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BACHELOR'S THESIS

on the topic:

"PEST MANAGEMENT SYSTEM IN OTTA FARM OGUN STATE"

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(Resolution: "For defense in the state examination commission")

Head of Department _____ _____ _____

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Abstract

This study looked at the most common pests in Otta Farm, Ogun State, as well as the harm they create, how residents there deal with the problem, and how they feel about it overall. Emphasis was on identifying the pests that are principal in Otta Farm Ogun State and examining the significant factors responsible for pest problems in Otta Farm Ogun State. The study further seeks to ascertain the various control methods used in controlling pests in Otta Farm Ogun State and to scertain the damage that has been caused by pests to farm produce in Otta Farm Ogun State. The descriptive research strategy was adopted and a deductive approach is considered suitable for this study. It was revealed that the Otta Farms' goal is to promote agriculture as an important and lucrative business that may improve people's lives in many ways. The implementation of technology and the structuring of entrepreneurial endeavours are both necessary in agriculture. It helps raise standards of life and it should provide for future generations as well as the current one. It is however recommended that Due to the high cost of research and development, there is an urgent need for the development of novel approaches to the administration of pesticides. These approaches should minimise the amount of unnecessary dosage while simultaneously improving selectivity against pest insects. It is also essential to develop ways of pest management that have a minimal negative impact on the environment. As a consequence of this, it may be possible to avoid the challenges connected with the use of specific pesticides, and it may also be possible to realise the promise for efficient pest management that is also safe and cost-effective.

Keywords: Pesticides, microbes, pests, farm produce, pest management, economic performance, illnesses.

CONTENT

INTRODUCTION

The research looked at the most common pests in Otta Farm, Ogun State, as well as the harm they create, how residents there deal with the problem, and how they feel about it overall. Pests are defined as any creature that poses a threat to human health, safety, welfare, or property [44]. Plants and animals that spread sickness, induce illnesses, or ruin crops are examples of hazardous species [52]. However, anything from invertebrates and worms to infections and germs to mollusks and rodents to plants and parasites and annelids is fair game [33]. In the same vein, human society is home to a wide variety of microbes, including cockroaches, bed bugs, mosquitoes, rats, wildlife, and parasite [33]. In recognition of their detrimental effects on society, whether financial, medicinal, or physical, a number of these are classified as pests.

In certain regions, the organic equilibrium of the natural world can be disrupted by human-made concepts and operations, causing a formerly non-pest species to evolve into a pest [34]. The problem here is that as more people move into cities, pest control will become more pressing a concern. It is in this vein that this research focuses on Nigeria, a country in which mosquitoes, houseflies, rodents, insects, and termites are common residential parasites. According to [32], mosquitoes are a major problem in both urban and rural areas. Even if there is an obvious require, no vaccine delivering substantial defense from mosquitoes presently develops, which is why the disease is usually linked to impoverishment and may serve as a source of deprivation as well as an important obstacle to economic growth [24].

In industrialized nations for instance, precise documentation of insect-borne diseases have been maintained to aid in the application of suitable pest control techniques [20]. However, in the United Kingdom, 89% of widespread destruction of residential property is caused by pests that wolf down clothing or carpeting, 77% by insects that chew on plumbing, and 63% by pests that damage furnishings [15]. However, as the urban pest crisis worsens, more effective measures, such as pesticide

and holistic pest management, are needed. This study follows suit, providing a critical analysis of the pest management strategy employed by Otta Farm in Ogun State.

1.1Aim and objectives of the study

The general objective of this study is to critically examine pest management system in Otta Farm, Ogun State, Nigeria. Specifically, this study seeks to:

1. Identify the pests that are principal in Otta Farm Ogun State.
2. Examine the significant factors responsible for pest problems in Otta Farm Ogun State;
3. Ascertain the various control methods used in controlling pests in Otta Farm Ogun State;
4. Ascertain the damage that has been caused by pests to farm produce in Otta Farm Ogun State.

1.2 Significance of the Study

In order to encourage producers and companies to get involved and participate in the research endeavor, it is anticipated that the results of the research will encourage the agricultural economy and possibly purchase chemical pesticides instantly or by means of those who benefit. This is particularly relevant given that a preliminary risk evaluation of these appreciate sequences for pