedes the formation of attitudes with human beings assumed to be rational and capable of analyzing available information.

The theory emphasizes intent to execute behaviour as a preeminent predictor of people’s behaviour in any given situation (Montano and Kasprzy, 2008), suggesting a positive correlation between perception and behaviour. The expectation of good consequences from a specific behaviour creates a positive perception towards that behaviour. For example, if a farmer expects a pest control method to protect his crops against pest attack, he has a positive perception of the use of that pest control method. Correspondingly, the expectation of detrimental consequences creates a negative perception towards that behaviour.

This theory assumes that people factor in the consequences of their actions in an environment at any given time. The theory holds that a mix of accumulated experiences over a lifetime produces a set of attitudes toward behaviour. Thus, perception influences behaviour via the formation of intention. The TRA is individualistic at its core and does not capture the social nature of change or the process of social change itself. It overlooks the importance of social factors that are sometimes determinant factors of individual behaviour (Werner 2004). However, it is a useful theory in understanding decision making and the effects of personal factors on the decision making process.

# 2.17.2 Theory of Planned Behaviour (TPB)

Developed by Ajzen (1991) and in fact a derivative of the TRA containing the same central principles, recent studies (Lamm, Lamm, & Strickland, 2013) have incorporated this theory into the theoretical framework for the explanation of perception and behaviours. This theory provides a valuable structure for comprehending farmers’ decision making in line with their perceptions and beliefs and explores how diverse stimuli trigger a particular behaviour, in this case the use of different insect pest control methods. It helps to understand the influence of socio-cultural factors in adoption and utilization behaviours.

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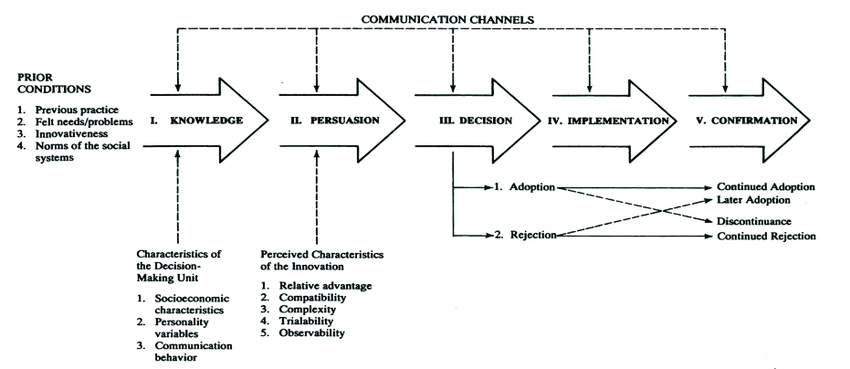
**Figure 1: Diagrammatic presentation of the Theory of Planned Behaviour**

**Source: Ajzen, 2015**

According to this theory, attitude, subjective norm and perceived behavioural control are the three basic components of intention and may be anticipated from beliefs with respect to behaviour. Further, pertinent beliefs about a particular behaviour determine the intention which is the possibility that a person will be involved in a certain behaviour. Thus, the strength of the intention determines the chance of the performance of that behaviour. Perceived behavioural control denotes the simplicity or difficulty of carrying out a behaviour in an individual’s opinion taking into cognizance the situational and internal factors that may serve to restrict or facilitate the performance of behaviour while subjective norms entail a person’s view of the group expectations to carry out or not to carry out a behaviour. That is, the motivation to comply exerts pressure on the individual to a greater degree. Attitudes reflect the individual’s evaluation of behaviour and are influenced by beliefs and the outcomes of the evaluation. It may be positive or negative. Human behaviour is complex and not easily predicted. The relationships and scenarios proposed by the theory do not always exist.

# 2.17.3 Diffusion of Innovation Theory (DOI)

First put forward by Everett Rogers as a viewpoint of social change theory and has remained central to extension activities. It is the fusion of several theoretical perspectives rather than a single all-inclusive theory (Rogers, 1995). It defines diffusion as the process through which innovations spread among members of a social environment by way of particular communication channels over time. The theory is valuable in explaining change resulting from adoption and use of innovations in agriculture.



**Figure 2:** Diagrammatic presentation of Diffusion of Innovation Theory

Source: Rogers, 1995

It emphasizes a plethora of connections arising from the learning experience that humans have in a community asserting that the use of an innovation is contingent on knowing about it or knowing people that have adopted and used it, that is, contact with people who have adopted and are using an innovation stimulates an individual to do the same. Diffusion of Innovation theory provides a robust point of view on factors that drive adoption of innovations and those that inhibit them as it is concerned with the spread from the creation of an innovation, its communication among members in a social system through particular channels. Theoretically, the use of indigenous, conventional and alternative pest control methods can be explained by technological diffusion which is affected by the attribute and behaviour of users.

Arimi and Adekoya (2013) emphasize that the Diffusion of Innovation theory implies that members of a social system have different characteristics which influences who adopts an innovation early and who adopts an innovation late. Rogers (1995) described four factors prompting adoption and utilization of a practice.:

1. The innovation itself: The attributes of an innovation and its contribution to the aims and objectives of smallholders is useful in predicting the probability of adoption of an innovation. The innovation traits, personal characteristics of clients, and the local environment as crucial elements in the adoption process. Rogers (2008) further identified some fundamental factors relating to the practice or technology itself which influence its adoption and use:
2. Relative Advantage: This describes the level to which a practice is deemed superior to the one it is replacing or that which a farmer is presently using. The level at which it is considered better than current methods and may be considered in terms of convenience, low cost and immediacy of reward.
3. Compatibility: This is how consistent the technology or practice is with the background, values, lifestyle patterns, experiences, norms and needs of individuals in a social milieu. Hence, lower levels of compatibility connote slower diffusion rates while higher levels of compatibility symbolize quicker diffusion rates. Simply put, it signifies how farmers assess a novelty as being in harmony with the extant norms, ideals, beliefs, experiences, and desires.
4. Complexity: This describes the extent a practice or technology is seen as easy or hard to comprehend and practice. The simpler it is to grasp and carry out a practice, the greater the likelihood of quick acceptance by members of a society, and vice versa.
5. Triability: This is the ease with which an innovation can be tested or tried. It determines the rate of acceptance as it allows for an evaluation period, before adoption decision after farmers have experimented or tried out a new practice.
6. Observability: This is the extent to which the benefits or results of an innovation can be observed, perceived, imagined or seen by a potential adopter.
7. The communication channels: The channels employed to disseminate information about a practice exerts influence on the speed of diffusion and utilization of an innovation in a particular social system. The use of appropriate channels facilitates adoption while inappropriate methods may slow its pace. Methods in use include interpersonal, group, farmer-to-farmer, mass media, print media, and on-farm researcher-led demonstrations amongst others.
8. Time: The process of diffusion and adoption of a practice or technology in a social system takes time. More time may be required for a complex innovation than a simple one. This is related to the period of time required for a change in attitude and beliefs after information about a technology is received.

Rogers (2008), on the basis of speed of uptake, that is, innovativeness, created five innovation adopter groups:

1. Innovators: They are the first 2.5 percent to accept and use a practice or technology in a social system. Innovators are enthusiastic about experiencing new ideas and want to be the first to try innovations. They are enthusiastic about taking risks, and are favourably disposed to new ideas and enterprising. They are pioneers who set the trend and act as gatekeepers that bring innovation into a social system and require little or no appeal before they adopt and use a practice.
2. Early Adopters: These are the succeeding 13.5 percent to embrace a practice or technology in a social system. They are generally opinion leaders who play certain leadership roles and are crucial to speeding up the diffusion process. They have vast interpersonal networks through which their assessment of innovations is spread to members of a social system.
3. Early Majority: The next 34 percent to adopt and use an innovation are called the early majority. Neither the first nor the last to adopt an innovation, they require more time to come to an innovation-decision than innovators and early adopters. They seldom embrace leadership positions, but they take on new ideas before the typical member of a social system. They wait to see results before making a decision.
4. Late Majority: The next 34 percent to adopt and use a practice or technology in a social system are called the late majority. They are defined by their skepticism of change and caution. This group will only accept an practice after it has been tried by the majority and have been adopted by most of their peers. They require more convincing and are sometimes only compelled by economic reasons or peer pressure to adopt a practice.
5. Laggards: The last 16 percent to adopt and use a practice or technology in a social system are considered laggards. Conservative and steeped in tradition, they have the longest innovation decision time. By the time a laggard decides to adopt an innovation, other members may have moved on to newer improved practices.
6. The society: Characteristics of the social environment to which an innovation is introduced may significantly influence that rate of diffusion and adoption. This includes a broad range of factors peculiar to the local environment in relation to the nature of the society, social norms, beliefs, religions, attitudes, and knowledge of the target users and existing structures.

While the theory has remained relevant in explaining adoption and use decisions over the last six decades, it has been criticized for not considering the possibility that members of a social system may reject an improved technology even if they completely comprehend it. Botha and Atkins (2005) argued that the theory does not adequately consider the changes to an innovation’s characteristics over time. The theory as also being disparaged for its failure to consider the fact that diffusion and adoption may fail because it was a bad idea to begin with.

# 2.17.4 Theory of Perception

Perception enables people to attain true beliefs about their situation and environment, and it involves the use of the senses (Coats, 1998). Gibson’s Theory of Perception (1950) holds that exposures to the structures and abilities in the external environment are the building blocks of cognition. At the centre of this theory is how the volume of information and knowledge extracted and processed form the basis of human perception.

The concept of perception holds that although the social system consists of many individuals receiving similar stimuli and impressions through the ears and eyes, and to a lesser degree through the senses of smell, taste and touch, these individuals interpret the received stimuli differently. Ibeh (2001) viewed perception as utilizing sensory information in the identification, recognition and judgment of objects and events in the environment.

Thus, rather than been absolute, perceptions are relative and vary between individuals and cultures. Ajayi (2013) describes perception as occuring when stimuli is acknowledged from surroundings and transmuted into mental consciousness. They further assert that an individual receives a great assortment of stimuli from the environment but only responds to a selection of these stimuli, which largely depends on psychological and physical factors, and arranged in a manner that seem right to the individual. Cognition and experiences have a marked influence on individual perception. It is a product of experiences in the past, present and future which incorporates needs, motives and expectations. Also, personality factors such as degree of open or close mindedness, tolerance for ambiguity, authoritarianism and the individual mental processes may affect perception as well as values, needs and expectations. In like manner, perception informs behaviour to a large extent. Some scholars hold the view that a latent function of perception is that it influences our behaviour unintentionally and unknowingly (Ghimire, 2010).

In this study, the term perception describes the beliefs, expectations and motives of cowpea farmers as it concerns the use of different pest control methods in cowpea production and storage. It is an important subject of investigation because changes in behaviour towards agricultural technologies or innovations must be accompanied or preceded by changes in the end users’ perceptions (Leeuwis, 2013). Social, cultural and personality factors determine perception and affect the use of agricultural innovations along with needs, expectations, values and beliefs. This implies that the manner in which cowpea farmers will perceive the effect of different pest control methods will be based on their past experiences, needs and beliefs.

# 2.18 Related Gaps in Literature

Without a comprehensive understanding of the farmers’ beliefs and perceptions about a phenomenon, it is difficult to provide farmers with the much needed assistance to improve their ventures. An enhanced grasp of farmers’ beliefs and perceptions is required prior to making agricultural policies. Examining farmers’ beliefs and perceptions could make available both a new focal point and potential for farmer education programmess and policy developments that do not currently exist. Most studies in the discipline have focused on farmers’ pesticide use practices only (Williamson *et al.,* 2008; Ackerson and Awuah, 2010; Fianko, Donkor, Lowor & Yeboah, 2011), consequence of pesticide usage on farmers’ health and farming milieu (Ogah, 2012; Marquis, 2013; Crowdhary *et al.,* 2014 and Mahmood *et al.*, (2016) and their practices (Bagheri *et al*, 2007 and Marquis 2013). Ntow, Gijzen, Kelderman & Drechsel (2006) asserted that farmers’ perceptions on the subject matter have not been adequately investigated. The level of use of indigenous and alternative pest control methods have not been adequately studied as well.

Much of the studies highlighted above, good as they are, are not comprehensive enough to be used as planning inputs nor can they serve as a benchmark-baseline without the considerations of farmers’ perceptions. This investigation therefore aimed to investigate level of utilization in addition to perception of different pest control methods among cowpea farmers. It also evaluated source of information on pest control, a crucial aspect of the phenomenon among farmers.

# 2.19 Conceptual framework

This is a figurative manifestation of relationships used in explaining the connection between a set of variables. According to Asika (2003), the interrelationships between variables can be represented mathematically or schematically. For this study, it consists of a trifecta of segments; independent, dependent and intervening variables. The aim of this investigation was to identify the determinants of utilization of indigenous, conventional and alternative insect pest control methods among cowpea farmers in North Central Nigeria.

Within the context of this study and as shown in the composite conjectural illustration, the independent variables are the respondent’s age, size of household, years of experience, educational profile and contact with extension. It is assumed that socio-economic characteristics can exert an influence on farmers’ preferences, perceptions and practices in pest control. The use of insect pest control methods among cowpea farmers embodies the dependent variable.

Certain intervening variables interact with and operate in the existing boundary between the aforementioned variables and at the same time exert weight on pest control practices of cowpea farmers. These include the availability or lack thereof of a pesticide policy in the country. Government enforcement of regulations and sanctions may also influence the practices of farmers. Nevertheless, these intervening factors were not examined in this research.

**Antecedents**  **Independent variables Dependent variables**

Use of insect pest control methods

Intensity of use

**Socioeconomic characteristics (**Age**,** size of household, education in years**,** farming experience in years, contact with extension

Knowledge level on pest control methods

Preference of pest control methods

Information sources on pest control

Abuse of synthetic pesticides

Low awareness of alternatives

Non-adoption of alternative methods

Cowpea infestation

Poisoning

Environmental degradation

**Outcomes**

Government pest control policy

Adoption of alternative methods including IPM

Promotion of low pesticide use practice

Acceptance of cowpea

Improved wellbeing

**Intervening variables**

Government policy

Agricultural Development Project

Legal enforcement

Regulations and sanctions

**Figure 3: Conceptual framework**

**Source: Author’s construct (2021)**

# CHAPTER THREE

# METHODOLOGY

**3.1 Introduction**

This subdivision details particulars of procedures utilized in the process of data collection as well as the methodology used in the research. It further provides a thorough explanation of data collection tool, measurement of variables, reliability and validity of research instrument, in addition to different paradigms applied to analysis of data.

# 3.2 Study Area

The investigation was conducted in North Central Nigeria consisting of six states (Kogi, Kwara, Benue, Nasarawa, Niger, and Plateau) and the FCT. The zone is sometimes denoted to as the Middle Belt. Specifically, it was conducted in Kwara and Niger States. Both states are renowned for high production of cowpea (Bolarinwa, Ogunkanmi & Ogundipe, 2021).

# 3.2.1 Kwara State

It is located between Latitude 80 05’ and 100 05’ North and Longitude 20 50’ and 60 05’ East of Greenwich Meridian. Created in May 1967, it is one of thirty-six (36) states in Nigeria and currently comprises 16 Local Government Areas viz. Ilorin South, Oyun, Isin, Asa, Kaiaima, Baruten, Patigi, Ifelodun, Ilorin East, Edu, Ilorin West, Moro, Ekiti, Offa, Oke-Ero and Irepodun. These are further stratified into four distinct agricultural districts by Kwara State Agricultural Development Project (KWADP) along administrative convenience, bio-environmental features, and sociocultural attributes. Zone A (Baruten and Kaiama) with headquarters at Kaiama; Zone B (Moro, Edu and Patigi) with headquarters at Patigi, Zone C (Ilorin East, Ilorin South, Asa, and Ilorin West) with headquarters at Shao and Zone D (Ifelodun, Oke-Ero, Oyun, Ekiti, Isin, Irepodun and Offa) with headquarters at Igbaja. Agriculture remains the foremost foundation of the state’s economy with an annual rainfall range of 1000-1500mm. Typically, the wet season commences in March and terminates early September; the dry period begins in October and ends in February. The temperature is consistently high ranging between 25oC to 30oC. The great vastness of wooded savanna in the state in addition to the climate is favourable to the cultivation of crops such as cassava, rice, yam, cowpea, tomatoes, and maize. Major cash commodities churned out from the state are cotton, cocoa, kolanut, tobacco, coffee and sesame(Federal Government of Nigeria, [FGN] 2017). Rearing of animals is also common; goats, sheep and cattle are raised for milk, meat, hide and skin and for other commercial purposes.

Kwara state is within the tropical climate and covers 35,705 square kilometres (km2) (National Bureau of Statistics, 2012). National Population Commission estimates the population to be 2,371,089; 1,220,581 males and 1,150,508 females (FGN, 2007). It has mutual interior boundaries with Niger Kogi Oyo, Ekiti,and Osun States. It shares an external border with the Republic of Benin. Plains, valleys and undulating hills constitute the major landforms in the state.

The territorial entity now known as Kwara State came into existence as one of the twelve states fashioned in Nigeria on May 27th 1967. The state got its name from the local name of the River Niger, which is its boundary in the north and east precincts, and its capital is Ilorin. Predominant ethnic clusters are Nupe, Yoruba, and Baruba with significant Fulani minority (Kwara State Government, 2016).

There are quite a number of educational institutions in the area. While there are a lot of primary and secondary institutions, the tertiary institutions, both private and public, also abound in their numbers. The six universities are located in Ilorin (University of Ilorin & Al-Hikmah University), Malete (Kwara State University), Omu-Aran (Landmark University), Offa (Summit University) and EiyeN’Korin (Crown-Hill University). The polytechnics are in Ilorin (Kwara State Polytechnic) and Offa (Federal Polytechnic). Others include but not limited to an International Aviation College in Ilorin, State Colleges of Education in Ilorin, Oro and Lafiagi (Technical) and nursing schools in Ilorin and Oke-Ode respectively.

# 3.2.2 Niger State

It is to be found between Latitudes 8020’ N and 11030’ N and Longitudes 3030’ E and 7020’ E. Created in February 1976, it is currently made up of 25 Local Government Areas namely Mokwa, Rafi, Bida, Lapai, Agaie, Rijau, Agwara, , Edati, Munya, Bosso, Shiroro, Gbako, Magama, Lavun, Gurara, Katcha, Mariga, Kontagora, Paikoro, Tafa, Borgu, Suleja, Mashegu, Chanchaga and Wushishi. These are clustered into three agricultural zones by the Niger State Agricultural Development Project (NSADP) in lieu of operational administration and supervision. These are firstly, Niger South known as Zone I headquartered at Bida; then Niger Central cited as Zone II with head office at Kuta, as well as Niger East delineated as Zone III with control center at Kontagora. A predominantly agrarian state, its rainfall on an annual basis ranges between 1100mm – 1600mm while normal temperature ranges between 230C to 370C in a month. The rains start in April, peaks in July then terminates in October (rainy season) while the dry period runs from November through March. The prominent arable crops cultivated are sugarcane, maize, cowpea, cassava, guinea corn, yam, millet, rice, cocoyam and groundnut. Rearing of livestock is not uncommon and often includes donkey, goat, chicken, sheep, and cattle. (FGN, 2017).

Among the states in the Federation, it is the second largest behind Borno covering 68,925 square kilometres (km2) representing 9.3% of Nigeria’s land. National Population Commission sets the population of the state at 3,954,772; 2,004,350 men and 1,950,422 women (FGN, 2007). The State is endowed with abundant, large, perennial natural water bodies which include Rivers Niger, Kaduna and Gurara and three giant man–made lakes supporting hydroelectric power stations–Kainji, Jebba and Shiroro. Water bodies make up about 25% of the State. Some mineral deposits include gold, kaolin, talc, marble, lead, graphite, feldspar, mica, dolomite, manganese, copper, quartzite and granite

The capital is in Minna and the State has a border with Zamfara, Kebbi, Kogi and Kaduna States in addition to the Federal Capital Territory (FCT). There is also a mutual external frontier with the Republic of Benin in Agwara and Borgu. The predominant ethnic groups are the Nupes, Gwaris and Hausas.

Educational institutions in the State include Universities in Minna (Federal University of Technology) and Lapai (Ibrahim Babangida University). There are polytechnics in Bida (Federal Polytechnic), Zungeru (Niger State Polytechnic) and Suleja (St. Mary Polytechnic). Others are a federal college of education located in Kontagora; a federal college of wildlife management sited in New Bussa, a federal college of freshwater fisheries technology situated New Bussa, two state colleges of education (Minna) and agriculture (New Bussa); four government technical colleges in Bussa, Kontagora, Minna and Bida, and colleges of health science and technology, nursing, and midwifery located in Minna, Bida and Minna respectively.

# 3.3 Population of the study

The population of this study encompassed all cowpea farmers who engage in production of cowpea in Kwara and Niger States.

# 3.4 Sampling Technique and Sample Size

Obtaining information from the entire population in an empirical investigation is often impracticable. Consequently, inferences are drawn from data obtained from a sample of the whole population. This investigation employed a multi-stage sampling technique to select respondents. At the first stage, there was the purposive selection of Zone B and C ADP zones in Kwara State and Zone I ADP zone in Niger State. Purposive sampling method enables the identification of particular objects for focused inquiry. Selection of zones was premised on preponderance of cowpea production activities in the area. The state of insecurity with the high level of kidnappings and banditry in Niger State (Duerksen, 2021) in Zones II & III is the key consideration for the choice of one zone in the state. Abdullahi & Tsowa (2014) reported a high concentration of cowpea farmers in Lavun, Edati and Mokwa Local Government Areas of Niger State ADP Zone I. Also, Ayinde & Ayinde (2006) and Abdullahi (2016) asserted that Kwara State ADP Zone B and C respectively are more involved in cowpea production than the other zones.

At the second stage, a purposive selection of two LGAs each in selected agricultural zones across both Kwara and Niger States namely Patigi and Edu (Zone B; Kwara State) Asa and Ilorin East (Zone C; Kwara State) and Edati and Mokwa (Niger South) to ensure that the entire population across the ADP zones in the state was represented in the drawn sample was carried out. In Kwara State, Zone B and Zone C have five (5) and six (6) blocks respectively (Ayinde, Adewumi & Omotesho, 2008) while in Niger State, Zone I has 8 extension blocks (Okolo and Osifo, 2017). The selected local governments in Kwara State cut across six ADP blocks (Lade, Lafiaji, Shonga, Paiye, Oloru and Bode Saadu) and two blocks (Mokwa and Edati) in Niger State. Thereafter four cells were randomly selected from each of the eight blocks; this gave a total of thirty-two cells.

Lastly, proportionate sampling of 384 respondents from the thirty-two cells in the two states. Thus, 384 cowpea farmers were selected and interviewed with the aid of the local extension staff from the listing frame of the States Agricultural Development Projects respectively. The three ADP zones (Pategi, Shao and Bida) across the two states have 47,015; 48,915 and 65,618 farmers respectively (Ayinde, Adewumi & Omotesho, 2008).

# 3.5 Sampling Procedure

**Table 1: Sampling Procedure**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **State** | **ADP Zones** | **Blocks** | **LGAs** | **Cells** | **Cowpea Farmers** | **Respondents** |
| Kwara | Patigi (B) | 3 | Patigi |  | 47,015 | 112 |
| Edu | 12 |
| Shao (C) | 3 | Asa |  | 48, 915 | 117 |
| Ilorin East | 12 |
| Niger | Bida (1) | 2 | Mokwa | 8 | 65,618 | 155 |
| Edati |  |
|  |  | 8 **blocks** | **6 LGAs** |  | **161,548** | **384** |

# 3.6 Method of Data Collection

This investigation utilized both primary and secondary data. The former were collected by the researcher with assistance from trained enumerators under researcher’s supervision through interviews using a interview schedule. It was used because of its ease of administration, scoring, and analyzing of the instrument. The secondary sources of data include research publications, journals, and related technical reports.

# 3.7 Data Collection Tool

Data used in this investigation was gotten with the aid of a well-thought-out interview schedule. The research tool had seven subdivisions with every single one paying attention to specific objectives. Section one focused on capturing personal characteristics data. Section two of the tool elicited data on availability and usage of different pest control methods. Section three examined preferences in pest control methods; section four investigated factors that influence farmers’ pest control decisions; the fifth section elicited data on information sources among cowpea farmers. Section six focused on collecting information on perception. Lastly, the seventh section attempted to bring to light farmers’ knowledge of pest control methods while the eighth section identified the constraints limiting choice of pest control methods.

**3.8 Measurement of Variables**

**Section A:** Socioeconomic characteristics questions

1. Age: This refers to chronological age of cowpea farmer. It influences a person’s perception, knowledge and practice; a primary assumption is that age determines his/her experience or resources. It was measured as actual number of years given by the respondent as at the time of data collection.
2. Gender: measured as male and or female.
3. Household size: Measured as number of individuals in respondent’s household sharing primary utilities including food when data collection was carried out.
4. Years of education: respondents were to indicate numbers of years of formal education received. This, as a variable is likely to increase ones access and opportunities to diverse knowledge.
5. Farm Size: Cowpea farmers were to specify size of farm (hectares).
6. Contact with Extension Agents: The more numbers of visits of extension agent to the respondent the more knowledge they are assumed to have. It was measured by the total number of times a cowpea farmer had visits from extension agents.
7. Annual Income (in Naira): cowpea farmers were to specify earnings.
8. Cowpea production experience: cowpea farmers were to specify the time (in years) they had been in cowpea production.
9. Group Membership: cowpea farmers were to specify number of farmers’ associations they belonged to.
10. Land ownership: cowpea farmers were to specify the form of land ownership held.
11. Cowpea varieties grown: Respondents were to specify cowpea varieties cultivated.

**Section B** – Use of Pest Control Methods: Operationalized as the dependent variable, cowpea farmers were to indicate awareness and availability of methods as either Yes or No. Using a 3-point Likert-type scale of Rarely, Often, Always; the intensity of usage was evaluated. A mean score of 2 was used to classify the commonly utilized pest control methods among cowpea farmers.

**Section C -**Farmers’ considerations in pest control decisions: cowpea farmers were to specify considerations before selecting pest control methods utilized as Yes or No. The considerations were then assessed via a 3-point Likert-type scale of Not Important, Important, Very Important. A ranking of actual mean score was adopted to ascertain the most important considerations in the selection of pest control methods among respondents.

**Section D** - Sources of Information: cowpea farmers were to specify information sources on pest control methods. As either Yes or No, the regularity of usage was appraised on a 3-point Likert-type scale comprising Rarely utilized, Occasionally utilized and Frequently utilized. A mean score was established to pinpoint habitually used sources among cowpea farmers. .

**Section E**– Pest Control Perception: Cowpea farmers’ view of pest control was measured taking into consideration their perceptions of the three different pest control methods operationalized in this study as indigenous, conventional and alternative as. Perception statements on pest control as a notion, indigenous control methods, conventional control methods and alternative control methods totalling 42 perception statements were offered to cowpea farmers and were evaluated on a 4-point Likert-type scale of strongly disagree, disagree, agree, and strongly agree.

**Section F** - Knowledge Level of cowpea farmers on pest control methods: The cowpea farmers' knowledge level on pest control methods was measured using 21 knowledge statements on pest control methods viz. indigenous, conventional and alternative. By means of a 2 point scale of true or false, respondents then indicated true or false.

**Section G**– Constraints limiting choice of pest control methods: Sixteen constraints (evaluated as Yes or No) were offered to cowpea farmers who had tp specify if they constituted constraints limiting choice of pest control methods. Those acknowledged as constraints limiting choice were further evaluated on a 4-point Likert-type scale comprising Little Severe, Somewhat Severe, Severe and Very severe.

**3.9 Validation of Instrument**

Validity is of significant value in the research scheme as it aims to ascertain whether the instrument meets the purpose for which it was designed. Validity also tests whether the items on the instrument were prepared in line with objectives of research. Researcher’s supervisory committee and experts in agricultural extension, rural development, rural sociology as well as crop protection and other related fields scrutinized the instrument for validity by face and content validation. It was carried out to improve the construction and appropriateness of the question items. Their input, remarks and suggestions were integrated into the instrument of data collection to improve its adequacy and quality.

# 3.10 Pilot Testing

Ten percent of total sample with similar characteristics is deemed suitable for pilot testing. This provides guidance in decision making between alternative methods of collecting data, translation of questions and wording of the questions on the instrument to prevent vagueness. A pilot study with forty smallholder farmers, with roughly similar characteristics to the final respondents in terms of the socio-economic qualities and climate, was carried out to pre-test the questionnaire, gauge respondents’ response time and thus refine the questionnaire in terms of ordering of questions and skip patterns. It assisted the researcher in capturing the important elements and suggestions from respondents thereby enabling an improvement in efficiency of research tool. In the last part, needed amendments were completed; confusing questions corrected to specific with unrelated questions discarded.

# 3.11 Reliability

This defines the degree to which findings made with a particular research instrument are consistent. The reliability of the data collection instrument was conducted with a sample of forty smallholder farmers using the test-retest method. This method was adopted because interval scale is mostly employed in the design of the data instrument. It is on record that the test-retest method is limited in that it may sometimes overestimate or underestimate the true reliability of the instrument as respondents may remember their responses during the test in the re-test. In order to combat this constraint, an interval of four weeks was allowed between the test and the re-test. Scores were assigned to the responses of the respondents before and after two weeks. In obtaining 0.75 as coefficient of reliability, the tool was considered consistent.

# 3.12 Techniques of Data Analysis

Analysis of data comprised the use of inferential statistics (regression and analysis of variance) and descriptive statistics (ranks, means, percentages and frequency counts). Hypothesis one was analyzed using Probit regression, Ordinary least square models was used for hypothesis two while ANOVA and Chi-Square were used for hypothesis three and four respectively. Reliability was ascertained using Pearson Product Moment Correlation Coefficient. The analytical tools for hypothesis testing, including Probit Regression, Principal Component Analysis, Analysis of Variance, Ordinary least square, as well as Chi-Square are specified below.

# 3.12.1 Principal Component Analysis

Principal Component Analysis (PCA) is a tool used to reduce large data sets which increases interpretability of data. It extracted the main components of factors considered by cowpea farmers in insect pest control decision in cowpea production. Respondents' response were categorized on a 3-point Likert scale of not important (0), important (1), very important (2). The model is stated as:

xj's is the *m* variables from ith member.

PC = Principal components

N = factor items used

# 3.12.2 Probit Regression Model

The effects of explanatory variables such as farm and farmer attributes on usage of control methods by cowpea farmers in north central Nigeria was assessed using probit regression model (Hypothesis two). The model was employed because it is an excellent method for the estimation of multi-category dependent variables (Khidir, 2020) and the dependent variable is binary in nature. The model is specified as follows:

Where; is the binary dependent variable indicating farmers' use status (Use =1; non-use =0)and are parameters of the estimates

= number of variables

= Error term

= the explanatory/independent variables

# 3.12.3 Ordinary Least Square Regression Model

In order to to evaluate the determinants of intensity of use of insect pest control methods among cowpea farmers (hypothesis three), a use intensity index was generated and fitted as the dependent variable in ordinary least square regression model. The use intensity index was calculated as the number of insect pest control methods adopted by a particular farmer, a percentage of total insect pest control methods. The model is specified explicitly as follows:

+ e

is the generated use intensity index

= explanatory variables

e is the error term.

**Table 2: Independent Variables in Probit and OLS Regression**

|  |  |
| --- | --- |
| **Variables** | **Description** |
| Age | In years (continuous) |
| Gender | Dummy; 1 for male, 0 if otherwise |
| Marital status | Dummy;1 for married, 0 if otherwise |
| Years of schooling | In years (continuous) |
| Household size | Number of persons (continuous) |
| Farm size | In hectares (continuous) |
| Experience in cowpea cultivation | In years (continuous) |
| Extension contact | Dummy; 1 for Yes, 0 if otherwise |
| Annual Income | In Naira (continuous) |
| Land ownership | Dummy; 1 for owned, 0 if otherwise |
| Cowpea varieties grown | Dummy; 1 for local, 0 if otherwise |
| Membership of farmers group | Dummy;1 for Yes, 0 if otherwise |
| Knowledge level | 1 high; 0 if not |
| Perception | 1 for positive, 0 if not |
| Information sources | 1 for utilized, 0 if not utilized |
| Constraints | Aggregate value (continuous) |

# 3.12.4 Analysis of Variance

The intention to test for significant difference in use of indigenous, conventional and alternative insect pest control methods among cowpea farmers was executed using analysis of variance (ANOVA). As a statistical tool, it is employed inexploring differences among group means as well as differences within groups. In this investigation, it was used to determine if significant differences existed in the means of the different control methods.

# CHAPTER FOUR

# RESULTS AND DISCUSSION OF FINDINGS

# 4.1 Introduction

This section is concerned with presentation and elucidation of data collected for analysis of use of pest control methods in cowpea production and storage in Kwara and Niger States. It is separated into nine sections. Section one describes cowpea farmers’ socioeconomic attributes, the second shows with pest control methods used by cowpea farmers, the third section shows the preferences for pest control methods, the fourth section investigates the factors influencing cowpea farmers’ pest control decisions, the fifth section identifies the cowpea farmers’ sources of information on pest control methods, the sixth section depicts farmers’ perceptions of pest control methods, the seventh section portrays the farmers’ knowledge on pest control methods, the eighth section identifies the constraints limiting choice of pest control methods, while the ninth section dealt with testing research hypotheses of the study.

# 4.2 Socio-Economic Characteristics of Respondents

The study collected data on the socio-economic characteristics of respondents including sex, age, marital status, level of educational, farm size, household size, other occupation, membership of group, income, quantity of cowpea store, farming experience, land ownership, contact with extension agents, and frequency of extension contact, varieties of cowpea grown, cropping system and sources of pesticide.

# 4.2.1 Social Characteristics of Respondents

For this study, variables grouped as social characteristics include age, sex, education profile, marital status, size of household and other occupation. Results are presented in Table 3.

# 4.2.1.1 Sex

The results as presented (Table 3) shows that majority (80.2%) of cowpea farmers were male with only a small number (19.8%) being female. This suggests that cowpea cultivation in Kwara and Niger States is male dominated, reflecting the patriarchal nature of many Nigerian societies as well as the typical distribution of male and female involvement in the agricultural sector (Kolawole, Owolabi, Ajala & Onuh, 2017). Men and women make significant contributions to agricultural activities but differ in the tasks they perform. This finding corroborates an assertion that women in Nigerian societies do not execute on-farm tasks requiring heavy labour such as land clearing, tilling and harvesting but are principally involved in postharvest activities (Rahman 2008; Mohammed *et al.*, 2021). In a related study, Allen, Heinrigs & Heo (2018) found that women carry out 75% of postharvest activities in Africa. That majority (80.2%) are male contradicts the findings of Mafimisebi (2008) that most farmers in Africa are women and Nordhagen (2021) that they tend to be over-represented in the sector.

**4.2.1.2 Age**

Results on age of cowpea farmers (Table 3) shows that most cowpea farmers (64.3%) were beween 41 and 60 years with mean age being 48.9 years and indicates that cowpea farmers in Kwara and Niger States are middle aged. Akangbe, Ogunyinka, Ayanda, Achem & Adisa (2012) submitted that the age of the farmer is expected to affect output, productivity and adoption of innovations in farming. This finding therefore implies that farmers are likely to be agile and capable of performing more than a few tasks involved in cowpea cultivation and storage thereby contributing greatly to the production of cowpea in the states under study and Nigeria as a whole. However, going by the definition of who a youth is by the National Policy on Youth Development (Federal Ministry of Health, 2009), this finding implies that there is low participation of youths in cowpea production in the study area.

# 4.2.1.3 Marital Status

Table 3 also shows that most cowpea farmers were married (85.4%). A mere 5.7% were single, 2.9% were divorced and 2.1% had separated from their spouses. In traditional farming systems, being married is an indication of availability of a partner(s) that could help in performing gender related tasks, that is, while male spouses undertake tedious tasks like land clearing, their female counterparts may manage harvesting, processing, and storage. This is a form of partnership that is expected to enhance the production of cowpea in north central Nigeria. This finding corresponds with Omolehin *et al.,* (2007) who submitted that farmers with spouses were mindful of getting improved harvests in order to fulfil family sustenance obligations. The need to produce marketable surplus for family needs is high among married farmers, that is, agricultural ventures are all the more important for married folks as it represents an income channel to meet up with the financial responsibilities associated with having a family (Ajala, Kolawole, Owolabi & Faseyi, 2017).

# 4.2.1.4 Education

As shown in Table 3, 31.5% of cowpea farmers received no formal education, 27.1% only had primary education, 19.0% obtained secondary education, and 22.4% acquired tertiary education. It may well be deduced that most cowpea farmers received some form of formal education ranging from primary to tertiary education. The level of education exerts an influence on implementation strategies employed for agricultural development initiatives (Komolafe, Akangbe, Ajibola & Dairo, 2015) and according to Oladeebo and Masuku (2013) education may directly improve farm productivity by enhancing the quality of labour and the tendency to effectively adopt innovations. It also elevates the ability of farmers to adjust to disequilibria and its effects on their operations. This finding suggests that these farmers may be able to read simple instructions to appropriately use improved technologies and practices relating to cowpea production that may be introduced to them. Less literate farmers’ groups may require greater extension efforts before adoption or utilization of innovations can occur.

# 4.2.1.5 Household Size

On population of people in their households, 33.9% had 1 to 5 persons, 58.6% had 6 to 10 persons, while 7.6% had 11 person and above. The average number of persons in their households was approximately 7 persons (Table 3). Seven persons as members in a household is relatively high considering the present economic reality in Nigeria since large household size means an increase in household needs and demands (Abulude and Kolawole, 2020). Conversely, large household sizes are central to the operations of smallholders in rural areas since it guarantees economical admittance to manual labour suitable in field operations. This may translate to high responsibility that is expected to favourably trigger higher commitment to cowpea production among cowpea farmers. Table 3 also shows 57.1% primarily engaged in agriculture-related off-farm activities, 15.9% were into trading of other commodities, 19.8% were also civil servants, and 7.3% were also artisans.

**Table 3: Distribution of respondents by their social features**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Frequency (n=384)** | **Percentage** | **Mean (Std Dev.)** |
| **Sex** |  |  |  |
| Male | 308 | 80.2 |  |
| Female | 76 | 19.8 |  |
|  |  |  |  |
| **Age (years)** |  |  | 48.9 (10.71) |
| 21 – 40 | 89 | 23.2 |  |
| 41 – 60 | 247 | 64.3 |  |
| 61 and above | 48 | 12.5 |  |
| Min.= 21 |  |  |  |
| Max.= 80 |  |  |  |
|  |  |  |  |
| **Marital Status** |  |  |  |
| Single | 22 | 5.7 |  |
| Married | 328 | 85.4 |  |
| Divorced | 11 | 2.9 |  |
| Separated | 8 | 2.1 |  |
|  |  |  |  |
| **Level of Education** |  |  |  |
| 0 year (No formal education) | 121 | 31.5 |  |
| 1-6years (Primary education) | 104 | 27.1 |  |
| 7-12years (Secondary education) | 73 | 19.0 |  |
| Above 12years (Tertiary education) | 86 | 22.4 |  |
|  |  |  |  |
| **Household size (persons)** |  |  | 6.7 (2.61) |
| 1 – 5 | 130 | 33.9 |  |
| 6 – 10 | 225 | 58.6 |  |
| 11 and above | 29 | 7.6 |  |
| Min.= 2 |  |  |  |
| Max.= 15 |  |  |  |
|  |  |  |  |
| **Other Occupation** |  |  |  |
| Agriculture-based off-farm | 219 | 57.1 |  |
| Trading of other commodities | 61 | 15.9 |  |
| Civil Servant | 76 | 19.8 |  |
| Artisan | 28 | 7.3 |  |

*Source: Field Survey, 2021*

# 4.2.2 Economic Characteristics of Respondents

Variables grouped as economic characteristics include farm size, quantity of cowpea stored, and income earned from cowpea production. Results are presented in Table 4.

# 4.2.2.1 Farm Size and Quantity Stored

Majority (81.8%) of respondents cultivated cowpea farm size between 1.0 and 5.0 hectares of land as shown in Table 4. Others cultivated less than 1 hectare (2.6%); between 6.0 and 10.0 hectares (11.7%) and above 10.1 hectares (3.9%). The average land area cultivated by the respondents was 3.6 hectares; cowpea farmers in Kwara and Niger States are therefore small scale farmers. The average cowpea farm size in this study is thrice of that reported in southern Nigeria (Saka *et al.,* 2018). With respect to cowpea quantities harvested and stored by cowpea farmers, 36.7% stored less than 1 ton, 54.4% stored between 1 to 10 tons, 6.5% stored between 11 to 20 tons while 2.3% stored above 20 tons. The average quantity of cowpea stored was 4.1tons in the last farming season.

# 4.2.2.2 Income

Respondents earned between N20,000 (lowest) to N3,500,000 (highest) with average annual income of N570,203.1±579,407.95. The estimated average daily income was N1,583.89. This is equivalent to $3.81 per day considering CBN exchange rate as at the time of the analysis (February, 2022). This is higher than the World Bank International poverty line of US$1.9 a day reported for Sub-Saharan African countries; this implies that cowpea farmers in Kwara and Niger States are not in extreme poverty. This shows that cowpea production as a business is can bring farmers out of poverty if government efforts are intensified to empower cowpea farmers on use of improved technologies. This study therefore supports the view that cowpea possesses the potential to aid resource-poor farmers ascent out of insufficiency (Manda *et al*.*,* 2019).

**Table 4: Distribution of respondents by economic characteristics**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Frequency** | **Percentage** | **Mean (Std Dev.)** |
| **Cowpea Farm size (Hectares)** |  |  | 3.6 (2.59) |
| Less than 1.0 | 10 | 2.6 |  |
| 1.0 – 5.0 | 314 | 81.8 |  |
| 6.0 – 10.0 | 45 | 11.7 |  |
| 10.1 and above | 15 | 3.9 |  |
| Min.= 0.5; Max.= 13.0 |  |  |  |
|  |  |  |  |
| **Quantity Stored (Tons)** |  |  | 4.1 (11.66) |
| Less than 1 | 141 | 36.7 |  |
| 1 – 10 | 209 | 54.4 |  |
| 11 – 20 | 25 | 6.5 |  |
| Above 20 | 9 | 2.3 |  |
| Min.= 0.04; Max.= 120 |  |  |  |
|  |  |  |  |
| **Annual Income (Naira)** |  |  | 570,203.1 (579,407.95) |
| ≤ 200,000 | 107 | 27.9 |  |
| 201,000 - 400,000 | 94 | 24.5 |  |
| 401,000 – 600,000 | 71 | 18.5 |  |
| 601,000 – 1,000,000 | 61 | 15.9 |  |
| Above 1,000,000 | 51 | 13.3 |  |
| Min.= 20,000; Max.= 3,500,000 |  |  |  |

*Source: Field Survey, 2021*

# 4.2.3 Experience, Land Ownership and Type of Cowpea Variety Grown

This sub-section covers years of experience, land ownership and types of cowpea variety grown by respondents. Results are presented in Table 5.

# 4.2.3.1 Experience

The years of respondents’ experience in cowpea farming ranges from 3 to 41 years with average of 18.1±9.58years are as shown in Table 5. This suggests that respondents take to agriculture relatively early in life. Eighteen years of experience is considered long years through which the cowpea farmers must have gained a lot of knowledge on pest control methods. Afolami, Obayelu, & Vaughan, (2015) maintain that farming experience exerts a substantial stimulus on acceptance and application of innovations by rural households.

# 4.2.3.2 Land ownership

Most of the respondents (59.4%) inherited farmland used for cowpea farming and 16.9% acquired land through communal land. This implies that land acquisition by inheritance is the main means of acquiring land for cowpea production in Kwara and Niger States. Accessibility to arable farmland influences farmers’ involvement in secondary occupations (Odoh and Nwibo, 2016). This mode of land acquisition is expected to reduce cowpea production cost as farmers may need not to spend on land acquisition and free up some funds for other secondary ventures.

# 4.2.3.3 Type of Cowpea Variety Grown

Findings (Table 5) showed that varieties mostly cultivated by respondents include SAMPEA-7 (8.1%), SAMPEA-8 (6.5%), SAMPEA-9 (10.4%), SAMPEA-10 (4.9%) and only 28.7% cultivated local variety. This implies that improved varieties were the commonly grown cowpea varieties among farmers in Kwara and Niger States. Improvements in genetic characteristics are employed in tackling diseases in cowpea (Omoigui *et al.,* 2019). Aggregated percentage cultivation of improved varieties of cowpea farmers is higher than 36–38% reported in previous studies (Manda *et al*.*,* 2020) and 30.5% in Niger (Baoua, Rab´e, Murdock & Baributsa, 2021). The cultivation of local varieties among respondents can be ascribed to poor seed reproduction rates, inadequate cognizance of improved varieties, low diffusion of better-quality assortments, and inadequate dissemination conduits towards guaranteeing availability among rural dwellers (Ojiewo, Omoigui, Pasupuleti & Lenn´e, 2020). Furthermore, studies attribute the reasonably poor adoption of enhanced cowpea among farmers to lack of desired qualities in colour and seed size (Mohammed *et al*.*,* 2019; Manda *et al*.*,* 2020).

# 4.2.3.4 Cropping System

A little over half (54.7%) of respondents practiced sole cropping while 45.3% carried out mixed cropping as shown in Table 5. Thus, the adoption of sole cropping system is slightly higher than mixed cropping. The sole cropping of cowpea is projected to provide high yield. A related study carried out in southern Nigeria with high rainfall reported about 42.5% sole cowpea fields (Saka et al., 2018). However, appreciable percentage (45.3%) of respondents still practice mixed cropping. The neglect of sole cropping system among these farmers may be attributable to its unsuitability with current practices, since most smallholders desire multiple benefits from their investment with the primary focus being generating adequate food (Snapp, Rahmanian & Batello, 2018).

Similar findings point to its attractiveness as an intercrop which is ascribable to the resulting adavantages and great pest control costs accompanying sole cowpea fields (Mawo, Mohammed & Garko, 2016). Others have shown that smallholder farmers observe mixed cropping to alleviate other unforeseen risks (Singh, Jaglan & Verma, 2018). The use of strip intercropping with soil enrichers and upgraded varieties considerably amplify harvests by more than three times (Saidou, Ajeigbe & Singh, 2011).

**Table 5: Distribution of respondents by experience, land ownership and type of cowpea variety grown**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Frequency** | **Percentage** | **Mean (Std Dev.)** |
| **Experience in Cowpea Farming (years)** |  |  | 18.1 (9.58) |
|  |  |  |  |
| 1 – 10 | 106 | 27.6 |  |
| 11 – 20 | 153 | 39.8 |  |
| 21 – 30 | 73 | 19.0 |  |
| Above 30 | 52 | 13.5 |  |
| Min.= 3; Max.= 41 |  |  |  |
|  |  |  |  |
| **Land Ownership for Cowpea Farming** |  |  |  |
| Inherited | 228 | 59.4 |  |
| Purchase | 16 | 4.2 |  |
| Lease | 31 | 8.1 |  |
| Gift | 40 | 10.4 |  |
| Lease at the will of government | 4 | 1.0 |  |
| Communal | 65 | 16.9 |  |
|  |  |  |  |
| **Type of Cowpea Variety grown** |  |  |  |
| SAMPEA-7 | 31 | 8.1 |  |
| SAMPEA-8 | 25 | 6.5 |  |
| SAMPEA-9 | 40 | 10.4 |  |
| SAMPEA-10 | 19 | 4.9 |  |
| Brown | 56 | 14.5 |  |
| Ife Brown | 21 | 5.5 |  |
| Drum | 6 | 1.6 |  |
| Kwankwaso | 16 | 4.2 |  |
| Local | 110 | 28.7 |  |
|  |  |  |  |
| **Cropping System** |  |  |  |
| Sole cropping | 210 | 54.7 |  |
| Mixed cropping | 174 | 45.3 |  |

*Source: Field Survey, 2021*

# 4.2.4 Respondents’ Access to Social Contact

This subsection covers contact with extension staff, frequency of extension visits, sources of pesticides, group membership and types of group. Findings are presented in Table 6.

# 4.2.4.1 Contact with Extension Agents

Majority (89.3%) had contact with extension agents. The frequency of extension contacts mostly signified by the respondents was on monthly (35.2%) and quarterly (34.1%) basis. This demonstrates reasonably high contact between cowpea farmers and extension agents in Kwara and Niger States. It may be inferred that these farmers are likely to be knowledgeable of improved insect pest control practices. Public extension systems are the most common source of information for smallholder farmers in Nigeria and limited support from the system is an hindrance to agricultural development (Olayemi, Omodara, Owojaiye & Pessu, 2021). Previous studies (Huber, Davis & Lion, 2017; Davis, Lion & Arokoyo, 2019) have reported low contact with extension agents. In this case however, it is noteworthy that both states have input subsidy programmes for farmers in place and this may be responsible for the relatively high contact with extension agents. The contact is not always initiated by the agents but also by the farmers who require information and update on the status of the input subsidy for fertilizers, pesticides and improved seeds. Tsinigo and Behrman (2017) asserted that number of contact with extension was a most vital predictor of resolution to accept innovative practices. Consequently, upping extension visits would help smallholders obtain required information about a practice and expose them to its use. Ullah and Khan (2019) concluded in a study that a reduction in contact between farmers and extension staff decreases knowledge level of farmers on different pest control methods.

# 4.2.4.2 Group Membership

Majority (99.2%) of the respondents belonged to a group. Less than half (45.1%) of cowpea farmers belonged to farmers’ association with All Farmers Association of Nigeria (AFAN) being the most prominent. Membership farmers’ group/association is known to provide opportunities for accessing information and knowledge, credit, input and technologies such as improved pest control practices needed for enhanced production activities. Similarly, farmer groups are seem as important in linking farmers to markets, increasing adoption of agricultural innovations and enhancing commercialization (Only about one-fifth (21.4%) belonged to a cooperative society. This may suggest the availability of less formal sources of finance in the study area.

# 4.2.4.3 Source of Pesticides

Cowpea farmers further indicated agro-dealers (75.3%) as leading sources of synthetic pesticides used. This suggests that the input-subsidy programme by the state governments may not meet all the pest control needs of the beneficiaries. Further, agro-dealers as a source of pesticide represent an unregulated and unprofessional source with implications for farmers’ in pest control behaviour. It creates a huge risk of non-adherence to instructions in the use of pesticides (Uduji, Okolo-Obasi & Asongu, 2018). Again, similar to Uduji, Okolo-Obasi & Asongu (2018) only one in five (20.1%) of respondents source the synthetic pesticides they use from the state ADPs.

**Table 6: Distribution of respondents by their access to social contact**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Frequency** | **Percentage** |
| **Contact with Extension Agents** |  |  |
| Yes | 341 | 89.3 |
| No | 41 | 10.7 |
|  |  |  |
| **Frequency of contact with Extension Agents** |  |  |
| No contact | 41 | 10.7 |
| Weekly | 6 | 1.6 |
| Fortnightly | 46 | 12.0 |
| Monthly | 135 | 35.2 |
| Quarterly | 131 | 34.1 |
| Annually | 25 | 6.5 |
|  |  |  |
| **Sources of Pesticides** |  |  |
| ADP | 77 | 20.1 |
| Agro-dealers | 289 | 75.3 |
| AFAN | 2 | 0.5 |
| Others | 16 | 4.2 |
|  |  |  |
| **Group Membership** |  |  |
| Yes | 281 | 99.2 |
| No | 3 | 0.8 |
|  |  |  |
| **Group Membership Type** |  |  |
| Cooperative Society | 82 | 21.4 |
| Credit and Thrift | 19 | 4.9 |
| Farmers’ Association | 173 | 45.1 |
| FADAMA Users’ group | 52 | 13.5 |
| Others | 55 | 14.3 |
| None | 3 | 0.8 |

*Source: Field Survey, 2021*

# 4.3 Insect Pest Control Methods Used by Respondents

This section presents the pest control methods used by respondents and delineates awareness, availability, use and intensity of pest control methods.

# 4.3.1 Awareness of Pest Control Methods

Information on awareness of use of indigenous, conventional and alternatives pest control methods were collected in this study since adoption and use of improved technologies and recommendations is contingent on farmers’ awareness (Mendesil, Shumeta, Anderson & Ramert, 2016). Summary of findings is presented in Table 7.

The awareness of indigenous cowpea field pest control specified among majority of the respondents in the study are include planting early maturing crops that can be harvested early (97.7%), intercrop with non-host plants (93.2%), use of early planting date (88.5%), ploughing to expose eggs, larvae, nymphs and adults in the soil (86.2%), handpicking of insect immature stages (80.7%), spray application of ash mixture on foliage (69.8%), removing weed host of pests (68.5%), and application of neem extracts (63.8%). During the storage of cowpea, the indigenous pest control methods indicated by majority of the respondents include sunning at regular intervals (91.7%), use of jerry cans (89.1%), storing unthreshed (87.8%), application of neem extracts (81.0%), admixture with wood ash (80.7%), use of cooking oils (sunflower, cotton seed, groundnut) (57.0%), and admixture with fine sand (57.0%). Comparatively, the aggregate average percentage response to awareness of use of indigenous pest control methods is high for field pest control (74.6%) when compared to store pest control (73.4%). The implication is that awareness of the use of indigenous is higher for field pest control than for store pest control. This is consistent with Alalade, Matanmi, Olaoye, Adegoke & Olaitan (2017) that the bulk of farmers were aware of indigenous pest control methods.

Table 7 also illustrates awareness of conventional pest control methods by respondents. Majority of cowpea farmers were aware of use of synthetic chemicals to control cowpea pests on field (93.0%) and store (93.8%). These findings imply that farmers are more aware of the use of conventional pest control methods to control cowpea pest in store than field pest control in the study area.

Furthermore on awareness of alternative pest control methods, majority of the respondents indicated the awareness of PICS Bag (74.7%), Improved Drying (61.5%), NSPRI Hermetic Steel Drum (59.1%), and Improved Inert Atmosphere Silo (58.1%). Only few indicated the awareness of NSPRIDUST (38.8%), Cold Treatment (49.0%), and ZeroFly® hermetic bag (50.3%).

**Table 7: Distribution by awareness of use of insect pest control methods**

|  |  |  |
| --- | --- | --- |
| **Pest Control Methods** | **Aware** | **Not Aware** |
| **Field Pest Control** | **Freq. (%)** | **Freq. (%)** |
| **Indigenous** |  |  |
| Spray application of ash mixture on foliage | 268 (69.8) | 116(30.2) |
| Intercrop with non-host plants | 358 (93.2) | 26(6.8) |
| Handpicking of insect immature stages | 310 (80.7) | 74(19.3) |
| Ploughing to expose eggs, larvae, nymphs and adults in the soil | 331 (86.2) | 53(13.8) |
| Use of early planting date | 340 (88.5) | 44(11.5) |
| Planting early maturing crops that can be harvested early | 375 (97.7) | 9(2.3) |
| Inorganic compounds: e.g. salt | 188 (49.0) | 196(51.0) |
| Removing weed host of pests | 263 (68.5) | 121(31.5) |
| Application of Neem extracts | 245 (63.8) | 139(36.2) |
| Application of pepper fruit extract | 187 (48.7) | 197(51.3) |
| *Average percentage response* | ***74.6%*** |  |
| **Conventional** |  |  |
| Use of synthetic chemicals | 357(93.0) | 27(7.0) |
|  |  |  |
| **Store Pest Control** |  |  |
| **Indigenous** |  |  |
| Admixture with wood ash | 310(80.7) | 74(19.3) |
| Application of Neem extracts | 311(81.0) | 73(19.0) |
| Use of Jerry Cans | 342(89.1) | 42(10.9) |
| Storing unthreshed | 337(87.8) | 47(12.2) |
| Sunning at regular intervals | 352(91.7) | 32(8.3) |
| Admixture with fine sand | 219(57.0) | 165(43.0) |
| Admixture with clay dust | 159(41.4) | 225(58.6) |
| Use of cooking oils (sunflower, cotton seed, groundnut) | 225(58.6) | 159(41.4) |
| *Average percentage response* | ***73.4%*** |  |
| **Conventional** |  |  |
| Use of synthetic pesticides | 360(93.8) | 24(6.3) |
| **Alternative** |  |  |
| NSPRIDUST | 149(38.8) | 235(61.2) |
| ZeroFly® hermetic bag | 193(50.3) | 191(49.7) |
| Cold Treatment | 188(49.0) | 196(51.0) |
| PICS Bag | 287(74.7) | 97(25.3) |
| Improved Drying | 236(61.5) | 148(38.5) |
| NSPRI Hermetic Steel Drum | 227(59.1) | 157(40.9) |
| Improved Inert Atmosphere Silo® | 223(58.1) | 161(41.9) |
| *Average percentage response* | ***55.9%*** |  |

Aware=1, Not aware=0

*Source: Field Survey, 2021*

# 4.3.2 Availability of pest control methods

The indigenous pest control methods indicated by majority of cowpea farmers to be available include intercrop with non-host plants (95.6%), spray application of ash mixture on foliage (79.4%), handpicking of insect immature stages (78.9%), ploughing to expose eggs, larvae, nymphs and adults in the soil (85.2%), use of early planting date (89.8%), planting early maturing crops that can be harvested early (94.0%), inorganic compounds: e.g. salt (63.5%), removing weed host of pests (71.4%), application of neem extracts (72.1%), and application of pepper fruit extract (63.3%).

In store, indigenous insect pest control methods indicated to be available by majority of the respondents include: admixture with wood ash (84.9%) and application of neem extracts (84.9%), use of jerry-cans (86.2%), storing unthreshed (87%) and sunning at regular intervals (87.0%), admixture with fine sand (59.6%), use of cooking oils (sunflower, cotton seed, groundnut) (68.8%). Comparatively, the aggregate average percentage response to availability indigenous pest control methods is high for field pest control (79.3%) when compared to store pest control (75.8%). This means that indigenous insect pest control methods are highly available for field pest control than methods for store pest control and may be attributed to most indigenous insect pest control methods on field being rooted in cultural practices domiciled in the farms’ environs while for storage, the methods are from a mix of practices.

On availability of conventional pest control, majority of respondents indicated that use of synthetic chemicals is available for both field pest control (87.8%) and store pest control (90.4%). The high percentages demonstrate the availability of synthetic pesticides for insect pest control both on field and in store and shows that conventional pest control method is more available for store pest control than pest control in field. On the subject of availability of alternative pest control, results in Table 8 showed that majority indicated the availability of Improved Inert Atmosphere Silo® (68.5%), Improved Drying (65.9%), PICS Bag (63.8%), NSPRI Hermetic Steel Drum (58.1%) and Cold Treatment (51.0%). Only few indicated the availability of NSPRIDUST (20.3%) and ZeroFly® hermetic bag (36.2%).

**Table 8: Distribution according to availability of insect pest control methods**

|  |  |  |
| --- | --- | --- |
| **Pest Control Methods** | **Available** | **Not Available** |
| **Field Pest Control** | **Freq. (%)** | **Freq. (%)** |
| **Indigenous** |  |  |
| Spray application of ash mixture on foliage | 305 (79.4) | 79(20.6) |
| Intercrop with non-host plants | 367 (95.6) | 17(4.4) |
| Handpicking of insect immature stages | 303 (78.9) | 81(21.1) |
| Ploughing to expose eggs, larvae, nymphs and adults in the soil | 327 (85.2) | 57(14.8) |
| Use of early planting date | 345 (89.8) | 39(10.2) |
| Planting early maturing crops that can be harvested early | 361 (94.0) | 23(6.0) |
| Inorganic compounds: e.g. salt | 244 (63.5) | 140(36.5) |
| Removing weed host of pests | 274 (71.4) | 110(28.6) |
| Application of Neem extracts | 277 (72.1) | 107(27.9) |
| Application of pepper fruit extract | 243 (63.3) | 141(36.7) |
| *Average percentage response* | ***79.3%*** |  |
| **Conventional** |  |  |
| Use of synthetic chemicals | 337(87.8) | 47(12.2) |
|  |  |  |
| **Store Pest Control** |  |  |
| **Indigenous** |  |  |
| Admixture with wood ash | 326(84.9) | 58(15.1) |
| Application of Neem extracts | 326(84.9) | 58(15.1) |
| Use of Jerry Cans | 331(86.2) | 53(13.8) |
| Storing unthreshed | 334(87.0) | 50(13.0) |
| Sunning at regular intervals | 334(87.0) | 50(13.0) |
| Admixture with fine sand | 229(59.6) | 155(40.4) |
| Admixture with clay dust | 184(47.9) | 200(52.1) |
| Use of cooking oils (sunflower, cotton seed, groundnut) | 264(68.8) | 120(31.3) |
| *Average percentage response* | ***75.8%*** |  |
| **Conventional** |  |  |
| Use of synthetic pesticides | 347(90.4) | 37(9.6) |
| **Alternative** |  |  |
| NSPRIDUST | 78(20.3) | 306(79.7) |
| ZeroFly® hermetic bag | 138(36.2) | 245(63.8) |
| Cold Treatment | 196(51.0) | 188(49.0) |
| PICS Bag | 245(63.8) | 139(36.2) |
| Improved Drying | 253(65.9) | 131(34.1) |
| NSPRI Hermetic Steel Drum | 223(58.1) | 161(41.9) |
| Improved Inert Atmosphere Silo® | 263(68.5) | 121(31.5) |

Available=1, Not available=0 *Source: Field Survey, 2021*

# 4.3.3 Use of Insect Pest Control Methods

Results of use of indigenous, conventional and alternative insect pest control methods are presented in Table 9 and shows use of early planting date (90.9%), planting early maturing crops that can be harvested early (90.4%), intercrop with non-host plants (83.6%), ploughing to expose eggs, larvae, nymphs and adults in the soil (78.4%), handpicking of insect immature stages (61.7%), and removing weed host of pests (59.6%) to be the most used indigenous cowpea insect pest control methods on field. Planting early maturing crops helps combat insect pests and is also employed to capture high market prices at the commencement of the cropping season (Munyuli *et al,* 2017). For storage of cowpea, the indigenous pest control methods most used among respondents were use of jerry cans (80.2%), sunning at regular intervals (77.3%), storing unthreshed (70.1%), and admixture with wood ash (56.8%). Comparatively, the aggregate average percentage response ofuse of indigenous pest control methods is high for field pest control (61.3%) when compared to store pest control (54.2%). The implication is usage of indigenous methods is higher in pest control on field than in store among cowpea farmers.

Findings show neem extracts application (39.1%) and application of pepper fruit extract (29.9%) are used by only a fraction of farmers. This shows that use of plant extracts as pest control in Kwara and Niger States is low despite high percentage of farmers indicating its availability and awareness to control pests. The findings are similar to those of a previous study (Akintobi, Evinemi & Achagwa, 2018) that use of plant materials for cowpea pest control was low among farmers in Nigeria. Other related studies have similarly noted that aqueous extracts sourced from neem and other plants are efficacious in controlling cowpea pests on field with an increase of 77% in yield (Ganiyu, Popoola, Yussuf, Owolade & Gbolade, 2018), however, their use it is limited in application (Zakari *et al.,* 2018). Among farmers in the Adjohoun community, Benin; Michozounnou, Dovonou, Hounsou & Agbossou (2018) found that the low rate of the use of the neem aqueous extract is due to the non-availability of this plant in the commune. Sabo, Bashir, Gidado, Sani & Adeniji (2014) linked immense dependence on synthetic pesticides to the inavailability of commercial quantities of plant based biopesticides.

Table 9 also shows the use of conventional methods with ajority of respondents using synthetic chemicals to control cowpea pests on field (87.8%) and store (79.2%). These findings imply that cowpea farmers used more of conventional pest control methods in field than in store in the study area. The high use in field is probably an attempt to prevent infect on the field which may move to store. For example, *Callosobruchus* *maculatus* often starts its attack on the field before completing its devastation in store. In an earlier study, Sabo *et al.,* 2014) asserted that about 99% of cowpea farmers in Mubi zone of Adamawa State, Nigeria use synthetic pesticides to control cowpea pest attack and further concluded that misuse of inorganic pesticides was prevalent.

In addition, as shown in Table 9, for alternative insect pest control methods, 65.4% of respondents signified use of PICS Bag. 46.1, 44, 41.7, 19, and 28.4% indicated use of improved drying, NSPRI hermetic steel drum, Improved Inert Atmosphere Silo®, NSPRIDUST and ZeroFly® hermetic bag respectively; these methods have gained less traction in the study area compared to the conventional. While farmers’ knowledge and perceptions of alternative practices are essential to accomplishing sustainable agriculture (Karamidehkordi and Hashemi, 2010), there is low awareness and use of these methods compared to conventional

**Table 9: Distribution according to use of insect pest control methods**

|  |  |  |
| --- | --- | --- |
| **Insect Pest Control Methods** | **Used** | **Not used** |
| **Field Pest Control** | **Freq. (%)** | **Freq. (%)** |
| **Indigenous** |  |  |
| Spray application of ash mixture on foliage | 165 (43.0) | 219(57.0) |
| Intercrop with non-host plants | 321 (83.6) | 63(16.4) |
| Handpicking of insect immature stages | 237 (61.7) | 147(38.3) |
| Ploughing to expose eggs, larvae, nymphs and adults in the soil | 301 (78.4) | 83(21.6) |
| Use of early planting date | 349 (90.9) | 35(9.1) |
| Planting early maturing crops that can be harvested early | 347 (90.4) | 37(9.6) |
| Inorganic compounds: e.g. salt | 138 (35.9) | 246(64.1) |
| Removing weed host of pests | 229 (59.6) | 155(40.4) |
| Application of Neem extracts | 150 (39.1) | 234(60.9) |
| Application of pepper fruit extract | 115 (29.9) | 243(63.3) |
| *Average percentage response* | ***61.3%*** |  |
| **Conventional** |  |  |
| Use of synthetic chemicals | 337(87.8) | 47(12.2) |
| **Store Pest Control** |  |  |
| **Indigenous** |  |  |
| Admixture with wood ash | 218(56.8) | 166(43.2) |
| Application of Neem extracts | 195(50.8) | 189(49.2) |
| Use of Jerry Cans | 308(80.2) | 76(19.8) |
| Storing unthreshed | 269(70.1) | 115(29.9) |
| Sunning at regular intervals | 297(77.3) | 87(22.7) |
| Admixture with fine sand | 112(29.2) | 272(70.8) |
| Admixture with clay dust | 101(26.3) | 283(73.7) |
| Use of cooking oils (sunflower, cotton seed, groundnut) | 166(43.2) | 218(56.8) |
| *Average percentage response* | ***54.2%*** |  |
| **Conventional** |  |  |
| Use of synthetic pesticides | 304(79.2) | 80(20.8) |
| **Alternative** |  |  |
| NSPRIDUST | 73(19.0) | 311(81.0) |
| ZeroFly® hermetic bag | 109(28.4) | 275(71.6) |
| Cold Treatment | 145(37.8) | 239(62.2) |
| PICS Bag | 251(65.4) | 133(34.6) |
| Improved Drying | 177(46.1) | 207(53.9) |
| NSPRI Hermetic Steel Drum | 169(44.0) | 215(56.0) |
| Improved Inert Atmosphere Silo® | 160(41.7) | 224(58.3) |
| *Average percentage response* | ***40.3%*** |  |

Used=1, not used=0 *Source: Field Survey, 2021*

Further, Table 10 shows the level of use of different insect pest control methods. 53.4% of respondents were users of indigenous methods, 72.4% were users of conventional method, and 13.8% were users of alternative methods. Cumulatively, however, 40.0% used alternative methods, 59.0% used indigenous methods, and 83.0% used conventional methods. This implies that alternative methods are the least used, followed by indigenous methods, while the most commonly used was the conventional method. The high rate of use of conventional methods may be attributed to its perceived effectiveness and ability to give increased grain yield among farmers (Egho, 2011). The reliance of cowpea farmers on the conventional method to manage insect pest outbreaks contributes to the low use of pesticide alternatives (Wyckhuys and O’Neil, 2007). Similarly, Akintobi et al. (2018) observed that synthetic pesticides were the pest control method most commonly used by cowpea farmers. On the other hand, use of pest control method in this study is higher than percentage use of pest control methods in Ekiti State where Oso, Kolawole and Ashafa (2021) reported 41.7% use of synthetic pesticides and 25.8% of botanicals for pest control. While the combined use of all three methods (56%) would normally connote the use of more environmentally friendly strategy such as Integrated Pest Management (Pellegrini 2013), it is negated by that fact that the combination of methods is dominated by the use of conventional methods. This may be ascribed to farmers having very little exposure to IPM in its true form (Joshi, Matchoc, Bahatan & Dela Pena, 2000).

**Table 10: Distribution of level of use of insect pest control methods by respondents**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Range of Percentage Total Score (%)** | **Indigenous** | | **Conventional** | | **Alternative** | | **Combined** | | **Remark** |
|  | **Freq.** | **%** | **Freq.** | **%** | **Freq.** | **%** | **Freq.** | **%** |  |
| 0 | 0 | 0.0 | 21 | 5.5 | 78 | 20.3 | 0 | 0.0 | No usage |
| 1 – 30 | 22 | 5.7 | 0 | 0.0 | 134 | 34.9 | 47 | 12.2 | Low usage |
| 31 – 60 | 205 | 53.4 | 85 | 22.1 | 53 | 13.8 | 200 | 52.1 | Average usage |
| 61 – 100 | 157 | 40.9 | 278 | 72.4 | 119 | 31.0 | 137 | 35.7 | High usage |
| Average score | 59 | | 83 | | 40 | | 56 | |  |

*Source: Field Survey, 2021*

# 4.3.4 Frequency of Use of Pest Control Methods

The frequency of use of different insect pest control methods are presented in Table 11. The frequently used indigenous pest control methods were planting crops that can be harvested early (mean=1.67), use of early planting date (mean=1.62), use of synthetic chemicals (mean=1.59), ploughing to expose eggs, larvae, nymphs and adults in the soil (mean=1.34). The frequently used indigenous store pest control methods were sunning at regular intervals (mean=1.19), use of jerry cans (mean=1.24), and storing unthreshed (mean=1.05).Table 11 also shows that use of synthetic chemicals as conventional pest control method is a frequently used method for field (mean=1.59) and store (mean=1.37) pest control in cowpea. On alternative pest control methods, methods such as NSPRIDUST, ZeroFly® hermetic bag, cold treatment, PICS bag, improved drying, hermetic steel drum, and Improved Inert Atmosphere Silo® were not frequently employed by cowpea farmers.

**Table 11: Frequency of use of insect pest control methods indicated by the respondents**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Pest Control Methods** | **Always used** | **Often Used** | **Rarely Used** | **Mean(SD)** | **Remark** |
| **Field Pest Control** | **Freq. (%)** | **Freq. (%)** | **Freq. (%)** |  |  |
| **Indigenous** |  |  |  |  |  |
| Spray application of ash mixture on foliage | 36(9.4) | 129(33.6) | 219(57.0) | 0.52(0.66) | NFU |
| Intercrop with non-host plants | 165(43.0) | 156(40.6) | 63(16.4) | 1.27(0.72) | FU |
| Handpicking of insect immature stages | 72(18.8) | 165(43.0) | 147(38.3) | 0.80(0.73) | NFU |
| Ploughing to expose eggs, larvae, nymphs and adults in the soil | 212(55.2) | 89(23.2) | 83(21.6) | 1.34(0.81) | FU |
| Use of early planting date | 273(71.1) | 76(19.8) | 35(9.1) | 1.62(0.64) | FU |
| Planting early maturing crops that can be harvested early | 294(76.6) | 53(13.8) | 37(9.6) | 1.67(0.64) | FU |
| Inorganic compounds: e.g. salt | 27(7.0) | 111(28.9) | 246(64.1) | 0.43(0.62) | NFU |
| Removing weed host of pests | 111(28.9) | 118(30.7) | 155(40.4) | 0.89(0.83) | NFU |
| Application of Neem extracts | 102(26.6) | 45(11.7) | 237(61.7) | 0.65(0.87) | NFU |
| Application of pepper fruit extract | 83(21.6) | 62(16.1) | 239(62.2) | 0.59(0.82) | NFU |
| **Conventional** |  |  |  |  |  |
| Use of synthetic chemicals | 273(71.1) | 66(17.2) | 45(11.7) | 1.59(0.69) | FU |
| **Store Pest Control** |  |  |  |  |  |
| **Indigenous** |  |  |  |  |  |
| Admixture with wood ash | 90(23.4) | 128(33.3) | 166(43.2) | 0.80(0.79) | NFU |
| Application of Neem extracts | 109(28.4) | 86(22.4) | 189(49.2) | 0.79(0.86) | NFU |
| Use of Jerry Cans | 169(44.0) | 139(36.2) | 76(19.8) | 1.24(0.76) | FU |
| Storing unthreshed | 135(35.2) | 134(34.9) | 115(29.9) | 1.05(0.81) | FU |
| Sunning at regular intervals | 160(41.7) | 137(35.7) | 87(22.7) | 1.19(0.78) | FU |
| Admixture with fine sand | 35(9.1) | 77(20.1) | 272(70.8) | 0.38(0.65) | NFU |
| Admixture with clay dust | 51(13.3) | 50(13.0) | 283(73.7) | 0.40(0.71) | NFU |
| Use of cooking oils | 87(22.7) | 79(20.6) | 218(56.8) | 0.66(0.83) | NFU |
| **Conventional** |  |  |  |  |  |
| Use of synthetic pesticides | 223(58.1) | 81(21.1) | 80(20.8) | 1.37(0.81) | FU |
| **Alternative** |  |  |  |  |  |
| NSPRIDUST | 20(5.2) | 53(13.8) | 311(81.0) | 0.24(0.54) | NFU |
| ZeroFly® hermetic bag | 34(8.9) | 75(19.5) | 275(71.6) | 0.37(0.64) | NFU |
| Cold Treatment | 64(16.7) | 81(21.1) | 239(62.2) | 0.54(0.73) | NFU |
| PICS Bag | 102(26.6) | 149(38.8) | 133(34.6) | 0.92(0.78) | NFU |
| Improved Drying | 67(17.4) | 140(36.5) | 177(46.1) | 0.71(0.74) | NFU |
| NSPRI Hermetic Steel Drum | 61(15.9) | 108(28.1) | 215(56.0) | 0.60(0.75) | NFU |
| Improved Inert Atmosphere Silo® | 83(21.6) | 77(20.1) | 224(58.3) | 0.63(0.82) | NFU |

Scale: Always=2, Sometimes=1, never=0. FU: Frequently used; NFU: Not Frequently Used

*Source: Field Survey, 2021*

# 4.4 Preference for Insect Pest Control Methods

The preference of farmers for the different insect pest control methods is presented in Table 12. Result shows that for indigenous insect pest control methods, planting crops that can be harvested early (mean=2.65) ranked first, use of early planting date (mean=2.56) ranked second, use of jerry cans (mean=2.54) ranked third, ploughing to expose eggs, larvae, nymphs and adults in the soil (mean=2.32) ranked fourth and sun drying at regular intervals (mean=2.30) ranked fifth among other indigenous methods used by respondents. Consequently, planting early maturing crops, use of early planting date, and use of jerry cans for storage were the foremost indigenous pest control methods preferred by cowpea farmers in Kwara and Niger States.

For conventional methods, utilizing synthetic pesticides for field pest control in store (mean=2.79) is more preferred to field use (mean=2.33) and may not be unconnected to need to protect harvested crops to prevent complete loss of the entire planting season. For alternative insect pest control methods, PICS Bag (mean=2.10) ranked first, NSPRI Hermetic Steel Drum (mean=1.74) ranked second, improved drying (mean=1.67) ranked third, Improved Inert Atmosphere Silo® (mean=1.62) ranked fourth, Cold Treatment (mean=1.54) ranked fifth, ZeroFly® hermetic bag (mean=1.54) ranked sixth in the order of preference. This implies that the use of PICS Bag, NSPRI Hermetic Steel Drum, and improved drying were the leading alternative pest control methods preferred by cowpea farmers in Kwara and Niger States.

**Table 12: Distribution of respondents by their preference for insect pest control methods**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Most Preferred** | **Preferred** | **Least Preferred** | **Mean (SD)** | **Rank** |
| ***Field*** |  |  |  |  |  |
| Planting early maturing crops harvested early | 271(70.6) | 91(23.7) | 22(5.7) | 2.65(0.586) | 1st |
| Use of early planting date | 236(61.5) | 126(32.6) | 22(5.7) | 2.56(0.602) | 2nd |
| Use of synthetic pesticides for field pest control (conventional method) | 206(53.6) | 99(25.8) | 79(20.6) | 2.33(0.797) | 3rd |
| Ploughing to expose eggs, larvae, nymphs and adults in the soil | 184(47.9) | 140(36.5) | 60(15.6) | 2.32(0.730) | 4th |
| Intercrop with non-host plants | 132(34.4) | 193(50.3) | 59(15.4) | 2.19(0.680) | 5th |
| Removing weed host of pests | 105(27.3) | 169(44.0) | 110(28.6) | 1.99(0.749) | 6th |
| Handpicking of insect immature stages | 52(13.5) | 198(51.6) | 134(34.9) | 1.79(0.663) | 7th |
| Inorganic compounds:e.g. salt | 96(25.0) | 108(28.1) | 180(46.9) | 1.78(0.820) | 8th |
| Application of Neem extracts | 96(25.0) | 86(22.4) | 202(52.6) | 1.72(0.838) | 9th |
| Spray application of ash mixture on foliage | 72(18.8) | 116(30.2) | 196(51.0) | 1.68(0.771) | 10th |
| Application of pepper fruit extract | 76(19.8) | 87(22.7) | 221(57.6) | 1.62(0.795) | 11th |
| ***Store*** |  |  |  |  |  |
| Use of synthetic pesticides for store pest control | 327(85.2) | 33(8.6) | 24(6.3) | 2.79(0.541) | 1st |
| Use of Jerry Cans | 238(62.0) | 117(30.5) | 29(7.6) | 2.54(0.633) | 2nd |
| Sun drying at regular intervals | 168(43.8) | 163(42.4) | 53(13.8) | 2.30(0.698) | 3rd |
| Storing unthreshed | 159(41.4) | 153(39.8) | 72(18.8) | 2.23(0.743) | 4th |
| PICS Bag | 169(44.0) | 84(21.9) | 131(34.1) | 2.10(0.879) | 5th |
| Admixture with wood ash | 106(27.6) | 94(24.5) | 184(47.9) | 1.80(0.846) | 6th |
| Application of Neem extracts | 78(20.3) | 141(36.7) | 165(43.0) | 1.77(0.764) | 7th |
| NSPRI Hermetic Steel Drum | 79(20.6) | 128(33.3) | 177(46.1) | 1.74(0.777) | 8th |
| Use of cooking oils | 108(28.1) | 53(13.8) | 223(58.1) | 1.70(0.880) | 9th |
| Improved Drying | 89(23.2) | 81(21.1) | 214(55.7) | 1.67(0.828) | 10th |
| Improved Inert Atmosphere Silo® | 74(19.3) | 91(23.7) | 219(57.0) | 1.62(0.789) | 11th |
| Admixture with fine sand | 57(14.8) | 100(26.0) | 227(59.1) | 1.56(0.738) | 12th |
| Cold Treatment | 45(11.7) | 127(33.1) | 212(55.2) | 1.54(0.694) | 13th |
| ZeroFly® hermetic bag | 39(10.2) | 131(34.1) | 214(55.7) | 1.54(0.673) | 14th |
| Admixture with clay dust | 60(15.6) | 47(12.2) | 277(72.1) | 1.43(0.748) | 15th |
| NSPRIDUST | 15(3.9) | 75(19.5) | 294(76.6) | 1.27(0.527) | 16th |

Most Preferred=3, Preferred=2, Least Preferred=1

*Source: Field Survey, 2021*

# 4.5 Factors Influencing Pest Control Decisions

This section covers factors influencing cowpea farmers’ pest control decisions. Summary of results on factors considered for cowpea insect pest control in field and in store are presented in Tables 13, 14 and 15 respectively.

# 4.5.1 Factors Considered for Cowpea Field Insect Pest Control

The results of factors considered for cowpea field pest control methods (Table 13) shows that effectiveness of control method (mean=1.35), availability of pest control method (mean=1.32), and quantity of pesticide required (mean=1.32) ranked 1st , 2nd and 3rd in that order among cowpea farmers. This implies effectiveness of control method, availability of pest control method, and quantity of pesticide required were the leading factors considered for cowpea field pest control methods in Kwara and Niger States. That the quantity of pesticide required ranks high is a pointer to high level use of conventional method.

**Table 13: Factors considered for insect pest control on field**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factors** | **No** | **Yes** | | Mean (SD) | Rank |
| Not Important | Important | Very important |
| Effectiveness of control method | 28(7.3) | 193(50.3) | 163(42.4) | 1.35(0.612) | 1st |
| Availability of pest control method | 52(13.5) | 158(41.1) | 174(45.3) | 1.32(0.699) | 2nd |
| Quantity of pesticide required | 51(13.3) | 159(41.4) | 174(45.3) | 1.32(0.696) | 3rd |
| Climatic and environmental condition | 45(11.7) | 175(45.6) | 164(42.7) | 1.31(0.670) | 4th |
| Labour requirement | 51(13.3) | 165(43.0) | 168(43.8) | 1.30(0.692) | 5th |
| Advice from agrochemical dealers | 81(21.1) | 111(28.9) | 192(50.0) | 1.29(0.793) | 6th |
| Time of application | 47(12.2) | 177(46.1) | 160(41.7) | 1.29(0.674) | 7th |
| Time required to apply control method | 60(15.6) | 164(42.7) | 160(41.7) | 1.26(0.712) | 8th |
| Recommendation by extension agents | 80(20.8) | 128(33.3) | 176(45.8) | 1.25(0.778) | 9th |
| Price/cost benefit analysis | 56(14.6) | 179(46.6) | 149(38.8) | 1.24(0.690) | 10th |
| Intended time of harvest | 51(13.3) | 196(51.0) | 137(35.7) | 1.22(0.664) | 11th |
| Familiarity with control method | 42(10.9) | 214(55.7) | 128(33.3) | 1.22(0.627) | 12th |
| Level of infestation | 67(17.4) | 172(44.8) | 145(37.8) | 1.20(0.716) | 13th |
| Method of application of pest control | 56(14.6) | 198(51.6) | 130(33.9) | 1.19(0.670) | 14th |
| Period of efficiency of control method | 75(19.5) | 168(43.8) | 141(36.7) | 1.17(0.731) | 15th |
| Size of farm | 56(14.6) | 221(57.6) | 107(27.9) | 1.13(0.639) | 16th |
| Type of pest | 91(23.7) | 152(39.6) | 141(36.7) | 1.13(0.767) | 17th |
| Cost of control method | 88(22.9) | 163(42.4) | 133(34.6) | 1.12(0.751) | 18th |
| Period of field protection desired | 85(22.1) | 168(43.8) | 131(34.1) | 1.12(0.741) | 19th |
| Counsel by researcher/ or any other professionals like personnel from research Institutes. | 115(29.9) | 117(30.5) | 152(39.5) | 1.10(0.829) | 20th |
| Ease of application of pest control method | 90(23.4) | 171(44.5) | 123(32.0) | 1.09(0.741) | 21st |
| Used by peers | 110(28.6) | 160(41.7) | 114(29.7) | 1.01(0.765) | 22nd |
| Tradition | 123(32.0) | 137(35.7) | 124(32.3) | 1.00(0.803) | 23rd |

Not Important=0, Important=1, Very Important=2 *Source: Field Survey, 2021*

# 4.5.2 Factors considered for insect pest control methods in store

Table 14 shows the factors considered for pest control methods of cowpea in store. It shows that intended time of sale (mean=1.55), time required to apply control method (mean=1.47), and time of application (mean=1.43) ranked first, second and third among respondents. This implies that intended time of sale, time required to apply control method, and time of application were the leading factors considered for cowpea store pest control methods in Kwara and Niger States.

**Table 14: Factors considered for insect pest control in store**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factors** | **No** | **Yes** | | **Mean (SD)** | Rank |
| Not Important | Important | Very important |
| Intended time of sale | 29(7.6) | 121(31.5) | 234(60.9) | 1.55(0.633) | 1st |
| Time required to apply control method | 40(10.4) | 123(32.0) | 221(57.6) | 1.47(0.677) | 2nd |
| Time of application | 37(9.6) | 143(37.2) | 204(53.1) | 1.43(0.663) | 3rd |
| Quantity of pesticide required | 43(11.2) | 137(35.7) | 204(53.1) | 1.42(0.685) | 4th |
| Cost of control method | 44(11.5) | 145(37.8) | 195(50.8) | 1.39(0.685) | 5th |
| Climatic and environmental condition | 21(5.5) | 191(49.7) | 172(44.8) | 1.39(0.591) | 6th |
| Type of pest | 42(10.9) | 153(39.8) | 189(49.2) | 1.38(0.675) | 7th |
| Availability of pest control method | 22(5.7) | 196(51.0) | 166(43.2) | 1.38(0.591) | 8th |
| Quantity of grains to be stored | 19(4.9) | 206(53.6) | 159(41.4) | 1.36(0.576) | 9th |
| Familiarity with control method | 25(6.5) | 200(52.1) | 159(41.4) | 1.35(0.599) | 10th |
| Labour requirement | 41(10.7) | 174(45.3) | 169(44.0) | 1.33(0.661) | 11th |
| Effectiveness of control method | 11(2.9) | 241(62.8) | 132(34.4) | 1.32(0.523) | 12th |
| Period of storage desired | 51(13.3) | 163(42.4) | 170(44.3) | 1.31(0.693) | 13th |
| Price/cost benefit analysis | 28(7.3) | 210(54.7) | 146(38.0) | 1.31(0.600) | 14th |
| Method of application of pest control | 33(8.6) | 207(53.9) | 144(37.5) | 1.29(0.615) | 15th |
| Recommendation by extension agents | 48(12.5) | 200(52.1) | 136(35.4) | 1.23(0.654) | 16th |
| Advice from agrochemical dealers | 65(16.9) | 169(44.0) | 150(39.1) | 1.22(0.716) | 17th |
| Ease of application of pest control method | 49(12.8) | 214(55.7) | 121(31.5) | 1.19(0.639) | 18th |
| Period of efficiency of control method | 79(20.6) | 156(40.6) | 149(38.8) | 1.18(0.750) | 19th |
| Level of infestation | 49(12.8) | 245(63.8) | 90(23.4) | 1.11(0.593) | 20th |
| Counsel by researcher/ or any other professionals like personnel from stored products research institute | 94(24.5) | 169(44.0) | 121(31.5) | 1.07(0.746) | 21st |
| Used by peers | 83(21.6) | 198(51.6) | 103(26.8) | 1.05(0.695) | 22nd |
| Tradition | 127(33.1) | 130(33.9) | 127(33.1) | 1.00(0.814) | 23rd |

Not Important=0, Important=1, Very Important=2. *Source: Field Survey, 2021*

# 4.5.3 Component structure of factors considered for insect pest control methods

Using a correlation matrix, Principal Component Analysis was employed in extracting important components of factors considered for insect pest control in store in Kwara and Niger States. Cronbach's alpha was used to test for reliability with 0.94 obtained which was considered fit. Bartlett's sphericity test (X2 = 16885.159, p≤ 0.01) values demonstrate the reliable nature of the identity matrix and its capacity to make available significant data dimension reductions. Variables showing factor loadings more than ± 0.10 were chosen with selected loadings shown in Table 15. Three key components explained 44% of variation in the dataset; F1 (first principal component) explained 18% of variation in cowpea farmers’ decision to use pest control methods while F2 & F3 explained 13% and 12% in that order.

The first factor (Fl) was largely dominated by time required to apply control method, quantity required, availability of pest control method, quantity of grains to be stored and climatic and environmental condition. Second factor (F2) was dominated by considerations on ease of application of pest control method, familiarity with control method, price/cost benefit analysis, price/cost benefit analysis, labour requirement, and type of pest. The Third factor (F3) cuts across tradition, advice from agrochemical dealers, used by peers and cost of control method. This implies that government agencies and agricultural extension must include these considerations in planning and executing advocacy for adoption of low pesticide use practices among farmers.

**Table 15: Principal Component Analysis (PCA) of Factors Considered in Selection of Cowpea Pest Control Methods**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Component | | | Communalities  Extraction |
| Factor 1 | Factor 2 | Factor 3 |
| **Factors** |  |  |  |  |
| Cost of control method | .001 | -.061 | **.133** | .788 |
| Time required to apply control method | **.113** | -.098 | .025 | .776 |
| Quantity of pesticide required | **.124** | -.079 | -.009 | .775 |
| Availability of pest control method | **.120** | -.082 | -.001 | .757 |
| Quantity of grains to be stored\* | **.113** | **-.**111 | .039 | .797 |
| Ease of application of pest control method | .023 | **.102** | -.050 | .825 |
| Method of application of pest control | .063 | .074 | -.099 | .810 |
| Period of storage desired | .064 | .050 | -.071 | .844 |
| Period of efficiency of control method | .019 | .082 | -.026 | .765 |
| Climatic and environmental condition | **.122** | -.027 | -.064 | .807 |
| Time of application | -.013 | .074 | .011 | .757 |
| Tradition | -.076 | .006 | **.144** | .776 |
| Advice from agrochemical dealers | -.070 | -.003 | **.157** | .735 |
| Recommendation by extension agents | -.039 | .063 | .031 | .771 |
| Counsel by researcher/ or any other professionals like personnel from stored products research institute | -.046 | .091 | .027 | .750 |
| Used by peers | -.020 | -.034 | **.160** | .804 |
| Level of infestation | -.012 | .021 | .099 | .760 |
| Effectiveness of control method | .023 | .034 | .036 | .789 |
| Familiarity with control method | -.029 | **.122** | -.025 | .780 |
| Price/cost benefit analysis | -.069 | **.188** | -.029 | .793 |
| Labour requirement | -.047 | **.163** | -.044 | .805 |
| Type of pest | -.077 | **.178** | .014 | .797 |
| Intended time of sale | .042 | .029 | .004 | .779 |
| Eigen Value | 8.459 | 6.113 | 5.712 |  |
| Variance explained | 18.389 | 13.289 | 12.418 |  |
| Cumulative % of variance explained | 18.389 | 31.679 | 44.096 |  |
| Bartlett's sphericity value= 16885.159 \*\*\* p=0.000 | | | |  |
| Measure of sampling adequacy = 0.749 | | |  |  |
| Overall Cronbach's alpha = 0.94 | | |  |  |

Loadings > ±0.10 are bold

p≤ 0.01 (\*)

\* Variables that loaded under more than one factor

*Source: Field Survey, 2021*

# 4.6 Cowpea farmers’ information sources

The spread of cowpea farmers according to information sources on cowpea pest control methods is presented in Table 16. The sources were ranked from 1st to 12th using their mean score ranging from highest mean score to the lowest. The use of Agricultural Development Project (ADP) agents ranked first (mean=2.49), input dealers ranked second (mean=2.39), agricultural research institutes ranked third (mean=2.31), farmers’ group ranked fourth (mean=2.29), radio ranked fifth (mean=2.28), fellow farmers ranked sixth position (mean=2.24), family members ranked seventh (mean=2.08). Others lower-ranked sources are television, cooperative societies, social media, print media, and journals. This invariably connotes that agricultural extension agents of ADP played the leading role in disseminating information on pest control methods in the study area with input dealers, and agricultural research institutes as other prime sources of information utilized for cowpea pest control in Kwara and Niger States.

Extension advisory services aims at improving income and livelihood of ruralites by enhancing access to information, increasing knowledge and developing farmers’ aptitude for group effort Agricultural extension delivers essential facts to farmers while advancing their knowledge on insect pest control methods. This is critical for agricultural and rural development since a myriad of social and production bottlenecks oblige smallholders to accept innovative pest control systems in addition to production methods (Prager, Creaney & Lorenzo-Arribas, 2017). The radio (mean=2.28) is a valuable information source (Adebayo, 2013) but requires upgrading in service delivery in order to effectively present key points and interpret scientific findings and measurements (Olaleye, Gana, Umar, Ndanisa & Peter, 2009). Other sources such as farmers group (mean=2.29), fellow farmers (mean=2.24), family members (mean=2.08) which constitute the informal networks in rural areas are also frequently utilized and are considered reliable by rural dwellers (Momodu, 2002).

**Table 16: Frequency of use of sources of information by the respondents**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sources | No | Yes | | | Mean (SD) | Rank |
| Frequently | Occasionally | Rarely |
| ADP | 2(0.5) | 245(63.8) | 85(22.1) | 52(13.5) | 2.49(0.744) | 1st |
| Input Dealers | 3(0.8) | 206(53.6) | 123(32.0) | 52(13.5) | 2.39(0.746) | 2nd |
| Agricultural Research Institutes | 3(0.8) | 192(50.0) | 121(31.5) | 68(17.7) | 2.31(0.785) | 3rd |
| Farmers Group | 8(2.1) | 177(46.1) | 149(38.8) | 50(13.0) | 2.29(0.770) | 4th |
| Radio | 10(2.6) | 185(48.2) | 133(34.6) | 56(14.6) | 2.28(0.808) | 5th |
| Fellow Farmers | 7(1.8) | 188(49.0) | 107(27.9) | 82(21.4) | 2.24(0.849) | 6th |
| Family Members | 20(5.2) | 162(42.2) | 110(28.6) | 92(24.0) | 2.08(0.931) | 7th |
| Television | 25(6.5) | 95(24.7) | 179(46.6) | 85(22.1) | 1.90(0.849) | 8th |
| Cooperative Societies | 19(4.9) | 122(31.4) | 113(29.4) | 130(33.9) | 1.88(0.918) | 9th |
| Social Media | 30(7.8) | 88(22.9) | 99(25.8) | 167(43.5) | 1.64(0.921) | 10th |
| Print Media | 16(4.2) | 62(16.1) | 56(14.6) | 250(65.1) | 1.43(0.808) | 11th |
| Journals | 32(8.3) | 36(9.4) | 80(20.8) | 236(61.5) | 1.31(0.755) | 12th |

No=0, Rarely=1, Occasionally=2, Frequently=3 *Source: Field Survey, 2021*

# 4.7 Farmers’ perceptions of insect pest control methods

Cowpea farmers’ perceptions of pest control practices and methods are presented in Table 17. 40 of 42 perception statements were above the mean (2.50) and were positively perceived while only 2 were negatively perceived by respondents. Of the statements positively perceived, the leading statements with mean score equal to 3.0 and above on the scale were: a good pest control method kills pests immediately (mean=3.50), a selected pest control method must kill all insect pests (mean=3.07), any of the pest control methods guarantees insect-free cowpea (mean=3.26), cowpea production is impossible without using synthetic pesticides (mean=3.17). Taken together, this suggests that farmers have a propensity to use insect pest control methods and base use on the need to remove insects at all cost and forestall the possibility of loss in yield or store (Robinson, Das & Chancellor, 2007).

Other statements include the level of pest infestation determines the type of control method to be used (mean=3.38)**,** indigenous pest control in field and store requires the addition of synthetic pesticides for effectiveness (mean=3.18), alternative pest control in field and store requires the use of synthetic pesticides for effectiveness (mean=3.14), indigenous pest control is sufficient on its own (mean=2.83), conventional pest control is sufficient on its own (mean=3.11), alternative pest control is sufficient on its own (mean=2.87), use of conventional method on field and in store guarantees insect-free cowpea (mean=3.19), use of alternative methods on field and in store guarantees insect-free cowpea (mean=3.00), conventional pest control is the most effective (mean=3.39), alternative pest control is the most effective (mean=3.02), conventional insect pest control method is better because they save time (mean=3.19), indigenous insect pest control methods are better because they require less labour (mean=3.00), conventional insect pest control method is better because they require less labour (mean=3.11), Conventional pest control method kills pests quickly (mean=3.21), efficacy of indigenous pest control methods is easily ascertained (mean=3.05), efficacy of conventional pest control method is easily ascertained (mean=3.15), and use of conventional pest control on field and store guarantee profits (mean=3.09).

It could be deduced that the top three pest control statements; a good pest control method kills pests immediately (mean=3.50), conventional pest control is the most effective method (mean=3.39), and the level of pest infestation determines the type of control (mean=3.38) points to a positive perception of the conventional method among respondents. The statements ‘You don’t have to adhere strictly to instruction on the label (mean=1.139)**’** and ‘Residue of chemicals is not dangerous to consumers (mean=1.190)’ were negatively perceived by the respondents. The desire to protect crops on field and in store is primary, with the actual need being secondary with the result being an overestimation of the benefits of pesticide use (Escalada and Heong, 2004). These perceptions are of great consequence and these views are closely related to the high number of deaths reported from the consumption of cowpea over the years. The ban on cowpea exports from Nigeria is attributed to high amount of residues resulting from indiscriminate use of synthetic pesticides.

The implication for agricultural extension organizations is the need to develop recommendations on cowpea production and storage in the two states and the Extension Agents should be well trained on the use of the package. The recommendation should address the fears and views of cowpea farmers as revealed in this study. Similarly, cowpea farmers should make themselves available for regular training on production and storage. They should also adhere to instructions on the of pest control methods in both production and storage.

**Table 17: Distribution of respondents according to their perceptions of insect pest control**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Perception** | **SA** | **A** | **D** | **SD** | **Mean(SD)** | **Remark** |
| A good pest control method kills pests immediately | 214(55.7) | 148(38.5) | 22(5.7) | 0 | 3.50(0.605) | P |
| A selected control method must kill all insect pests | 154(40.1) | 133(34.6) | 66(17.2) | 31(8.1) | 3.07(0.945) | P |
| Any of the pest control methods guarantees insect-free cowpea | 190(46.9) | 153(39.8) | 22(5.7) | 29(7.6) | 3.26(0.873) | P |
| Cowpea production is impossible without the use of synthetic pesticides as a pest control | 157(40.9) | 146(38.0) | 71(18.5) | 10(2.6) | 3.17(0.819) | P |
| The level of pest infestation determines the type of control method to be used. | 185(48.2) | 161(41.9) | 38(9.9) | 0 | 3.38(0.660) | P |
| Mixing different pest control methods improves their potency | 155(40.4) | 116(30.2) | 68(17.7) | 45(11.7) | 2.99(1.026) | P |
| Time of application of synthetic pesticides does not affect harvesting and consumption | 112(29.2) | 126(32.8) | 65(16.9) | 81(21.1) | 2.70(1.104) | P |
| Indigenous pest control in field and store requires the addition of synthetic pesticides for effectiveness | 166(43.2) | 136(35.4) | 69(18.0) | 13(3.4) | 3.18(0.846) | P |
| Alternative pest control in field and store requires the use of synthetic pesticides for effectiveness | 146(38.0) | 158(41.1) | 66(17.2) | 14(3.6) | 3.14(0.825) | P |
| Indigenous pest control is sufficient on its own | 100(26.0) | 146(38.0) | 111(28.9) | 27(7.0) | 2.83(0.897) | P |
| Conventional pest control is sufficient on its own | 166(43.2) | 146(38.0) | 21(5.5) | 51(13.3) | 3.11(1.007) | P |
| Alternative pest control is sufficient on its own | 111(28.9) | 155(40.4) | 74(19.3) | 44(11.5) | 2.87(0.962) | P |
| The use of the conventional method on field and in store guarantees insect-free cowpea. | 176(45.8) | 145(37.8) | 23(6.0) | 40(10.4) | 3.19(0.949) | P |
| The use of indigenous methods on field and in store guarantees insect-free cowpea. | 131(34.1) | 141(36.7) | 88(22.9) | 24(6.3) | 2.99(0.907) | P |
| The use of alternative methods on field and in store guarantees insect-free cowpea. | 115(29.9) | 167(43.5) | 88(22.9) | 14(3.6) | 3.00(0.822) | P |
| Indigenous pest control is the most effective | 129(33.6) | 136(35.4) | 72(18.8) | 47(12.2) | 2.90(1.003) | P |
| Conventional pest control is the most effective | 208(54.2) | 133(34.6) | 29(7.6) | 14(3.6) | 3.39(0.781) | P |
| Alternative pest control is the most effective | 160(41.7) | 105(27.3) | 84(21.9) | 35(9.1) | 3.02(1.001) | P |
| Conventional pest control method is better because they save time | 175(45.6) | 136(35.4) | 44(11.5) | 29(7.6) | 3.19(0.916) | P |
| Indigenous pest control methods are better because they require less labour | 125(32.6) | 142(37.0) | 108(28.1) | 9(2.3) | 3.00(0.838) | P |
| Conventional pest control method is better because they require less labour | 154(40.1) | 131(34.1) | 85(22.1) | 14(3.6) | 3.11(0.871) | P |
| Indigenous pest control methods kills pests quickly | 131(34.1) | 105(27.3) | 107(27.9) | 41(10.7) | 2.85(1.013) | P |
| Conventional control method kills pests quickly | 150(39.1) | 181(47.1) | 35(9.1) | 18(4.7) | 3.21(0.793) | P |
| The efficacy of using indigenous control methods is easily ascertained | 145(37.8) | 131(34.1) | 91(23.7) | 17(4.4) | 3.05(0.889) | P |
| The efficacy of using conventional control method is easily ascertained. | 132(34.4) | 192(50.0) | 44(11.5) | 16(4.2) | 3.15(0.778) | P |
| Washing crop with warm water before cooking takes care of any residual effect. | 130(33.9) | 166(43.2) | 28(7.3) | 60(15.6) | 2.95(1.018) | P |
| The use of conventional pest control on field and store guarantee profits | 142(37.0) | 172(44.8) | 32(8.3) | 38(9.9) | 3.09(0.918) | P |
| The possibility of re-application of synthetic pesticides many times makes it more advantageous | 107(27.9) | 159(41.4) | 84(21.9) | 34(8.9) | 2.88(0.917) | P |
| Indigenous pest control methods are not suitable for large farms and stores | 103(26.8) | 129(33.6) | 101(26.3) | 51(13.3) | 2.74(0.999) | P |
| You don’t have to adhere strictly to instruction on the label | 62(16.1) | 64(16.7) | 73(19.0) | 185(48.2) | 2.01(1.139) | N |
| Residue of chemicals is not dangerous to consumers | 75(19.5) | 24(6.3) | 60(15.6) | 225(58.6) | 1.87(1.190) | N |
| **Aggregate mean perception** |  |  |  |  | 2.99 | P |

Strongly Agree (SA)=4, Agree (A)=3, Disagree (D)=2, Strongly Disagree (SD)=1

P: Positive; N: Negative

*Source: Field Survey, 2021*

# 4.8 Farmers’ knowledge of insect pest control methods

Table 18 presents results of the knowledge of cowpea farmers on use of indigenous, conventional and alternative pest control methods. The results indicates that majority of respondents have the knowledge of pest control methods in all presented knowledge areas. The general knowledge statements signified by respondents were pest control methods have far reaching effects beyond the control of pests alone (86.7%), a pest control method should eliminate pests and not merely inhibit their activities (84.1%), use of synthetic pesticides leads to ecosystem imbalance (81.0%), there is a chance of food poisoning with conventional method use (85.7%), synthetic pesticides should be used as recommended on the container (85.2%), alternative methods do not leave any residual effects on produce (81.0%), the use of conventional pest control degrades the environment (86.5%), residues from use of conventional method constitute a health risk, and hermetic steel drums for storage of cowpea does not require the use of phostoxin tablets (88.8%), PICS bag for storage of cowpea does not require the use of phostoxin tablets (82.8%), choice of pest control method influences quality of produce (88.5%), fumigants must be removed from cowpea and opened up in a airy place to ward off the toxicity (85.2%). The knowledge statement ‘phostoxin may be dropped directly in storage bags’ (44.5%) was not well known among respondents.

It can be deduced from the findings that knowledge on residues from the use of conventional method constitute a health risk, hermetic steel drums for storage of cowpea does not require the use of phostoxin tablets, pest control methods have far reaching effects beyond annihilating pests, and use of conventional method degrades the environment were the foremost knowledge areas of insect pest control methods of respondents in Kwara and Niger States. Kishi (2002) posited that farmers’ knowledge concerning pest control is crucial for promoting pesticide safety, but does not lead to a change of practice and behaviour.

**Table 18: Distribution of respondents by their knowledge on insect pest control methods**

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | **Knowledge Statements** | **True** | **False** |
| 1. | Pest control methods have far reaching effects beyond the control of pests alone | 333(86.7) | 51(13.3) |
| 2. | A pest control method should eliminate pests and not merely inhibit their activities. | 323(84.1) | 61(15.9) |
| 3. | The use of synthetic pesticides leads to ecosystem imbalance | 311(81.0) | 73(19.0) |
| 4. | There is a chance of food poisoning with conventional method use | 329(85.7) | 55(14.3) |
| 5. | There is a waiting time associated with the use of the conventional method in field and in store. | 315(82.0) | 69(18.0) |
| 6. | Indigenous methods are effective on small and large farms | 234(60.9) | 150(39.1) |
| 7. | Any quantity of synthetic pesticides can be administered as long as it keeps cowpea in good condition | 251(65.4) | 133(34.6) |
| 8. | Synthetic pesticides should be used as recommended on the container. | 327(85.2) | 57(14.8) |
| 9. | Alternative methods do not leave any residual effects on produce. | 311(81.0) | 73(19.0) |
| 10 | Indigenous and alternative pest control methods are as effective as the conventional method | 230(59.9) | 154(40.1) |
| 11. | The use of the conventional pest control degrades the environment. | 332(86.5) | 52(13.5) |
| 12. | Residues from the use of conventional method constitute a health risk. | 341(88.8) | 43(11.2) |
| 13. | Hermetic steel drums for storage of cowpea does not require the use of phostoxin tablets | 341(88.8) | 43(11.2) |
| 14 | PICS bag for storage of cowpea does not require the use of phostoxin tablets | 318(82.8) | 66(17.2) |
| 15. | The choice of pest control method influences quality of produce. | 340(88.5) | 44(11.5) |
| 16. | Alternative pest control methods do not harm the environment. | 288(75.0) | 96(25.0) |
| 17. | The choice of pest control method affects marketability of final produce | 295(76.8) | 89(23.2) |
| 18. | Synthetic pesticide can be applied two weeks before harvest | 299(77.9) | 85(22.1) |
| 19. | Spraying can be done when podding is at the maturing stage | 279(72.7) | 105(27.3) |
| 20. | Fumigants must be removed from cowpea and opened up in a airy place to ward off the toxicity | 327(85.2) | 57(14.8) |
| 21. | Phostoxin may be dropped directly in storage bags | 171(44.5) | 213(55.5) |

*Source: Field Survey, 2021*

Furthermore, Table 19 shows distribution of cowpea farmers by knowledge of pest control. It shows majority (90.4%) of respondents had high knowledge of pest control methods while the aggregate percentage score was 78% denoting that most cowpea farmers in Kwara and Niger States are knowledgeable with respect to pest control methods. High knowledge is expected to influence appropriate use of control measures. Jayasooriya & Aheeyar (2016) asserted that adequate knowledge of pest control methods among farmers strongly correlates appropriate use of insect pest control methods. A fundamental constraint to establishing effective pest control system for farmers is dearth of data on their pest control knowledge, perceptions and habits. This finding therefore provides data that may serve as input for planning an extension intervention programme that covers recommendations and monitoring.

**Table 19: Distribution of cowpea farmers according to knowledge level of cowpea insect pest control methods**

|  |  |  |  |
| --- | --- | --- | --- |
| **Range of percentage total score (%)** | **Frequency** | **%** | **Remark** |
| 1 – 30 | 10 | 2.6 | Low knowledge |
| 31 – 60 | 27 | 7.0 | Average knowledge |
| 61 – 100 | 347 | 90.4 | High knowledge |
| Average score | 78 | |  |

*Source: Field Survey, 2021*

# 4.9 Constraints to the choice of insect pest control methods

Results presented in Table 20 shows that risk of failure (mean=2.67), uncertain outcome (mean=2.64), and inadequate capital (mean=2.58) were the leading constraints limiting choice of pest control methods. Risk of failure and uncertain outcome is an indication that cowpea farmers are risk averse. Uncertain outcome is likely associated with reduced contact between subject matter specialists and extension agents leading to incapability of local agents to convince farmers of certainty of methods as derived from research. Farmers’ unwillingness to take risk implies that they may not be quick to adopt improved pest control methods that may be disseminated in the study area. They could be grouped as late majority or laggards (Rogers, 2003). Inadequate capital (mean=2.58) as a constraint to use of cowpea pest control methods may be attributed to high cost of alternative pest control method as earlier reported by Alalade et al. (2017) in Kwara State as some alternative methods are more expensive to adopt. For example, to store one ton of cowpea, PICS bags are more expensive than polypropylene bags and use of synthetic pesticides. Pinthukas (2015) reported comparable outcomes in submitting that information limitations farmers encounter severely undermine adoption efforts. The lack of incentives constitute a constraint to cowpea farmers’ choice of control methods in that use of conventional method is incentivized while there are no incentives for the uptake of either indigenous or alternative methods. Some of these are market and financial in nature. Efforts to ensure safe and reduced use of synthetic pesticides are often in conflict with these incentives. As at the time of data collection, both Kwara and Niger States have input subsidy programmes for a range of fertilizer and synthetic pesticides as well as knapsack sprayers. The lack of incentives may contribute to the discontinuance of use of both indigenous and alternative methods among cowpea farmers.

Efforts to alleviate these constraints must therefore focus on regular training of extension agents to keep them abreast of these alternative methods and to equip them with relevant skills as they fulfil their responsibilities to the farmers. Also, regular training for cowpea farmers and organizing them into small cooperative groups may solve the problem of high cost of alternatives and inadequate capital. These farmers must also be assisted in the marketing of their produce while agricultural development organizations and research institutes must develop appropriate, simple to comprehend advisory manuals that cover production and postharvest activities for use by cowpea farmers.

**Table 20: Distribution of respondents according to constraints limiting choice of insect pest control methods**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Constraints** | **No** | **Yes** | | | | **Mean(SD)** | **Rank** |
| **VS** | **S** | **S** | **ALS** |
| Risk of failure | 21(5.5) | 89(23.2) | 173(45.1) | 50(13.0) | 51(13.3) | 2.67(1.132) | 1st |
| Uncertain outcome | 23(6.0) | 120(31.3) | 106(27.6) | 79(20.6) | 56(14.6) | 2.64(1.229) | 2nd |
| Inadequate capital | 20(5.2) | 118(30.7) | 97(25.3) | 79(20.6) | 70(18.2) | 2.58(1.241) | 3rd |
| High Cost of alternatives | 30(7.8) | 102(26.6) | 115(29.9) | 88(22.9) | 49(12.8) | 2.55(1.228) | 4th |
| Lack of incentives | 11(2.9) | 79(20.6) | 124(32.3) | 118(30.7) | 52(13.5) | 2.54(1.051) | 5th |
| Limited access to information | 31(8.1) | 80(20.8) | 157(40.9) | 60(15.6) | 56(14.6) | 2.52(1.203) | 6th |
| Incompatibility with operation size | 35(9.1) | 92(24.0) | 131(34.1) | 72(18.8) | 54(14.1) | 2.50(1.250) | 7th |
| Profitability not guaranteed | 27(7.0) | 75(19.5) | 152(39.6) | 73(19.0) | 57(14.8) | 2.50(1.167) | 8th |
| Non availability of desired alternatives | 27(7.0) | 70(18.2) | 157(40.9) | 67(17.4) | 63(16.4) | 2.47(1.169) | 9th |
| Limited technical know-how | 18(4.7) | 70(18.2) | 150(39.1) | 70(18.2) | 76(19.8) | 2.46(1.137) | 10th |
| Fear of continued infestation | 41(10.7) | 73(19.0) | 137(35.7) | 79(20.6) | 54(14.1) | 2.38(1.242) | 11th |
| Unfamiliarity with methods of use | 31(8.1) | 60(15.6) | 136(35.4) | 85(22.1) | 72(18.8) | 2.32(1.180) | 12th |
| Lack of alternatives | 37(9.6) | 52(13.5) | 143(37.2) | 83(21.6) | 69(18.0) | 2.27(1.187) | 13th |
| Inadequate support from extension | 37(9.6) | 57(14.8) | 106(27.6) | 101(26.3) | 83(21.6) | 2.16(1.203) | 14th |
| Lack of farmer examples | 63(16.4) | 74(19.3) | 89(23.2) | 98(25.5) | 60(15.6) | 2.13(1.342) | 15th |
| Incompatibility with practices | 35(9.1) | 44(11.5) | 104(27.1) | 114(29.7) | 87(22.7) | 2.09(1.147) | 16th |

*Source: Field Survey, 2021*VS: Very severe S:Severe SS: Somewhat severe ALS: A little severe

# 4.10 Hypotheses of the Study

# 4.10.1 Factors Influencing Use of Conventional Pest Control Methods

Probit regression result presented in Table 21 addresses hypothesis 1 of the study stated in null thus: there is no significant relationship between socio-economic characteristics of respondents and use of conventional control methods.

The results for the Probit analysis for use of pest control methods revealed the model to be well fitted at 1% with a Chi-Square value of 18057.525, p < 0.01. Four variables; age (t=0.21, p<0.01), farm size (t=0.41, p<0.01), group membership (t=0.193, p<0.01) andquantity stored (t=0.003, p<0.01) were positively significant. This demonstrates that for every unit increase in age, hectares farm size, number of groups and tonnage quantity of cowpea stored, there will likely be an increase in the use of pest control methods.

Conversely, variables such as education (t=0.-085,p<0.01), extension contact (t=-0.149, p<0.01), frequency of contact (t=-0.049, p<0.01), farming experience (t=-0.008, p<0.01), have a negative relationship but are significant. Education shows a significant negative relationship with the use of conventional pest control (t=0.085, p<0.01) implying that the more educated a farmer is, the less likely the use of conventional pest control. Education leads to increased awareness of consequences of use of synthetic pesticides.

Extension contact also has a significant negative relationship with the use of conventional pest control (t=0.149, p<0.01). This implies that those who have had contact with agricultural extension agents are less likely to use conventional pest control than those who have no access to them. This is likely so since the use of synthetic pesticides is only one of many recommendations for pest control in cowpea production by extension agents. Similarly, frequency of extension contact also has a significant negative relationship with the use of conventional pest control (t=-0.049, p<0.01) and this suggests that the more a farmer meets extension agent, the more he hears about the different pest control methods and consequently, the likelihood of reducing the use of the conventional method.

Farming experience shows a significant negative relationship with the use of conventional pest control (t=-0.008, p<0.01) and it suggests that the more years of experience a farmer has, the less the use of the conventional method. Therefore, the hypothesis (stated in the null form) that there is no significant relationship between selected socio-economic characteristics of respondents and use of conventional pest control methods was rejected while the alternative was accepted.

The more experienced farmers are expected to have had more trainings, more exposure to research and are generally more aware of the consequences of the use of the conventional method. This finding corroborates the position of Adebayo (2013) that experienced farmers have more favourable attitudes to the use of organic farming practices compared to farmers with fewer years in farming. This is consistent with previous studies on factors influencing the use of pest control methods; Alabi, Oladele & Oladele (2020) observed statistical and significant factors influencing adoption of integrated pest management and pesticides to be age, sex, educational level, household size, extension contact, and experiences in cowpea farming. Correspondingly, Sabo *et al.,* (2014) found that farmers’ use of inorganic pesticides was associated with age, educational attainment, and membership of socio-cultural organization.

**Table 21: Parameter estimates of probit regression analysis showing factors influencing therespondents’use of pest control methods**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **Std. Error** | **Z** | **Sig.** |
| 1. Sex | .027 | .016 | 1.710 | .087 |
| 2.Age | .021 | .001 | 27.419 | .000\* |
| 3. Marital status | -.028 | .009 | -3.261 | .223 |
| 4. Education | -.085 | .006 | -14.734 | .000\* |
| 5. Farm size | .042 | .003 | 12.441 | .000\* |
| 6. Household size | -.002 | .003 | -.585 | .558 |
| 7. Other occupation | -.053 | .006 | -8.868 | .409 |
| 8. Group membership | .193 | .014 | 14.100 | .000\* |
| 9.Group type | -.023 | .004 | -6.473 | .411 |
| 10.Income | .000 | .000 | -55.950 | .232 |
| 11. Quantity Stored | .003 | .001 | 3.738 | .000\* |
| 12. Farming experience | -.008 | .001 | -11.627 | .000\* |
| 13.Land ownership | -.038 | .003 | -11.251 | .224 |
| 14. Extension contact | -.149 | .035 | 4.238 | .000\* |
| 15.Frequency contact | -.049 | .008 | 6.000 | .000\* |
| 16. Types of cowpea | -.019 | .002 | -9.721 | .278 |
| 17.Cropping system | -.032 | .012 | -2.584 | .644 |
| 18.Sources of pesticide | -.033 | .005 | -6.072 | .976 |
| Intercept | -.734 | .059 | -12.370 | .000 |

a. PROBIT model: PROBIT (p) = Intercept + BX; Chi-Square= 18057.525

# 4.10.2 Determinants of Frequency (intensity) of Use of Conventional Pest Control Methods using Ordinary Least Square Regression

This section addresses Hypothesis 2 **(**H0): There exists no significant relationship between selected socio-economic characteristics of cowpea farmers and intensity of use of conventional pest control methods among cowpea farmers in Kwara and Niger States. Table 22 shows summary of results. The Table shows that the coefficient of multiple determinations value of 0.328 revealed that 32.8% of variations in the dependent variable were explained by exogenous variables included in the model. The F-value of 9.882 was significant at 1% probability, showing a relatively good model fit. Regression coefficients of exogenous variables included in the model had both positive and negative direction. The statistical and positive significant variables are farm size in hectares (t=4.681), group membership (t=4.688), and quantity stored in tons (t=2.312). Conversely, years of education (t=-2.196), years of cowpea farming experience (t=-3.419), and frequency of contact (t=-.534) were significant inferring that the six factors significantly define the frequency (intensity) of use of conventional pest control methods hence the research hypothesis (Ho3) was rejected. Its implication is that farm size, group membership and quantity stored in tons positively influence the frequency (intensity) of use of pest control methods while the years of education, years of experience, and sources of pesticide negatively influence the frequency (intensity) of use of pest control methods.

The coefficient of farm size in hectares (t=4.681), group membership (t=4.688) and quantity stored in tons (t=2.312) are indication that that a unit increase in the hectare of land cultivated, year of membership status in group, and tons of cowpea stored by the farmers will increase their frequency of use of pest control methods. On the other hand, the negative coefficient ofyears of education (t=-2.196), years of cowpea farming experience (t=-3.419), and frequency of contact (t=-.534) imply probability for reduced frequency of use of conventional pest control methods at every unit increase in years of education and farming experience in years.

In relation to previous studies, Haddabi (2019) reported that the use of pest control method by cowpea farmers is influenced unswervingly by education profile, size of farm and household as well as experience in years.

**Table 22: OLS estimates of determinants of frequency of use of conventional pest control methods**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Coef. (β)** | **Std. Error** | **t-value** | ***P>|t|*** |
| (Constant) | 30.593 | 4.190 | 7.301 | 0.000 |
| 1. Sex | -.186 | 1.141 | -.163 | 0.871 |
| 2. Age | -.037 | .056 | -.656 | 0.512 |
| 3. Marital Status | -.738 | .672 | -1.098 | 0.273 |
| 4. Education | -.914 | .416 | -2.196 | 0.029\* |
| 5. Farm Size | 1.073 | .229 | 4.681 | 0.000\* |
| 6. Household Size | -.195 | .222 | -.877 | 0.381 |
| 7. Other Occupation | -.812 | .456 | -1.782 | 0.076 |
| 8. Group Membership | 4.880 | 1.041 | 4.688 | 0.000\* |
| 9. Group Type | .386 | .264 | 1.463 | 0.144 |
| 10. Income | 4.249 | .000 | .430 | 0.667 |
| 11. Quantity Stored | .104 | .045 | 2.312 | 0.021\* |
| 12. Farming Experience | -.187 | .055 | -3.419 | 0.001\* |
| 13. Land ownership | -.092 | .245 | -.375 | 0.708 |
| 14. Extension contact | 3.797 | 2.528 | 1.502 | 0.134 |
| 15. Frequency of extension contact | -.534 | .574 | -.931 | 0.000\* |
| 16. Types of Cowpea grown | -.254 | .143 | -1.785 | 0.075 |
| 17. Cropping system | .149 | .928 | .160 | 0.873 |
| 18. Sources of Pesticide | -1.573 | .390 | -4.037 | 0.976 |
| **Model Summary**  Number of obs = 384  R =0.572  R Square =0.328  Adjusted R Square = 0.294  Std. Error of the Estimate =8.179  Root MSE = 8.1785  F =9.882Prob > F = 0.0000\*Significant at p≤0.05 level. | | |  |  |
|  |  |

# 4.10.3 Statistical Difference in the Use of Indigenous, Conventional and Alternative Method

This section addresses Hypothesis 3 **(**H0): There exists no significant difference in use of indigenous, conventional and alternative methods among cowpea farmers. Table 23 shows summary of results. The use of indigenous (F=190.534, p<0.01), use of conventional pest control (F= 4.668; p<0.01), and alternative pest control (F=60.872; p<0.01) statistically differs from one another. This connotes that farmers do not use the different insect pest control methods at the same level. This accords with *a priori* projections and provides factual evidence for the planning of interventions to increase the use of both indigenous and alternative methods. Cowpea farmers’ perception of the different methods plays a role in the choice of methods. Constraints such as uncertainty over outcome of use of alternative methods also contribute to the difference in use of the different methods. The levels of awareness of the methods differ and could be a contributory factor to the significant difference in use among cowpea farmers. Market and financial incentives to farmers have been found to increase the utilization of conventional method above all other methods.

**Table 23: ANOVA showing statistical difference in the use of indigenous, conventional and alternative methods**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | Sum of Squares | Df | Mean Square | F | Sig. |
| **Indigenous** | Between Groups | 6325.060 | 24 | 263.544 | 190.534 | 0.000 |
| Within Groups | 496.565 | 359 | 1.383 |  |  |
| Total | 6821.625 | 383 |  |  |  |
| **Conventional** | Between Groups | 30.205 | 24 | 1.259 | 4.668 | 0.000 |
| Within Groups | 96.792 | 359 | .270 |  |  |
| Total | 126.997 | 383 |  |  |  |
| **Alternative** | Between Groups | 1767.598 | 24 | 73.650 | 60.872 | 0.000 |
| Within Groups | 434.361 | 359 | 1.210 |  |  |
| Total | 2201.958 | 383 |  |  |  |

# 4.10.4 Influence of Knowledge on the Use of Pest Control Methods

This section addresses Hypothesis 4 **(**H0): There exists no significant association between knowledge and use of pest control methods among cowpea farmers. Summary of results (Table 24) reveals that the knowledge of pest control methods has significant association with the use of indigenous, conventional and alternative methods among cowpea farmers (X2=752.900; p<0.01). Therefore, the hypothesis (stated in the null form) that there exists no significant association between knowledge and use of pest control methods among cowpea farmers was rejected while the alternative was accepted. The finding implies that knowledge plays a significant role in the level of use of indigenous, conventional and alternative methods among cowpea farmers in Kwara and Niger States. However, Kishi (2002) reported that while pest control knowledge remains decisive, it does not always lead to a change of practice and behaviour. High knowledge coupled with high use of conventional method points to need for monitoring on the part of government. Going forward, extension agents in both states should document the specifics of farmers knowledge and document them for further training programmes, and for use by subject matter specialists in development of alternative insect pest control methods.

**Table 4: Chi-Square Tests test of association between knowledge on the use of pest control methods**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Value | Df | **Asymp. Sig.** (2-sided) |
| Pearson Chi-Square | 752.900a | 384 | .000 |
| Likelihood Ratio | 483.081 | 384 | .000 |
| Linear-by-Linear Association | 2.390 | 1 | .122 |
| N of Valid Cases | 384 |  |  |
| a. 419 cells (98.6%) have expected count less than 5. The minimum expected count is .00. | | | |
| b. Based on 10000 sampled tables with starting seed 2000000. | | | |
| c. The standardized statistic is 1.546. | | | |

A statistical test of the strength of the association (Table 25) revealed a strong positive relationship as indicated by a Cramer’s V of .350 as well as Contingency Coefficient of .814. The high value of these Chi Square based tests confirms the nexus between the variables. This finding implies that increase in knowledge of pest control methods willlikely increase the level of use of indigenous, conventional and alternative methods among cowpea farmers.

**Table 25: Symmetric Measures of the association between knowledge on the use of pest control methods**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | Value | Asymptotic Standardized Errora | Approximate Tb | Approximate Significance |
| Nominal by Nominal | Phi | 1.400 |  |  | 0.000 |
| Cramer's V | 0.350 |  |  | 0.000 |
| Contingency Coefficient | 0.814 |  |  | 0.000 |
| Ordinal by Ordinal | Gamma | 0.081 | 0.039 | 2.092 | 0.036 |
| Spearman Correlation | 0.104 | 0.050 | 2.041 | 0.042c |
| Interval by Interval | Pearson's R | 0.079 | 0.046 | 1.549 | 0.122c |
| N of Valid Cases | | 384 |  |  |  |
| a. Not assuming the null hypothesis. | | | | | |
| b. Using the asymptotic standard error assuming the null hypothesis. | | | | | |
| c. Based on normal approximation. | | | | | |

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

# 5.1 Summary

The overall purpose of this study was to investigate the use, intensity of use, preference, perceptions and knowledge of indigenous, conventional and alternative insect pest control methods and to determine the factors influencing the selection of insect pest control methods in Kwara and Niger States, Nigeria.

The specific objectives of the study were to describe the awareness, availability and use of insect pest control methods used by cowpea farmers in Kwara and Niger States; determine cowpea farmers’ preferences for insect pest control methods in Kwara and Niger States; investigate the factors influencing cowpea farmers’ insect pest control decisions in Kwara and Niger States; identify the cowpea farmers’ sources of information on insect pest control methods in Kwara and Niger States; examine farmers’ perceptions of insect pest control methods in Kwara and Niger States; examine cowpea farmers’ knowledge on pest control methods in Kwara and Niger States; and to identify the constraints to the choice of pest control methods in Kwara and Niger States.

This study was guided by five hypotheses: H0: There is no significant relationship between socio-economic characteristics of the respondents and their perception of pest control methods. H1: There is significant relationship between socio-economic characteristics of the respondents and their perception of pest control methods. (2) H0: There is no significant relationship between socio-economic characteristics of the respondents and their use of insect pest control methods. H1: There is significant relationship between socio-economic characteristics of the respondents and their use of insect pest control methods. (3) H0: There is no significant relationship socio-economic characteristics of the respondents and the intensity of use of conventional insect pest control method. H1: There is significant relationship socio-economic characteristics of the respondents and the intensity of use of conventional insect pest control method. (4)H0: There is no significant difference in the use of indigenous, conventional and alternative insect pest control methods. H1: There is significant difference in the use of indigenous, conventional and alternative insect pest control methods. (5)H0: There is no significant association between knowledge and use of insect pest control methods. H1: There is significant association between knowledge and use of insect pest control methods.

The study was carried out in two of the four agricultural zones of Kwara state and one of the three agricultural zones in Niger state. A total of 384 cowpea farmers constituted the sample size for the study. Data for the study was collected by means of structured questionnaire through interview schedule. Percentages and means were used to analyze the socio-economic characteristics of the cowpea farmers, level of awareness and availability of indigenous, conventional and alternative insect pest control methods as well as the use and frequency of use of the methods. Similarly, percentage and means were employed to analyze the knowledge level and perception of insect pest control methods, factors considered in the selection of insect pest control methods and the constraints to choice among cowpea farmers. Principal Component Analysis was used to reduce the dimensionality of the factors and extract the key factors considered by cowpea farmers in their insect pest control decisions. Also, Probit and Ordinary Least Square regression were employed to determine the socioeconomic factors influencing use and intensity of use of conventional insect pest control methods among cowpea farmers.

The study revealed that majority of the respondent (80.2 %) was male and the average age of respondents was 50 years. Majority (85.4%) of the respondents were married. About 31.5 percent of the respondents had no formal education while 27.1 percent received primary education. The mean household size of respondents is 6.7. The mean year of experience of our respondents is 18.1 years. Again, there is high extension contact in the study area; majority (89.3 %) of respondents have had contact with extension in the past year with 35.2% having contact with extension agents on a quarterly basis. Almost all (99.2%) of the respondents belonged to a group while majority (75.3%) obtained their pesticides from agricultural input dealers.

Additionally, a little more than half (54.7%) of the respondents cultivated their crops in a sole cropping system. Land ownership by inheritance (59.4%) was predominant among respondents. The majority (81.8%) had holdings between 1.0-5.0 hectares while the 91.1 percent of respondents stored between 1-10 tons. About a quarter of the respondents (24.5%) earned income of between ~~N~~201000-~~N~~400000 while the mean income is ~~N~~ 570,203. The study revealed that indigenous insect pest control methods for field control with highest awareness among respondents include planting early maturing crops that can be harvested early (97.7%), intercrop with non-host plants (93.2%) and use of early planting date (88.5%). For storage of cowpea, the indigenous pest control methods indicated by majority of the respondents include sunning at regular intervals (91.7%), use of jerry cans (89.1%) and storing unthreshed (87.8%). The aggregate average percentage response to awareness of use of indigenous pest control methods was higher for field pest control (74.6%) compared to store pest control (73.4%). There was high awareness of conventional methods to control cowpea pests on field (93.0%) and store (93.8%); and of alternative pest control methods especially PICS Bag (74.7%).

For availability, intercrop with non-host plants (95.6%), planting early maturing crops (94.0%), use of early planting date (89.8%) and ploughing to expose eggs, larvae, nymphs and adults in the soil (85.2%) were the most available indigenous insect pest control methods. For storage, indigenous insect pest control methods indicated to be most available by include: storing unthreshed (87%) and Sunning at regular intervals (87.0%), application of neem extracts (84.9%) and use of jerry-cans (86.2%). Majority of the respondents indicated that use of synthetic chemicals is available for both field pest control (87.8%) and store pest control (90.4%).

Furthermore, the aggregate average percentage for use of indigenous pest control methods was high for field pest control (61.3%) when compared to store pest control (54.2%) implying that indigenous methods for field pest control are used more compared to indigenous methods for store pest control in the study area. Majority of the respondents used synthetic chemicals to control cowpea pests on field (87.8%) and store (79.2%). The most used alternative pest control method is PICS Bag (65.4%). On the whole, 40.0% used alternative methods, 59.0% used indigenous methods and 83.0% used conventional method. The most frequently used indigenous insect pest control methods on field were intercrop with non-host, ploughing to expose eggs, larvae, nymph and adults in the soil, use of early planting date and planting early maturing crops while in store; use of jerry cans, storing unthreshed and sunning at regular intervals. This is in addition to conventional methods in both field and store.

The study also revealed that planting early maturing crops (mean=2.65), use of early planting date (mean=2.56), and use of jerry cans for storage (mean=2.54) were the principal indigenous pest control methods preferred by cowpea farmers in Kwara and Niger States. The use of synthetic pesticides for field pest control in store (mean=2.79) is more preferred to field use (mean=2.33). The result shows that effectiveness of control method, availability of pest control method, and quantity of pesticide required were the main factors considered for cowpea field pest control methods while the intended time of sale, time required to apply control method, and time of application were the most important factors considered for cowpea store pest control methods in Kwara and Niger States. Agricultural Development Project (ADP) agents (mean=2.49), input dealers (mean=2.39), agricultural research institutes (mean=2.31) were the most utilized source of information on insect pest control. Analysis of knowledge level of insect pest control reveals that majority (90.4%) of the respondents had high knowledge of pest control methods while the aggregate percentage score was 78%. The risk of failure (mean=2.67), uncertain outcome (mean=2.64), and inadequate capital (mean=2.58) were the principal constraints limiting choice of insect pest control methods.

The Probit regression of factors influencing use of insect pest control methods reveals that four variables such as age (t=0.21, p<0.01), farm size (t=0.41, p<0.01), group membership (t=0.193, p<0.01) and quantity stored (t=0.003, p<0.01) were positively significant. This demonstrates that unit increase in years of age, number of hectares farm size and tonnage quantity of cowpea stored, there will likely be an increase in the use of insect pest control methods in the study area. However, variables such as education (t=0.-085, p<0.01), extension contact (t=-0.149, p<0.01), frequency of contact (t=-0.049, p<0.01), farming experience (t=-0.008, p<0.01) had a significant negative relationship with the use of insect pest control methods in the study area.

Analysis of the factors influencing intensity of use by means of Ordinary Least Square regression also demonstrates positive significant relationship between farm size (t=4.681), group membership (t=4.688), and quantity stored in tons (t=2.312) and intensity of use. Conversely, years of education (t=-2.196), years of cowpea farming experience (t=-3.419), and frequency of extension contact (t=-.534) had significant negative relationship with intensity of use.

# 5.2. Conclusion

This study presents fresh perspectives on the awareness, availability, and use of indigenous, conventional and alternative insect pest control methods and provides empirical information on some socioeconomic factors that influence the use of the insect pest control methods in Kwara and Niger States, Nigeria. Also, it investigated the preference, knowledge, perceptions and factors considered by cowpea farmers in their insect pest control decisions. Based on the major findings of the study, the following conclusions are drawn:

The level of awareness of alternative insect pest control methods both on field and in store was low. The implication of low awareness of these methods is evident in the low use of the methods in store and the virtual non-use of these methods on field. The level of use of the conventional insect pest control methods was high among the respondents. There exists a significant difference in the use of the three methods. The knowledge level was high and there are similarities between farmers’ preferences for insect pest control and the methods they currently employ in tackling their insect problems. In making choice of insect pest control method to use on the farm and in store, effectiveness of control method, availability of pest control method, quantity of pesticide required, time of application, intended time of sale, time required to apply control method were the foremost considerations.

The use of the conventional method is currently incentivized in both states and input dealers represent a key source of information for the respondents. The risk of failure, uncertainty of outcome and inadequate capital were the main constraints to choice of insect pest control methods. On the whole, relationship exists between the independent variables and use of the method and frequency of use of the methods. Age, farm size, quantity stored, education and group membership are some of the factors that determine use and frequency of use.

# 5.3 Recommendations

The analysis of the collected data and the findings of the study provide insight to diverse stakeholders including government, policy makers, agricultural extension workers and donors on the current realities and allows for the development of appropriate interventions and guidelines to increase the uptake of alternative insect pest control methods, integrated pest management and low-synthetic pesticide-input pest management systems in general.

Based on the major findings, the study recommends the following:

1. Awareness creation as a matter of policy by government be carried out primarily through methods suitable to the socioeconomic characteristics of the farmers. The use of electronic media is emphasized but most importantly in the local language of the respondents. More awareness creation and popularization of alternative pest control methods is recommended in response to the low awareness.
2. Enforcement and sanctions are required to ensure conformity with standards since knowledge is relatively high. The existence of a standard without enforcement is tantamount to no standards. Frameworks for monitoring and reviewing the use of these alternative methods and their outcomes should be developed by government.
3. Promotion of Integrated Pest Management in its truest sense by research institutes and agricultural development organizations. If farmers must use synthetic pesticides, a combination of indigenous and alternative methods with low-pesticide-input would greatly reduce incidences of poisoning and deaths. It will engender responsible production in a sustainable manner.
4. Training and licensing of input dealers is recommended since farmers are especially reliant on them for information on pest control. Farmers and extension workers receive one form of training or the other but input dealers are left to do as they please. The business should be regulated by government and professionalized in a manner akin to pharmaceuticals. This is because they handle equally lethal and harmful substances.
5. Extension linkage with research should be strengthened so as to facilitate the spread of the methods and results. This would help extension staff to provide answers to questions of risk of failure and uncertainty of outcome that constitute barriers to the use of alternative insect pest control methods among farmers. Monthly Technical Review Meetings (MTRMs) and Fortnight Trainings (FNTs) should be resuscitated in ADP offices with the participation of subject matter specialists.
6. Uptake and use of alternative methods should be incentivized as it is sustainable. Akin to what obtains in the conventional where farmers receive market and financial incentives, alternative insect pest control methods and low-synthetic pesticide-input pest management should be subsidized by government and other non-governmental organizations to make them attractive to farmers.
7. Age, education, group membership, farm size, income, quantity stored, experience extension contact and frequency of contact were chief factors that influence perception and determine use and frequency of use of insect pest control methods. It is therefore recommended that policy makers and agricultural professionals should critically consider the roles of these factors in the extension strategy when designing agricultural development programmes and technology dissemination programmes.

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# APPENDIX I: RESEARCH INSTRUMENT

**INSECT PEST CONTROL METHODS AMONG COWPEA FARMERS IN SELECTED STATES IN NORTH CENTRAL NIGERIA**

Agricultural Extension and Rural Development Programme,

Department of Agricultural Economics and Extension,

College of Agricultural Sciences,

Landmark University, Omu Aran, Kwara State

**Dear respondent,**

I am a postgraduate student in the Department of Agricultural Economics and Extension, Landmark University, Omu Aran, Kwara State, currently researching the topic: **“INSECT PEST CONTROL METHODS AMONG COWPEA FARMERS IN SELECTED STATES IN NORTH CENTRAL NIGERIA”.**

Kindly answer the questions as appropriate to the best of your knowledge. All information provided therein will be treated with utmost confidentiality.

Thank you.

**Owojaiye Oluwasanjo Biodun**

1. **SOCIOECONOMIC CHARACTERISTICS**
2. Sex: (a) Male[ ] (b) Female [ ]
3. Age:
4. Marital status: (a) Single [ ] (b) Married [ ] (c) Divorced [ ] (d) Separated [ ]

(e) Widower [ ]

1. Level of education: (a) 0 year(No formal education) [ ] (b) 6 years(Primary education) [ ] (c) 12 years (secondary education) [ ] (d) 14 years (Tertiary education) [ ]
2. Farm size (ha):
3. Household size:
4. Other Occupation: Agriculture based off-farm [ ] Trading other commodities [ ] Civil Servant [ ] Artisan [ ]
5. Group Membership: Yes [ ] No [ ]
6. Group Membership Type: Cooperative society [ ] Credit and Thrift [ ]Farmers’ Association[ ] FADAMA User Group [ ] Others
7. Annual Income: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. Quantity stored: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. Farming Experience (years):
10. Land Ownership: Inheritance [ ] Purchase [ ] Lease [ ] Gift [ ] Leasehold at the will of Government [ ] Communal [ ]
11. Do you have Contact with extension agent? : Yes …… No ……….
12. Frequency of contact: Weekly [ ] Fortnightly [ ] Monthly [ ] Quarterly [ ] Annually [ ]
13. Type of cowpea varieties grown:
14. How do you grow your cowpea? Sole cropping [ ] Mixed cropping [ ]
15. Source of Pesticides Used: …………………………………..
16. **AWARENESS, AVAILABILITY AND USE OF PEST CONTROL METHODS**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Field** | | | | | | | | | |
|  |  | **Awareness** | | **Availability** | | **Use** | | **Frequency of Use** | | |
| **S/N** | **Indigenous Methods** | **Yes** | **No** | **Yes** | **No** | **Yes** | **No** | **Always** | **Sometimes** | **Never** |
|  | Spray application of ash mixture on foliage |  |  |  |  |  |  |  |  |  |
|  | Intercrop with non-host plants |  |  |  |  |  |  |  |  |  |
|  | Handpicking of insect immature stages |  |  |  |  |  |  |  |  |  |
|  | Ploughing to expose eggs, larvae, nymphs and adults in the soil |  |  |  |  |  |  |  |  |  |
|  | Use of early planting date |  |  |  |  |  |  |  |  |  |
|  | Planting early maturing crops that can be harvested early |  |  |  |  |  |  |  |  |  |
|  | Inorganic compounds: e.g. salt |  |  |  |  |  |  |  |  |  |
|  | Removing weed host of pests |  |  |  |  |  |  |  |  |  |
|  | Application of Neem extracts |  |  |  |  |  |  |  |  |  |
|  | Application of pepper fruit extract |  |  |  |  |  |  |  |  |  |
|  | **Conventional Method** | | | | | | |  | | |
| 11. | Use of synthetic chemicals |  |  |  |  |  |  |  |  |  |
|  | **Other Alternative Methods (please list)** | | | | | | |  | | |
| A. C. | | | | | | | | | | |
| B. D. | | | | | | | | | | |
|  | **Store** | | | | | | | | | |
|  |  | **Awareness** | | **Availability** | | **Use** | | **Frequency of Use** | | |
|  | **Indigenous** | **Yes** | **No** | **Yes** | **No** | **Yes** | **No** | **Always** | **Sometimes** | **Never** |
| 12. | Admixture with wood ash |  |  |  |  |  |  |  |  |  |
| 13. | Application of Neem extracts |  |  |  |  |  |  |  |  |  |
| 14. | Use of Jerry Cans |  |  |  |  |  |  |  |  |  |
| 15. | Storing unthreshed |  |  |  |  |  |  |  |  |  |
| 16. | Sunning at regular intervals |  |  |  |  |  |  |  |  |  |
| 17. | Admixture with fine sand |  |  |  |  |  |  |  |  |  |
| 18. | Admixture with clay dust |  |  |  |  |  |  |  |  |  |
| 19. | Use of cooking oils (sunflower, cotton seed, groundnut) |  |  |  |  |  |  |  |  |  |
|  | **Conventional Method** | | | | | | | | | |
| 19. | Use of synthetic pesticides |  |  |  |  |  |  |  |  |  |
|  | **Alternative Methods** | | | | | | | | | |
| 20. | NSPRIDUST |  |  |  |  |  |  |  |  |  |
| 21. | ZeroFly® hermetic bag |  |  |  |  |  |  |  |  |  |
| 22. | Cold Treatment |  |  |  |  |  |  |  |  |  |
| 23. | PICS Bag |  |  |  |  |  |  |  |  |  |
| 24. | Improved Drying |  |  |  |  |  |  |  |  |  |
| 25. | NSPRI Hermetic Steel Drum |  |  |  |  |  |  |  |  |  |
| 26. | Improved Inert Atmosphere Silo® |  |  |  |  |  |  |  |  |  |

1. **PREFERENCE FOR PEST CONTROL METHODS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/N** | **Available Pest control methods** | **Most Preferred** | **Preferred** | **Least Preferred** |
| **Field** | | | |  |
| **Indigenous Methods** | | | |  |
| 1. | Spray application of ash mixture on foliage |  |  |  |
| 2. | Intercrop with non-host plants |  |  |  |
| 3. | Handpicking of insect immature stages |  |  |  |
| 4. | Ploughing to expose eggs, larvae, nymphs and adults in the soil |  |  |  |
| 5. | Use of early planting date |  |  |  |
| 6. | Planting early maturing crops that can be harvested early |  |  |  |
| 7. | Inorganic compounds: e.g. salt |  |  |  |
| 8. | Removing weed host of pests |  |  |  |
| 9. | Application of Neem extracts |  |  |  |
| 10. | Application of pepper fruit extract |  |  |  |
| **Conventional Method** | | | |  |
| 11. | Use of synthetic chemicals |  |  |  |
| **Other Alternative Methods (please list)** | | | |  |
| A. C. | | | | |
| B. D. | | | | |
|  | **Store** | | |  |
|  | **Indigenous** | | |  |
| 17. | Admixture with wood ash |  |  |  |
| 18. | Application of Neem extracts |  |  |  |
| 19. | Use of Jerry Cans |  |  |  |
| 20. | Storing unthreshed |  |  |  |
| 21. | Sun drying at regular intervals |  |  |  |
| 22. | Admixture with fine sand |  |  |  |
| 23. | Admixture with clay dust |  |  |  |
| 24. | Use of cooking oils (sunflower, cotton seed, groundnut) |  |  |  |
|  | **Conventional Method** | | |  |
| 25. | Use of synthetic pesticides |  |  |  |
|  | **Alternative Methods** |  |  |  |
| 26. | NSPRIDUST |  |  |  |
| 27. | ZeroFly® hermetic bag |  |  |  |
| 28. | Cold Treatment |  |  |  |
| 29. | PICS Bag |  |  |  |
| 30. | Improved Drying |  |  |  |
| 31. | NSPRI Hermetic Steel Drum |  |  |  |
| 32. | Improved Inert Atmosphere Silo® |  |  |  |

1. **FARMERS’ CONSIDERATIONS IN PEST CONTROL DECISIONS**

Which factors do you consider before selecting pest control method to use in field and in store?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| S/N | **Factors** | Yes | No | Not Important | Important | Very Important |
|  | Cost of control method |  |  |  |  |  |
|  | Time required to apply control method |  |  |  |  |  |
|  | Quantity of pesticide required |  |  |  |  |  |
|  | Availability of pest control method |  |  |  |  |  |
|  | Size of farm |  |  |  |  |  |
|  | Ease of application of pest control method |  |  |  |  |  |
|  | Method of application of pest control |  |  |  |  |  |
|  | Period of field protection desired |  |  |  |  |  |
|  | Period of efficiency of control method |  |  |  |  |  |
|  | Climatic and environmental condition |  |  |  |  |  |
|  | Time of application |  |  |  |  |  |
|  | Tradition |  |  |  |  |  |
|  | Advice from agrochemical dealers |  |  |  |  |  |
|  | Recommendation by extension agents |  |  |  |  |  |
|  | Counsel by researcher/ or any other professionals like personnel from research Institutes. |  |  |  |  |  |
|  | Used by peers |  |  |  |  |  |
|  | Level of infestation |  |  |  |  |  |
|  | Effectiveness of control method |  |  |  |  |  |
|  | Familiarity with control method |  |  |  |  |  |
|  | Price/cost benefit analysis |  |  |  |  |  |
|  | Labour requirement |  |  |  |  |  |
|  | Type of pest |  |  |  |  |  |
|  | Intended time of harvest |  |  |  |  |  |
| **Store** | | | | | | |
|  | Cost of control method |  |  |  |  |  |
|  | Time required to apply control method |  |  |  |  |  |
|  | Quantity of pesticide required |  |  |  |  |  |
|  | Availability of pest control method |  |  |  |  |  |
|  | Quantity of grains to be stored |  |  |  |  |  |
|  | Ease of application of pest control method |  |  |  |  |  |
|  | Method of application of pest control |  |  |  |  |  |
|  | Period of storage desired |  |  |  |  |  |
|  | Period of efficiency of control method |  |  |  |  |  |
|  | Climatic and environmental condition |  |  |  |  |  |
|  | Time of application |  |  |  |  |  |
|  | Tradition |  |  |  |  |  |
|  | Advice from agrochemical dealers |  |  |  |  |  |
|  | Recommendation by extension agents |  |  |  |  |  |
|  | Counsel by researcher/ or any other professionals like personnel from stored products research institute |  |  |  |  |  |
|  | Used by peers |  |  |  |  |  |
|  | Level of infestation |  |  |  |  |  |
|  | Effectiveness of control method |  |  |  |  |  |
|  | Familiarity with control method |  |  |  |  |  |
|  | Price/cost benefit analysis |  |  |  |  |  |
|  | Labour requirement |  |  |  |  |  |
|  | Type of pest |  |  |  |  |  |
|  | Intended time of sale |  |  |  |  |  |

1. **SOURCE OF INFORMATION ON PEST CONTROL METHODS**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S/N** | **Information Sources** | **Yes** | **No** | **Frequently Utilized** | **Occasionally Utilized** | **Rarely Utilized** |
| **Indigenous Pest Control Methods** | | | | | | |
| 1. | Television |  |  |  |  |  |
| 2. | Radio |  |  |  |  |  |
| 3. | ADP |  |  |  |  |  |
| 4. | Agricultural Research Institutes |  |  |  |  |  |
| 5. | Journals |  |  |  |  |  |
| 6. | Social Media |  |  |  |  |  |
| 7. | Print Media |  |  |  |  |  |
| 8. | Input Dealers |  |  |  |  |  |
| 9. | Fellow Farmers |  |  |  |  |  |
| 10. | Family Members |  |  |  |  |  |
| 11. | Farmers Group |  |  |  |  |  |
| 12. | Cooperative Societies |  |  |  |  |  |

1. **FARMER’S PERCEPTION OF PEST CONTROL METHODS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S/N** | **Statements** | **Strongly Agree** | **Agree** | **Disagree** | **Strongly Disagree** |
| 1. | A good pest control method kills pests immediately |  |  |  |  |
| 2. | A selected pest control method must kill all insect pests |  |  |  |  |
| 3. | Any of the pest control methods guarantees insect-free cowpea |  |  |  |  |
| 4. | Cowpea production is impossible without the use of synthetic pesticides as a pest control |  |  |  |  |
| 5. | The level of pest infestation determines the type of control method to be used. |  |  |  |  |
| 6. | Mixing different pest control methods improves their potency |  |  |  |  |
| 7. | Time of application of synthetic pesticides does not affect harvesting and consumption |  |  |  |  |
| 8. | Indigenous pest control in field and store requires the addition of synthetic pesticides for effectiveness |  |  |  |  |
| 10. | Alternative pest control in field and store requires the use of synthetic pesticides for effectiveness |  |  |  |  |
| 12. | Indigenous pest control is sufficient on its own |  |  |  |  |
| 13. | Conventional pest control is sufficient on its own |  |  |  |  |
| 14. | Alternative pest control is sufficient on its own |  |  |  |  |
| 15 | The use of the conventional method on field and in store guarantees insect-free cowpea. |  |  |  |  |
| 16. | The use of indigenous methods on field and in store guarantees insect-free cowpea. |  |  |  |  |
| 17. | The use of alternative methods on field and in store guarantees insect-free cowpea. |  |  |  |  |
| 18. | Indigenous pest control is the most effective method |  |  |  |  |
| 19. | Conventional pest control is the most effective method |  |  |  |  |
| 20. | Alternative pest control is the most effective method |  |  |  |  |
| 22. | Conventional pest control method is better because they save time |  |  |  |  |
| 26. | Indigenous pest control methods are better because they require less labour |  |  |  |  |
| 27. | Conventional pest control method is better because they require less labour |  |  |  |  |
| 29. | Indigenous pest control methods kills pests quickly |  |  |  |  |
| 30. | Conventional pest control method kills pests quickly |  |  |  |  |
| 32. | The efficacy of the use of indigenous pest control methods is easily ascertained |  |  |  |  |
| 33. | The efficacy of the use of conventional pest control method is easily ascertained. |  |  |  |  |
| 35. | Washing crop with warm water before cooking takes care of any residual effect. |  |  |  |  |
| 36. | The use of conventional pest control on field and store guarantee profits |  |  |  |  |
| 37. | The possibility of re-application of synthetic pesticides many times makes it more advantageous |  |  |  |  |
| 38. | Indigenous pest control methods are not suitable for large farms and stores |  |  |  |  |
| 41. | You don’t have to adhere strictly to instruction on the label |  |  |  |  |
| 42. | Residue of chemicals is not dangerous to consumers |  |  |  |  |

1. **FARMER’S KNOWLEDGE OF PEST CONTROL METHODS**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Statements** | **True** | **False** |
|  | Pest control methods have far reaching effects beyond the control of pests alone |  |  |
|  | A pest control method should eliminate pests and not merely inhibit their activities. |  |  |
|  | The use of synthetic pesticides leads to ecosystem imbalance |  |  |
|  | There is a chance of food poisoning with conventional method use |  |  |
|  | There is a waiting time associated with the use of the conventional method in field and in store. |  |  |
|  | Indigenous methods are effective on small and large farms |  |  |
|  | Any quantity of synthetic pesticides can be administered as long as it keeps cowpea in good condition |  |  |
|  | Synthetic pesticides should be used as recommended on the container. |  |  |
|  | Alternative methods do not leave any residual effects on produce. |  |  |
|  | Indigenous and alternative pest control methods are as effective as the conventional method |  |  |
|  | The use of the conventional pest control degrades the environment. |  |  |
| **12.** | Residues from the use of conventional method constitute a health risk. |  |  |
| **13.** | Hermetic steel drums for storage of cowpea does not require the use of phostoxin tablets |  |  |
| **14.** | PICS bag for storage of cowpea does not require the use of phostoxin tablets |  |  |
| **15.** | The choice of pest control method influences quality of produce. |  |  |
| **16.** | Alternative pest control methods do not harm the environment. |  |  |
| **17.** | The choice of pest control method affects marketability of final produce |  |  |
| **18.** | Synthetic pesticide can be applied two weeks before harvest |  |  |
| **19.** | Spraying can be done when podding is at the maturing stage |  |  |
| **20.** | Fumigants must be removed from cowpea and opened up in a airy place to ward off the toxicity |  |  |
| **21** | Phostoxin may be dropped directly in storage bags |  |  |

1. **CONSTRAINTS LIMITING CHOICE OF PEST CONTROL METHODS**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S/N.** | **Constraints** | **Yes** | **No** | **Very Severe** | **Severe** | **Somewhat Severe** | **A little severe** |
| 1. | Incompatibility with operation size |  |  |  |  |  |  |
| 2. | Risk of failure |  |  |  |  |  |  |
| 3. | Limited access to information |  |  |  |  |  |  |
| 4. | Uncertain outcome |  |  |  |  |  |  |
| 5. | Limited technical know-how |  |  |  |  |  |  |
| 6 | Inadequate capital |  |  |  |  |  |  |
| 7. | Unfamiliarity with methods of use |  |  |  |  |  |  |
| 8. | Fear of continued infestation |  |  |  |  |  |  |
| 9. | High Cost of alternatives |  |  |  |  |  |  |
| 10. | Lack of alternatives |  |  |  |  |  |  |
| 11. | Inadequate support from extension |  |  |  |  |  |  |
| 12. | Incompatibility with practices |  |  |  |  |  |  |
| 13. | Lack of farmer examples |  |  |  |  |  |  |
| 14. | Profitability not guaranteed |  |  |  |  |  |  |
| 15. | Lack of incentives |  |  |  |  |  |  |
| 16. | Non availability of desired alternatives |  |  |  |  |  |  |

# APPENDIX II: DATA SHEETS

**Table 21: Social Characteristics of Farmers**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Frequency (n=384)** | **Percentage** | **Mean (Std Dev.)** |
| **Sex** |  |  |  |
| Male | 308 | 80.2 |  |
| Female | 76 | 19.8 |  |
| **Age (years)** |  |  | 48.9 (10.71) |
| 21 – 40 | 89 | 23.2 |  |
| 41 – 60 | 247 | 64.3 |  |
| 61 and above | 48 | 12.5 |  |
| Min.= 21 |  |  |  |
| Max.= 80 |  |  |  |
| **Marital Status** |  |  |  |
| Single | 22 | 5.7 |  |
| Married | 328 | 85.4 |  |
| Divorced | 11 | 2.9 |  |
| Separated | 8 | 2.1 |  |
| **Level of Education** |  |  |  |
| 0 year (No formal education) | 121 | 31.5 |  |
| 1-6years (Primary education) | 104 | 27.1 |  |
| 7-12years (Secondary education) | 73 | 19.0 |  |
| Above 12years (Tertiary education) | 86 | 22.4 |  |
| **Household size (persons)** |  |  | 6.7 (2.61) |
| 1 – 5 | 130 | 33.9 |  |
| 6 – 10 | 225 | 58.6 |  |
| 11 and above | 29 | 7.6 |  |
| Min.= 2 |  |  |  |
| Max.= 15 |  |  |  |
| **Other Occupation** |  |  |  |
| Agriculture-based off-farm | 219 | 57.1 |  |
| Trading of other commodities | 61 | 15.9 |  |
| Civil Servant | 76 | 19.8 |  |
| Artisan | 28 | 7.3 |  |

**Table 22: Economic Characteristics of Respondents**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Frequency** | **Percentage** | **Mean (Std Dev.)** |
| **Cowpea Farm size (Hectares)** |  |  | 3.6 (2.59) |
| Less than 1.0 | 10 | 2.6 |  |
| 1.0 – 5.0 | 314 | 81.8 |  |
| 6.0 – 10.0 | 45 | 11.7 |  |
| 10.1 and above | 15 | 3.9 |  |
| Min.= 0.5 |  |  |  |
| Max.= 13.0 |  |  |  |
| **Quantity Stored (Tons)** |  |  | 4.1 (11.66) |
| Less than 1 | 141 | 36.7 |  |
| 1 – 10 | 209 | 54.4 |  |
| 11 – 20 | 25 | 6.5 |  |
| Above 20 | 9 | 2.3 |  |
| Min.= 0.04 |  |  |  |
| Max.= 120 |  |  |  |
| **Annual Income (Naira)** |  |  | 570,203.1 (579,407.95) |
| ≤ 200,000 | 107 | 27.9 |  |
| 201,000 - 400,000 | 94 | 24.5 |  |
| 401,000 – 600,000 | 71 | 18.5 |  |
| 601,000 – 1,000,000 | 61 | 15.9 |  |
| Above 1,000,000 | 51 | 13.3 |  |
| Min.= 20,000 |  |  |  |
| Max.= 3,500,000 |  |  |  |

**Table 23: Experience, Land Ownership and Type of Cowpea Variety grown**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Frequency** | **Percentage** | **Mean (Std Dev.)** |
| **Experience in Cowpea Farming (years)** |  |  | 18.1 (9.58) |
| 1 – 10 | 106 | 27.6 |  |
| 11 – 20 | 153 | 39.8 |  |
| 21 – 30 | 73 | 19.0 |  |
| Above 30 | 52 | 13.5 |  |
| Min.= 3, Max.= 41 |  |  |  |
| **Land Ownership for Cowpea Farming** |  |  |  |
| Inherited | 228 | 59.4 |  |
| Purchase | 16 | 4.2 |  |
| Lease | 31 | 8.1 |  |
| Gift | 40 | 10.4 |  |
| Lease at the will of government | 4 | 1.0 |  |
| Communal | 65 | 16.9 |  |
| **Type of Cowpea Variety grown** | 19 | 4.9 |  |
| SAMPEA-7 | 31 | 8.1 |  |
| SAMPEA-8 | 25 | 6.5 |  |
| SAMPEA-9 | 40 | 10.4 |  |
| SAMPEA-10 | 19 | 4.9 |  |
| Benanado/Beewko/Bewene | 6 | 1.6 |  |
| Brown | 37 | 9.6 |  |
| Ife Brown | 5 | 1.3 |  |
| Drum | 6 | 1.6 |  |
| Kwankwaso | 16 | 4.2 |  |
| IAT | 16 | 4.2 |  |
| Hybrid | 1 | 0.3 |  |
| Local | 103 | 26.8 |  |
| **Cropping System** |  |  |  |
| Sole cropping | 210 | 54.7 |  |
| Mixed cropping | 174 | 45.3 |  |

**Table 24: Access to Social Contact**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Frequency** | **Percentage** |
| **Contact with Extension Agents** |  |  |
| Yes | 341 | 89.3 |
| No | 41 | 10.7 |
| **Frequency of contact with Extension Agents** |  |  |
| No contact | 41 | 10.7 |
| Weekly | 6 | 1.6 |
| Fortnightly | 46 | 12.0 |
| Monthly | 135 | 35.2 |
| Quarterly | 131 | 34.1 |
| Annually | 25 | 6.5 |
| **Sources of Pesticides** |  |  |
| ADP | 77 | 20.1 |
| Agro-dealers | 289 | 75.3 |
| AFAN | 2 | 0.5 |
| Others | 16 | 4.2 |
| **Group Membership** |  |  |
| Yes | 281 | 99.2 |
| No | 3 | 0.8 |
| **Group Membership Type** |  |  |
| Cooperative Society | 82 | 21.4 |
| Credit and Thrift | 19 | 4.9 |
| Farmers’ Association | 90 | 23.4 |
| FADAMA Users’ group | 52 | 13.5 |
| Others | 55 | 14.3 |
| None | 3 | 0.8 |

**Table 25: Awareness of the use of insect pest control methods**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Pest Control Methods** | **Aware** | **Not Aware** |
| **A.** | **Field Pest Control** | **Freq. (%)** | **Freq. (%)** |
|  | **Indigenous** |  |  |
| 1. | Spray application of ash mixture on foliage | 268 (69.8) | 116(30.2) |
| 2. | Intercrop with non-host plants | 358 (93.2) | 26(6.8) |
| 3. | Handpicking of insect immature stages | 310 (80.7) | 74(19.3) |
| 4. | Ploughing to expose eggs, larvae, nymphs and adults in the soil | 331 (86.2) | 53(13.8) |
| 5. | Use of early planting date | 340 (88.5) | 44(11.5) |
| 6. | Planting early maturing crops that can be harvested early | 375 (97.7) | 9(2.3) |
| 7. | Inorganic compounds: e.g. salt | 188 (49.0) | 196(51.0) |
| 8. | Removing weed host of pests | 263 (68.5) | 121(31.5) |
| 9. | Application of Neem extracts | 245 (63.8) | 139(36.2) |
| 10. | Application of pepper fruit extract | 187 (48.7) | 197(51.3) |
|  | *Average percentage response* | ***74.6%*** |  |
|  | **Conventional** |  |  |
| 11. | Use of synthetic chemicals | 357(93.0) | 27(7.0) |
| **B.** | **Store Pest Control** |  |  |
|  | **Indigenous** |  |  |
| 12. | Admixture with wood ash | 310(80.7) | 74(19.3) |
| 13. | Application of Neem extracts | 311(81.0) | 73(19.0) |
| 14. | Use of Jerry Cans | 342(89.1) | 42(10.9) |
| 15. | Storing unthreshed | 337(87.8) | 47(12.2) |
| 16. | Sunning at regular intervals | 352(91.7) | 32(8.3) |
| 17. | Admixture with fine sand | 219(57.0) | 165(43.0) |
| 18. | Admixture with clay dust | 159(41.4) | 225(58.6) |
| 19. | Use of cooking oils (sunflower, cotton seed, groundnut) | 225(58.6) | 159(41.4) |
|  | *Average percentage response* | ***73.4%*** |  |
|  | **Conventional** |  |  |
| 19. | Use of synthetic pesticides | 360(93.8) | 24(6.3) |
|  | **Alternative** |  |  |
| 20. | NSPRIDUST | 149(38.8) | 235(61.2) |
| 21. | ZeroFly® hermetic bag | 193(50.3) | 191(49.7) |
| 22. | Cold Treatment | 188(49.0) | 196(51.0) |
| 23. | PICS Bag | 287(74.7) | 97(25.3) |
| 24. | Improved Drying | 236(61.5) | 148(38.5) |
| 25. | NSPRI Hermetic Steel Drum | 227(59.1) | 157(40.9) |
| 26. | Improved Inert Atmosphere Silo® | 223(58.1) | 161(41.9) |
|  | *Average percentage response* | ***55.9%*** |  |

Aware=1, Not aware=0

**Table 26: Availability of pest control methods**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Pest Control Methods** | **Available** | **Not Available** |
| **A** | **Field Pest Control** | **Freq. (%)** | **Freq. (%)** |
|  | **Indigenous** |  |  |
| 1. | Spray application of ash mixture on foliage | 305 (79.4) | 79(20.6) |
| 2. | Intercrop with non-host plants | 367 (95.6) | 17(4.4) |
| 3. | Handpicking of insect immature stages | 303 (78.9) | 81(21.1) |
| 4. | Ploughing to expose eggs, larvae, nymphs and adults in the soil | 327 (85.2) | 57(14.8) |
| 5. | Use of early planting date | 345 (89.8) | 39(10.2) |
| 6. | Planting early maturing crops that can be harvested early | 361 (94.0) | 23(6.0) |
| 7. | Inorganic compounds: e.g. salt | 244 (63.5) | 140(36.5) |
| 8. | Removing weed host of pests | 274 (71.4) | 110(28.6) |
| 9, | Application of Neem extracts | 277 (72.1) | 107(27.9) |
| 10. | Application of pepper fruit extract | 243 (63.3) | 141(36.7) |
|  | *Average percentage response* | ***79.3%*** |  |
|  | **Conventional** |  |  |
| 11. | Use of synthetic chemicals | 337(87.8) | 47(12.2) |
| **B.** | **Store Pest Control** |  |  |
|  | **Indigenous** |  |  |
| 12. | Admixture with wood ash | 326(84.9) | 58(15.1) |
| 13. | Application of Neem extracts | 326(84.9) | 58(15.1) |
| 14. | Use of Jerry Cans | 331(86.2) | 53(13.8) |
| 15. | Storing unthreshed | 334(87.0) | 50(13.0) |
| 16. | Sunning at regular intervals | 334(87.0) | 50(13.0) |
| 17. | Admixture with fine sand | 229(59.6) | 155(40.4) |
| 18. | Admixture with clay dust | 184(47.9) | 200(52.1) |
| 19. | Use of cooking oils (sunflower, cotton seed, groundnut) | 264(68.8) | 120(31.3) |
|  | *Average percentage response* | ***75.8%*** |  |
|  | **Conventional** |  |  |
| 19. | Use of synthetic pesticides | 347(90.4) | 37(9.6) |
|  | **Alternative** |  |  |
| 20. | NSPRIDUST | 78(20.3) | 306(79.7) |
| 21. | ZeroFly® hermetic bag | 138(36.2) | 245(63.8) |
| 22. | Cold Treatment | 196(51.0) | 188(49.0) |
| 23. | PICS Bag | 245(63.8) | 139(36.2) |
| 24. | Improved Drying | 253(65.9) | 131(34.1) |
| 25. | NSPRI Hermetic Steel Drum | 223(58.1) | 161(41.9) |
| 26. | Improved Inert Atmosphere Silo® | 263(68.5) | 121(31.5) |

Available=1, Not available=0

**Table 27: Use of Insect Pest Control Methods**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Pest Control Methods** | **Used** | **Not used** |
| **A** | **Field Pest Control** | **Freq. (%)** | **Freq. (%)** |
|  | **Indigenous** |  |  |
| 1. | Spray application of ash mixture on foliage | 165 (43.0) | 219(57.0) |
| 2. | Intercrop with non-host plants | 321 (83.6) | 63(16.4) |
| 3. | Handpicking of insect immature stages | 237 (61.7) | 147(38.3) |
| 4. | Ploughing to expose eggs, larvae, nymphs and adults in the soil | 301 (78.4) | 83(21.6) |
| 5. | Use of early planting date | 349 (90.9) | 35(9.1) |
| 6. | Planting early maturing crops that can be harvested early | 347 (90.4) | 37(9.6) |
| 7. | Inorganic compounds: e.g. salt | 138 (35.9) | 246(64.1) |
| 8. | Removing weed host of pests | 229 (59.6) | 155(40.4) |
| 9. | Application of Neem extracts | 150 (39.1) | 234(60.9) |
| 10. | Application of pepper fruit extract | 115 (29.9) | 243(63.3) |
|  | *Average percentage response* | ***61.3%*** |  |
|  | **Conventional** |  |  |
| 11. | Use of synthetic chemicals | 337(87.8) | 47(12.2) |
| **B.** | **Store Pest Control** |  |  |
|  | **Indigenous** |  |  |
| 12. | Admixture with wood ash | 218(56.8) | 166(43.2) |
| 13. | Application of Neem extracts | 195(50.8) | 189(49.2) |
| 14. | Use of Jerry Cans | 308(80.2) | 76(19.8) |
| 15. | Storing unthreshed | 269(70.1) | 115(29.9) |
| 16. | Sunning at regular intervals | 297(77.3) | 87(22.7) |
| 17. | Admixture with fine sand | 112(29.2) | 272(70.8) |
| 18. | Admixture with clay dust | 101(26.3) | 283(73.7) |
| 19. | Use of cooking oils (sunflower, cotton seed, groundnut) | 166(43.2) | 218(56.8) |
|  | *Average percentage response* | ***54.2%*** |  |
|  | **Conventional** |  |  |
| 19. | Use of synthetic pesticides | 304(79.2) | 80(20.8) |
|  | **Alternative** |  |  |
| 20. | NSPRIDUST | 73(19.0) | 311(81.0) |
| 21. | ZeroFly® hermetic bag | 109(28.4) | 275(71.6) |
| 22. | Cold Treatment | 145(37.8) | 239(62.2) |
| 23. | PICS Bag | 251(65.4) | 133(34.6) |
| 24. | Improved Drying | 177(46.1) | 207(53.9) |
| 25. | NSPRI Hermetic Steel Drum | 169(44.0) | 215(56.0) |
| 26. | Improved Inert Atmosphere Silo® | 160(41.7) | 224(58.3) |
|  | *Average percentage response* | ***40.3%*** |  |

**Table 28: Level of use of pest control methods**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Range of Percentage Total Score (%)** | **Indigenous** | | **Conventional** | | **Alternative** | | **Combined** | | **Remark** |
|  | **Freq.** | **%** | **Freq.** | **%** | **Freq.** | **%** | **Freq.** | **%** |  |
| 0 | 0 | 0.0 | 21 | 5.5 | 78 | 20.3 | 0 | 0.0 | No usage |
| 1 – 30 | 22 | 5.7 | 0 | 0.0 | 134 | 34.9 | 47 | 12.2 | Low usage |
| 31 – 60 | 205 | 53.4 | 85 | 22.1 | 53 | 13.8 | 200 | 52.1 | Average usage |
| 61 – 100 | 157 | 40.9 | 278 | 72.4 | 119 | 31.0 | 137 | 35.7 | High usage |
| Average score | 59 | | 83 | | 40 | | 56 | |  |

**Table 29: Frequency of use of pest control methods**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S/N** | **Pest Control Methods** | **Always used** | **Often Used** | **Rarely Used** | **Mean(SD)** | **Remark** |
| **A** | **Field Pest Control** | **Freq. (%)** | **Freq. (%)** | **Freq. (%)** |  |  |
|  | **Indigenous** |  |  |  |  |  |
| 1. | Spray application of ash mixture on foliage | 36(9.4) | 129(33.6) | 219(57.0) | 0.52(0.66) | Not frequently used |
| 2. | Intercrop with non-host plants | 165(43.0) | 156(40.6) | 63(16.4) | 1.27(0.72) | Frequently used |
| 3. | Handpicking of insect immature stages | 72(18.8) | 165(43.0) | 147(38.3) | 0.80(0.73) | Not frequently used |
| 4. | Ploughing to expose eggs, larvae, nymphs and adults in the soil | 212(55.2) | 89(23.2) | 83(21.6) | 1.34(0.81) | Frequently used |
| 5. | Use of early planting date | 273(71.1) | 76(19.8) | 35(9.1) | 1.62(0.64) | Frequently used |
| 6. | Planting early maturing crops that can be harvested early | 294(76.6) | 53(13.8) | 37(9.6) | 1.67(0.64) | Frequently used |
| 7. | Inorganic compounds: e.g. salt | 27(7.0) | 111(28.9) | 246(64.1) | 0.43(0.62) | Not frequently used |
| 8. | Removing weed host of pests | 111(28.9) | 118(30.7) | 155(40.4) | 0.89(0.83) | Not frequently used |
| 9. | Application of Neem extracts | 102(26.6) | 45(11.7) | 237(61.7) | 0.65(0.87) | Not frequently used |
| 10. | Application of pepper fruit extract | 83(21.6) | 62(16.1) | 239(62.2) | 0.59(0.82) | Not frequently used |
|  | **Conventional** |  |  |  |  |  |
| 11. | Use of synthetic chemicals | 273(71.1) | 66(17.2) | 45(11.7) | 1.59(0.69) | Frequently used |
| **B.** | **Store Pest Control** |  |  |  |  |  |
|  | **Indigenous** |  |  |  |  |  |
| 12. | Admixture with wood ash | 90(23.4) | 128(33.3) | 166(43.2) | 0.80(0.79) | Not frequently used |
| 13. | Application of Neem extracts | 109(28.4) | 86(22.4) | 189(49.2) | 0.79(0.86) | Not frequently used |
| 14. | Use of Jerry Cans | 169(44.0) | 139(36.2) | 76(19.8) | 1.24(0.76) | Frequently used |
| 15. | Storing unthreshed | 135(35.2) | 134(34.9) | 115(29.9) | 1.05(0.81) | Frequently used |
| 16. | Sunning at regular intervals | 160(41.7) | 137(35.7) | 87(22.7) | 1.19(0.78) | Frequently used |
| 17. | Admixture with fine sand | 35(9.1) | 77(20.1) | 272(70.8) | 0.38(0.65) | Not frequently used |
| 18. | Admixture with clay dust | 51(13.3) | 50(13.0) | 283(73.7) | 0.40(0.71) | Not frequently used |
| 19. | Use of cooking oils (sunflower, cotton seed, groundnut) | 87(22.7) | 79(20.6) | 218(56.8) | 0.66(0.83) | Not frequently used |
|  | **Conventional** |  |  |  |  |  |
| 19b. | Use of synthetic pesticides | 223(58.1) | 81(21.1) | 80(20.8) | 1.37(0.81) | Frequently used |
|  | **Alternative** |  |  |  |  |  |
| 20. | NSPRIDUST | 20(5.2) | 53(13.8) | 311(81.0) | 0.24(0.54) | Not frequently used |
| 21. | ZeroFly® hermetic bag | 34(8.9) | 75(19.5) | 275(71.6) | 0.37(0.64) | Not frequently used |
| 22. | Cold Treatment | 64(16.7) | 81(21.1) | 239(62.2) | 0.54(0.73) | Not frequently used |
| 23. | PICS Bag | 102(26.6) | 149(38.8) | 133(34.6) | 0.92(0.78) | Not frequently used |
| 24. | Improved Drying | 67(17.4) | 140(36.5) | 177(46.1) | 0.71(0.74) | Not frequently used |
| 25. | NSPRI Hermetic Steel Drum | 61(15.9) | 108(28.1) | 215(56.0) | 0.60(0.75) | Not frequently used |
| 26. | Improved Inert Atmosphere Silo® | 83(21.6) | 77(20.1) | 224(58.3) | 0.63(0.82) | Not frequently used |

Scale: Always=2, Sometimes=1, never=0.

**Table 30: Preference for pest control methods**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Most Preferred | Preferred | Least Preferred | Mean (SD) | Rank |
| ***Field*** |  |  |  |  |  |
| Planting early maturing crops that can be harvested early | 271(70.6) | 91(23.7) | 22(5.7) | 2.65(0.586) | 1st |
| Use of early planting date | 236(61.5) | 126(32.6) | 22(5.7) | 2.56(0.602) | 2nd |
| Use of synthetic pesticides for field pest control (conventional method) | 206(53.6) | 99(25.8) | 79(20.6) | 2.33(0.797) | 3rd |
| Ploughing to expose eggs, larvae, nymphs and adults in the soil | 184(47.9) | 140(36.5) | 60(15.6) | 2.32(0.730) | 4th |
| Intercrop with non-host plants | 132(34.4) | 193(50.3) | 59(15.4) | 2.19(0.680) | 5th |
| Removing weed host of pests | 105(27.3) | 169(44.0) | 110(28.6) | 1.99(0.749) | 6th |
| Handpicking of insect immature stages | 52(13.5) | 198(51.6) | 134(34.9) | 1.79(0.663) | 7th |
| Inorganic compounds:e.g. salt | 96(25.0) | 108(28.1) | 180(46.9) | 1.78(0.820) | 8th |
| Application of Neem extracts | 96(25.0) | 86(22.4) | 202(52.6) | 1.72(0.838) | 9th |
| Spray application of ash mixture on foliage | 72(18.8) | 116(30.2) | 196(51.0) | 1.68(0.771) | 10th |
| Application of pepper fruit extract | 76(19.8) | 87(22.7) | 221(57.6) | 1.62(0.795) | 11th |
| ***Store*** |  |  |  |  |  |
| Use of synthetic pesticides for store pest control | 327(85.2) | 33(8.6) | 24(6.3) | 2.79(0.541) | 1st |
| Use of Jerry Cans | 238(62.0) | 117(30.5) | 29(7.6) | 2.54(0.633) | 2nd |
| Sun drying at regular intervals | 168(43.8) | 163(42.4) | 53(13.8) | 2.30(0.698) | 3rd |
| Storing unthreshed | 159(41.4) | 153(39.8) | 72(18.8) | 2.23(0.743) | 4th |
| PICS Bag | 169(44.0) | 84(21.9) | 131(34.1) | 2.10(0.879) | 5th |
| Admixture with wood ash | 106(27.6) | 94(24.5) | 184(47.9) | 1.80(0.846) | 6th |
| Application of Neem extracts | 78(20.3) | 141(36.7) | 165(43.0) | 1.77(0.764) | 7th |
| NSPRI Hermetic Steel Drum | 79(20.6) | 128(33.3) | 177(46.1) | 1.74(0.777) | 8th |
| Use of cooking oils (sunflower, cotton seed, groundnut) | 108(28.1) | 53(13.8) | 223(58.1) | 1.70(0.880) | 9th |
| Improved Drying | 89(23.2) | 81(21.1) | 214(55.7) | 1.67(0.828) | 10th |
| Improved Inert Atmosphere Silo® | 74(19.3) | 91(23.7) | 219(57.0) | 1.62(0.789) | 11th |
| Admixture with fine sand | 57(14.8) | 100(26.0) | 227(59.1) | 1.56(0.738) | 12th |
| Cold Treatment | 45(11.7) | 127(33.1) | 212(55.2) | 1.54(0.694) | 13th |
| ZeroFly® hermetic bag | 39(10.2) | 131(34.1) | 214(55.7) | 1.54(0.673) | 14th |
| Admixture with clay dust | 60(15.6) | 47(12.2) | 277(72.1) | 1.43(0.748) | 15th |
| NSPRIDUST | 15(3.9) | 75(19.5) | 294(76.6) | 1.27(0.527) | 16th |

Most Preferred=3, Preferred=2, Least Preferred=1

**Table 31: Important factors considered for cowpea field pest control methods**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factors** | **No** | **Yes** | | Mean (SD) | Rank |
| Not Important | Important | Very important |
| Effectiveness of control method | 28(7.3) | 193(50.3) | 163(42.4) | 1.35(0.612) | 1st |
| Availability of pest control method | 52(13.5) | 158(41.1) | 174(45.3) | 1.32(0.699) | 2nd |
| Quantity of pesticide required | 51(13.3) | 159(41.4) | 174(45.3) | 1.32(0.696) | 3rd |
| Climatic and environmental condition | 45(11.7) | 175(45.6) | 164(42.7) | 1.31(0.670) | 4th |
| Labour requirement | 51(13.3) | 165(43.0) | 168(43.8) | 1.30(0.692) | 5th |
| Advice from agrochemical dealers | 81(21.1) | 111(28.9) | 192(50.0) | 1.29(0.793) | 6th |
| Time of application | 47(12.2) | 177(46.1) | 160(41.7) | 1.29(0.674) | 7th |
| Time required to apply control method | 60(15.6) | 164(42.7) | 160(41.7) | 1.26(0.712) | 8th |
| Recommendation by extension agents | 80(20.8) | 128(33.3) | 176(45.8) | 1.25(0.778) | 9th |
| Price/cost benefit analysis | 56(14.6) | 179(46.6) | 149(38.8) | 1.24(0.690) | 10th |
| Intended time of harvest | 51(13.3) | 196(51.0) | 137(35.7) | 1.22(0.664) | 11th |
| Familiarity with control method | 42(10.9) | 214(55.7) | 128(33.3) | 1.22(0.627) | 12th |
| Level of infestation | 67(17.4) | 172(44.8) | 145(37.8) | 1.20(0.716) | 13th |
| Method of application of pest control | 56(14.6) | 198(51.6) | 130(33.9) | 1.19(0.670) | 14th |
| Period of efficiency of control method | 75(19.5) | 168(43.8) | 141(36.7) | 1.17(0.731) | 15th |
| Size of farm | 56(14.6) | 221(57.6) | 107(27.9) | 1.13(0.639) | 16th |
| Type of pest | 91(23.7) | 152(39.6) | 141(36.7) | 1.13(0.767) | 17th |
| Cost of control method | 88(22.9) | 163(42.4) | 133(34.6) | 1.12(0.751) | 18th |
| Period of field protection desired | 85(22.1) | 168(43.8) | 131(34.1) | 1.12(0.741) | 19th |
| Counsel by researcher/ or any other professionals like personnel from research Institutes. | 115(29.9) | 117(30.5) | 152(39.5) | 1.10(0.829) | 20th |
| Ease of application of pest control method | 90(23.4) | 171(44.5) | 123(32.0) | 1.09(0.741) | 21st |
| Used by peers | 110(28.6) | 160(41.7) | 114(29.7) | 1.01(0.765) | 22nd |
| Tradition | 123(32.0) | 137(35.7) | 124(32.3) | 1.00(0.803) | 23rd |

Not Important=0, Important=1, Very Important=2

**Table 32: Important factors considered for Store Pest Control Methods**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factors** | **No** | **Yes** | | **Mean (SD)** | Rank |
| Not Important | Important | Very important |
| Intended time of sale | 29(7.6) | 121(31.5) | 234(60.9) | 1.55(0.633) | 1st |
| Time required to apply control method | 40(10.4) | 123(32.0) | 221(57.6) | 1.47(0.677) | 2nd |
| Time of application | 37(9.6) | 143(37.2) | 204(53.1) | 1.43(0.663) | 3rd |
| Quantity of pesticide required | 43(11.2) | 137(35.7) | 204(53.1) | 1.42(0.685) | 4th |
| Cost of control method | 44(11.5) | 145(37.8) | 195(50.8) | 1.39(0.685) | 5th |
| Climatic and environmental condition | 21(5.5) | 191(49.7) | 172(44.8) | 1.39(0.591) | 6th |
| Type of pest | 42(10.9) | 153(39.8) | 189(49.2) | 1.38(0.675) | 7th |
| Availability of pest control method | 22(5.7) | 196(51.0) | 166(43.2) | 1.38(0.591) | 8th |
| Quantity of grains to be stored | 19(4.9) | 206(53.6) | 159(41.4) | 1.36(0.576) | 9th |
| Familiarity with control method | 25(6.5) | 200(52.1) | 159(41.4) | 1.35(0.599) | 10th |
| Labour requirement | 41(10.7) | 174(45.3) | 169(44.0) | 1.33(0.661) | 11th |
| Effectiveness of control method | 11(2.9) | 241(62.8) | 132(34.4) | 1.32(0.523) | 12th |
| Period of storage desired | 51(13.3) | 163(42.4) | 170(44.3) | 1.31(0.693) | 13th |
| Price/cost benefit analysis | 28(7.3) | 210(54.7) | 146(38.0) | 1.31(0.600) | 14th |
| Method of application of pest control | 33(8.6) | 207(53.9) | 144(37.5) | 1.29(0.615) | 15th |
| Recommendation by extension agents | 48(12.5) | 200(52.1) | 136(35.4) | 1.23(0.654) | 16th |
| Advice from agrochemical dealers | 65(16.9) | 169(44.0) | 150(39.1) | 1.22(0.716) | 17th |
| Ease of application of pest control method | 49(12.8) | 214(55.7) | 121(31.5) | 1.19(0.639) | 18th |
| Period of efficiency of control method | 79(20.6) | 156(40.6) | 149(38.8) | 1.18(0.750) | 19th |
| Level of infestation | 49(12.8) | 245(63.8) | 90(23.4) | 1.11(0.593) | 20th |
| Counsel by researcher/ or any other professionals like personnel from stored products research institute | 94(24.5) | 169(44.0) | 121(31.5) | 1.07(0.746) | 21st |
| Used by peers | 83(21.6) | 198(51.6) | 103(26.8) | 1.05(0.695) | 22nd |
| Tradition | 127(33.1) | 130(33.9) | 127(33.1) | 1.00(0.814) | 23rd |

Not Important=0, Important=1, Very Important=2

**Table 33: Principal component analysis (PCA) of Factors Considered in Selection of Cowpea Pest Control Methods**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Component | | | Communalities  Extraction |
| Factor 1 | Factor 2 | Factor 3 |
| **Factors** |  |  |  |  |
| Cost of control method | .001 | -.061 | **.133** | .788 |
| Time required to apply control method | **.113** | -.098 | .025 | .776 |
| Quantity of pesticide required | **.124** | -.079 | -.009 | .775 |
| Availability of pest control method | **.120** | -.082 | -.001 | .757 |
| Quantity of grains to be stored\* | **.113** | **-.**111 | .039 | .797 |
| Ease of application of pest control method | .023 | **.102** | -.050 | .825 |
| Method of application of pest control | .063 | .074 | -.099 | .810 |
| Period of storage desired | .064 | .050 | -.071 | .844 |
| Period of efficiency of control method | .019 | .082 | -.026 | .765 |
| Climatic and environmental condition | **.122** | -.027 | -.064 | .807 |
| Time of application | -.013 | .074 | .011 | .757 |
| Tradition | -.076 | .006 | **.144** | .776 |
| Advice from agrochemical dealers | -.070 | -.003 | **.157** | .735 |
| Recommendation by extension agents | -.039 | .063 | .031 | .771 |
| Counsel by researcher/ or any other professionals like personnel from stored products research institute | -.046 | .091 | .027 | .750 |
| Used by peers | -.020 | -.034 | **.160** | .804 |
| Level of infestation | -.012 | .021 | .099 | .760 |
| Effectiveness of control method | .023 | .034 | .036 | .789 |
| Familiarity with control method | -.029 | **.122** | -.025 | .780 |
| Price/cost benefit analysis | -.069 | **.188** | -.029 | .793 |
| Labour requirement | -.047 | **.163** | -.044 | .805 |
| Type of pest | -.077 | **.178** | .014 | .797 |
| Intended time of sale | .042 | .029 | .004 | .779 |
| Eigen Value | 8.459 | 6.113 | 5.712 |  |
| Variance explained | 18.389 | 13.289 | 12.418 |  |
| Cumulative % of variance explained | 18.389 | 31.679 | 44.096 |  |
| Bartlett's test of sphericity chi-square value= 16885.159 \*\*\* p=0.000 | | | |  |
| Kaiser-Meyer-Olkin measure of sampling adequacy = 0.749 | | |  |  |
| Overall Cronbach's alpha = 0.94 | | |  |  |
| Rotation Method: Varimax with Kaiser Normalization. | | | |  |

Note: Factor loadings greater than ±0.10 are shown in bold print

Statistical Significance at p≤ 0.01 (\*)

\* Variable that loaded under more than one factor

*Source: Field Survey, 2021*

**Table 34: Sources of information on insect pest control methods**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sources** | No | Yes, Utilized | | | Mean (SD) | Rank |
| Frequently | Occasionally | Rarely |
| ADP | 2(0.5) | 245(63.8) | 85(22.1) | 52(13.5) | 2.49(0.744) | 1st |
| Input Dealers | 3(0.8) | 206(53.6) | 123(32.0) | 52(13.5) | 2.39(0.746) | 2nd |
| Agricultural Research Institutes | 3(0.8) | 192(50.0) | 121(31.5) | 68(17.7) | 2.31(0.785) | 3rd |
| Farmers Group | 8(2.1) | 177(46.1) | 149(38.8) | 50(13.0) | 2.29(0.770) | 4th |
| Radio | 10(2.6) | 185(48.2) | 133(34.6) | 56(14.6) | 2.28(0.808) | 5th |
| Fellow Farmers | 7(1.8) | 188(49.0) | 107(27.9) | 82(21.4) | 2.24(0.849) | 6th |
| Family Members | 20(5.2) | 162(42.2) | 110(28.6) | 92(24.0) | 2.08(0.931) | 7th |
| Television | 25(6.5) | 95(24.7) | 179(46.6) | 85(22.1) | 1.90(0.849) | 8th |
| Cooperative Societies | 19(4.9) | 122(31.4) | 113(29.4) | 130(33.9) | 1.88(0.918) | 9th |
| Social Media | 30(7.8) | 88(22.9) | 99(25.8) | 167(43.5) | 1.64(0.921) | 10th |
| Print Media | 16(4.2) | 62(16.1) | 56(14.6) | 250(65.1) | 1.43(0.808) | 11th |
| Journals | 32(8.3) | 36(9.4) | 80(20.8) | 236(61.5) | 1.31(0.755) | 12th |

No=0, Rarely=1, Occasionally=2, Frequently=3

**Table 35: Perceptions on pest control methods**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| S/N | Perception | SA | A | D | SD | Mean(SD) | Remark |
| 1. | A good pest control method kills pests immediately | 214(55.7) | 148(38.5) | 22(5.7) | 0 | 3.50(0.605) | Positive |
| 2. | A selected pest control method must kill all insect pests | 154(40.1) | 133(34.6) | 66(17.2) | 31(8.1) | 3.07(0.945) | Positive |
| 3. | Any of the pest control methods guarantees insect-free cowpea | 190(46.9) | 153(39.8) | 22(5.7) | 29(7.6) | 3.26(0.873) | Positive |
| 4. | Cowpea production is impossible without the use of synthetic pesticides as a pest control | 157(40.9) | 146(38.0) | 71(18.5) | 10(2.6) | 3.17(0.819) | Positive |
| 5. | The level of pest infestation determines the type of control method to be used. | 185(48.2) | 161(41.9) | 38(9.9) | 0 | 3.38(0.660) | Positive |
| 6. | Mixing different pest control methods improves their potency | 155(40.4) | 116(30.2) | 68(17.7) | 45(11.7) | 2.99(1.026) | Positive |
| 7. | Time of application of synthetic pesticides does not affect harvesting and consumption | 112(29.2) | 126(32.8) | 65(16.9) | 81(21.1) | 2.70(1.104) | Positive |
| 8. | Indigenous pest control in field and store requires the addition of synthetic pesticides for effectiveness | 166(43.2) | 136(35.4) | 69(18.0) | 13(3.4) | 3.18(0.846) | Positive |
| 10. | Alternative pest control in field and store requires the use of synthetic pesticides for effectiveness | 146(38.0) | 158(41.1) | 66(17.2) | 14(3.6) | 3.14(0.825) | Positive |
| 12. | Indigenous pest control is sufficient on its own | 100(26.0) | 146(38.0) | 111(28.9) | 27(7.0) | 2.83(0.897) | Positive |
| 13. | Conventional pest control is sufficient on its own | 166(43.2) | 146(38.0) | 21(5.5) | 51(13.3) | 3.11(1.007) | Positive |
| 14. | Alternative pest control is sufficient on its own | 111(28.9) | 155(40.4) | 74(19.3) | 44(11.5) | 2.87(0.962) | Positive |
| 15. | The use of the conventional method on field and in store guarantees insect-free cowpea. | 176(45.8) | 145(37.8) | 23(6.0) | 40(10.4) | 3.19(0.949) | Positive |
| 16. | The use of indigenous methods on field and in store guarantees insect-free cowpea. | 131(34.1) | 141(36.7) | 88(22.9) | 24(6.3) | 2.99(0.907) | Positive |
| 17. | The use of alternative methods on field and in store guarantees insect-free cowpea. | 115(29.9) | 167(43.5) | 88(22.9) | 14(3.6) | 3.00(0.822) | Positive |
| 18. | Indigenous pest control is the most effective method | 129(33.6) | 136(35.4) | 72(18.8) | 47(12.2) | 2.90(1.003) | Positive |
| 19. | Conventional pest control is the most effective method | 208(54.2) | 133(34.6) | 29(7.6) | 14(3.6) | 3.39(0.781) | Positive |
| 20. | Alternative pest control is the most effective method | 160(41.7) | 105(27.3) | 84(21.9) | 35(9.1) | 3.02(1.001) | Positive |
| 22. | Conventional pest control method is better because they save time | 175(45.6) | 136(35.4) | 44(11.5) | 29(7.6) | 3.19(0.916) | Positive |
| 26. | Indigenous pest control methods are better because they require less labour | 125(32.6) | 142(37.0) | 108(28.1) | 9(2.3) | 3.00(0.838) | Positive |
| 27. | Conventional pest control method is better because they require less labour | 154(40.1) | 131(34.1) | 85(22.1) | 14(3.6) | 3.11(0.871) | Positive |
| 29. | Indigenous pest control methods kills pests quickly | 131(34.1) | 105(27.3) | 107(27.9) | 41(10.7) | 2.85(1.013) | Positive |
| 30. | Conventional pest control method kills pests quickly | 150(39.1) | 181(47.1) | 35(9.1) | 18(4.7) | 3.21(0.793) | Positive |
| 32. | The efficacy of the use of indigenous pest control methods is easily ascertained | 145(37.8) | 131(34.1) | 91(23.7) | 17(4.4) | 3.05(0.889) | Positive |
| 33. | The efficacy of the use of conventional pest control method is easily ascertained. | 132(34.4) | 192(50.0) | 44(11.5) | 16(4.2) | 3.15(0.778) | Positive |
| 35. | Washing crop with warm water before cooking takes care of any residual effect. | 130(33.9) | 166(43.2) | 28(7.3) | 60(15.6) | 2.95(1.018) | Positive |
| 36. | The use of conventional pest control on field and store guarantee profits | 142(37.0) | 172(44.8) | 32(8.3) | 38(9.9) | 3.09(0.918) | Positive |
| 37. | The possibility of re-application of synthetic pesticides many times makes it more advantageous | 107(27.9) | 159(41.4) | 84(21.9) | 34(8.9) | 2.88(0.917) | Positive |
| 38. | Indigenous pest control methods are not suitable for large farms and stores | 103(26.8) | 129(33.6) | 101(26.3) | 51(13.3) | 2.74(0.999) | Positive |
| 41. | You don’t have to adhere strictly to instruction on the label | 62(16.1) | 64(16.7) | 73(19.0) | 185(48.2) | 2.01(1.139) | Negative |
| 42. | Residue of chemicals is not dangerous to consumers | 75(19.5) | 24(6.3) | 60(15.6) | 225(58.6) | 1.87(1.190) | Negative |
|  | **Aggregate mean perception** |  |  |  |  | 2.99 | Positive |

SA=4, A=3, D=2, SD=1

**Table 36: Knowledge on pest control methods**

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | **Knowledge Statements** | **True** | **False** |
| 1. | Pest control methods have far reaching effects beyond the control of pests alone | 333(86.7) | 51(13.3) |
| 2. | A pest control method should eliminate pests and not merely inhibit their activities. | 323(84.1) | 61(15.9) |
| 3. | The use of synthetic pesticides leads to ecosystem imbalance | 311(81.0) | 73(19.0) |
| 4. | There is a chance of food poisoning with conventional method use | 329(85.7) | 55(14.3) |
| 5. | There is a waiting time associated with the use of the conventional method in field and in store. | 315(82.0) | 69(18.0) |
| 6. | Indigenous methods are effective on small and large farms | 234(60.9) | 150(39.1) |
| 7. | Any quantity of synthetic pesticides can be administered as long as it keeps cowpea in good condition | 251(65.4) | 133(34.6) |
| 8. | Synthetic pesticides should be used as recommended on the container. | 327(85.2) | 57(14.8) |
| 9. | Alternative methods do not leave any residual effects on produce. | 311(81.0) | 73(19.0) |
| 10 | Indigenous and alternative pest control methods are as effective as the conventional method | 230(59.9) | 154(40.1) |
| 11. | The use of the conventional pest control degrades the environment. | 332(86.5) | 52(13.5) |
| 12. | Residues from the use of conventional method constitute a health risk. | 341(88.8) | 43(11.2) |
| 13. | Hermetic steel drums for storage of cowpea does not require the use of phostoxin tablets | 341(88.8) | 43(11.2) |
| 14 | PICS bag for storage of cowpea does not require the use of phostoxin tablets | 318(82.8) | 66(17.2) |
| 15. | The choice of pest control method influences quality of produce. | 340(88.5) | 44(11.5) |
| 16. | Alternative pest control methods do not harm the environment. | 288(75.0) | 96(25.0) |
| 17. | The choice of pest control method affects marketability of final produce | 295(76.8) | 89(23.2) |
| 18. | Synthetic pesticide can be applied two weeks before harvest | 299(77.9) | 85(22.1) |
| 19. | Spraying can be done when podding is at the maturing stage | 279(72.7) | 105(27.3) |
| 20. | Fumigants must be removed from cowpea and opened up in a airy place to ward off the toxicity | 327(85.2) | 57(14.8) |
| 21. | Phostoxin may be dropped directly in storage bags | 171(44.5) | 213(55.5) |

**Table 37: Knowledge level of pest control methods on cowpea**

|  |  |  |  |
| --- | --- | --- | --- |
| **Range of percentage total score (%)** | **Frequency** | **%** | **Remark** |
| 1 – 30 | 10 | 2.6 | Low knowledge |
| 31 – 60 | 27 | 7.0 | Average knowledge |
| 61 – 100 | 347 | 90.4 | High knowledge |
| Average score | 78 | |  |

**Table 38: Constraints limiting choice of pest control methods**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Constraints | No | Yes | | | | Mean(SD) | Rank |
| Very severe | Severe | Somewhat severe | A little severe |
| Risk of failure | 21(5.5) | 89(23.2) | 173(45.1) | 50(13.0) | 51(13.3) | 2.67(1.132) | 1st |
| Uncertain outcome | 23(6.0) | 120(31.3) | 106(27.6) | 79(20.6) | 56(14.6) | 2.64(1.229) | 2nd |
| Inadequate capital | 20(5.2) | 118(30.7) | 97(25.3) | 79(20.6) | 70(18.2) | 2.58(1.241) | 3rd |
| High Cost of alternatives | 30(7.8) | 102(26.6) | 115(29.9) | 88(22.9) | 49(12.8) | 2.55(1.228) | 4th |
| Lack of incentives | 11(2.9) | 79(20.6) | 124(32.3) | 118(30.7) | 52(13.5) | 2.54(1.051) | 5th |
| Limited access to information | 31(8.1) | 80(20.8) | 157(40.9) | 60(15.6) | 56(14.6) | 2.52(1.203) | 6th |
| Incompatibility with operation size | 35(9.1) | 92(24.0) | 131(34.1) | 72(18.8) | 54(14.1) | 2.50(1.250) | 7th |
| Profitability not guaranteed | 27(7.0) | 75(19.5) | 152(39.6) | 73(19.0) | 57(14.8) | 2.50(1.167) | 8th |
| Non availability of desired alternatives | 27(7.0) | 70(18.2) | 157(40.9) | 67(17.4) | 63(16.4) | 2.47(1.169) | 9th |
| Limited technical know-how | 18(4.7) | 70(18.2) | 150(39.1) | 70(18.2) | 76(19.8) | 2.46(1.137) | 10th |
| Fear of continued infestation | 41(10.7) | 73(19.0) | 137(35.7) | 79(20.6) | 54(14.1) | 2.38(1.242) | 11th |
| Unfamiliarity with methods of use | 31(8.1) | 60(15.6) | 136(35.4) | 85(22.1) | 72(18.8) | 2.32(1.180) | 12th |
| Lack of alternatives | 37(9.6) | 52(13.5) | 143(37.2) | 83(21.6) | 69(18.0) | 2.27(1.187) | 13th |
| Inadequate support from extension | 37(9.6) | 57(14.8) | 106(27.6) | 101(26.3) | 83(21.6) | 2.16(1.203) | 14th |
| Lack of farmer examples | 63(16.4) | 74(19.3) | 89(23.2) | 98(25.5) | 60(15.6) | 2.13(1.342) | 15th |
| Incompatibility with practices | 35(9.1) | 44(11.5) | 104(27.1) | 114(29.7) | 87(22.7) | 2.09(1.147) | 16th |

**Table 45: Parameter estimates of probit regression analysis showing factors influencing the respondents’ use of pest control methods**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **Std. Error** | **Z** | **Sig.** |
| 1. Sex | .027 | .016 | 1.710 | .087 |
| 2.Age | .021 | .001 | 27.419 | .000\* |
| 3. Marital status | -.028 | .009 | -3.261 | .223 |
| 4. Education | -.085 | .006 | -14.734 | .000\* |
| 5. Farm size | .042 | .003 | 12.441 | .000\* |
| 6. Household size | -.002 | .003 | -.585 | .558 |
| 7. Other occupation | -.053 | .006 | -8.868 | .409 |
| 8. Group membership | .193 | .014 | 14.100 | .000\* |
| 9.Group type | -.023 | .004 | -6.473 | .411 |
| 10.Income | .000 | .000 | -55.950 | .232 |
| 11. Quantity Stored | .003 | .001 | 3.738 | .000\* |
| 12. Farming experience | -.008 | .001 | -11.627 | .000\* |
| 13.Land ownership | -.038 | .003 | -11.251 | .224 |
| 14. Extension contact | -.149 | .035 | 4.238 | .000\* |
| 15.Frequency contact | -.049 | .008 | 6.000 | .000\* |
| 16. Types of cowpea | -.019 | .002 | -9.721 | .278 |
| 17.Cropping system | -.032 | .012 | -2.584 | .644 |
| 18.Sources of pesticide | -.033 | .005 | -6.072 | .976 |
| Intercept | -.734 | .059 | -12.370 | .000 |

a. PROBIT model: PROBIT (p) = Intercept + BX; Chi-Square= 18057.525

**Table 46: Ordinary Least Square estimates of the determinants of frequency of use ofconventional pest control methods**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Coef. (β)** | **Std. Error** | **t-value** | ***P>|t|*** |
| (Constant) | 30.593 | 4.190 | 7.301 | 0.000 |
| 1. Sex | -.186 | 1.141 | -.163 | 0.871 |
| 2. Age | -.037 | .056 | -.656 | 0.512 |
| 3. Marital Status | -.738 | .672 | -1.098 | 0.273 |
| 4. Education | -.914 | .416 | -2.196 | 0.029\* |
| 5. Farm Size | 1.073 | .229 | 4.681 | 0.000\* |
| 6. Household Size | -.195 | .222 | -.877 | 0.381 |
| 7. Other Occupation | -.812 | .456 | -1.782 | 0.076 |
| 8. Group Membership | 4.880 | 1.041 | 4.688 | 0.000\* |
| 9. Group Type | .386 | .264 | 1.463 | 0.144 |
| 10. Income | 4.249 | .000 | .430 | 0.667 |
| 11. Quantity Stored | .104 | .045 | 2.312 | 0.021\* |
| 12. Farming Experience | -.187 | .055 | -3.419 | 0.001\* |
| 13. Land ownership | -.092 | .245 | -.375 | 0.708 |
| 14. Extension contact | 3.797 | 2.528 | 1.502 | 0.134 |
| 15. Frequency of extension contact | -.534 | .574 | -.931 | 0.000\* |
| 16. Types of Cowpea grown | -.254 | .143 | -1.785 | 0.075 |
| 17. Cropping system | .149 | .928 | .160 | 0.873 |
| 18. Sources of Pesticide | -1.573 | .390 | -4.037 | 0.976 |
| **Dependent variable**  Frequency of use of conventional pest control methods  **Model Summary**  Number of obs = 384  R =0.572  R Square =0.328  Adjusted R Square = 0.294  Std. Error of the Estimate =8.179  Root MSE = 8.1785  F =9.882  Prob > F = 0.0000 | | |  |  |
|  |  |

\*Significant at p≤0.05 alpha level.

**Table 47: ANOVA showing statistical difference in the use of indigenous, conventional and alternative methods**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | Sum of Squares | Df | Mean Square | F | Sig. |
| **Indigenous** | Between Groups | 6325.060 | 24 | 263.544 | 190.534 | 0.000 |
| Within Groups | 496.565 | 359 | 1.383 |  |  |
| Total | 6821.625 | 383 |  |  |  |
| **Conventional** | Between Groups | 30.205 | 24 | 1.259 | 4.668 | 0.000 |
| Within Groups | 96.792 | 359 | .270 |  |  |
| Total | 126.997 | 383 |  |  |  |
| **Alternative** | Between Groups | 1767.598 | 24 | 73.650 | 60.872 | 0.000 |
| Within Groups | 434.361 | 359 | 1.210 |  |  |
| Total | 2201.958 | 383 |  |  |  |

**Table 48: Chi-Square Tests test of association between knowledge on the use of pest control methods**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Value | Df | **Asymp. Sig.** (2-sided) |
| Pearson Chi-Square | 752.900a | 384 | .000 |
| Likelihood Ratio | 483.081 | 384 | .000 |
| Linear-by-Linear Association | 2.390 | 1 | .122 |
| N of Valid Cases | 384 |  |  |
| a. 419 cells (98.6%) have expected count less than 5. The minimum expected count is .00. | | | |
| b. Based on 10000 sampled tables with starting seed 2000000. | | | |
| c. The standardized statistic is 1.546. | | | |

**Table 49: Symmetric Measures of the association between knowledge on the use of pest control methods**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | Value | Asymptotic Standardized Errora | Approximate Tb | Approximate Significance |
| Nominal by Nominal | Phi | 1.400 |  |  | 0.000 |
| Cramer's V | .350 |  |  | 0.000 |
| Contingency Coefficient | .814 |  |  | 0.000 |
| Ordinal by Ordinal | Gamma | .081 | .039 | 2.092 | 0.036 |
| Spearman Correlation | .104 | .050 | 2.041 | 0.042c |
| Interval by Interval | Pearson's R | .079 | .046 | 1.549 | 0.122c |
| N of Valid Cases | | 384 |  |  |  |
| a. Not assuming the null hypothesis. | | | | | |
| b. Using the asymptotic standard error assuming the null hypothesis. | | | | | |
| c. Based on normal approximation. | | | | | |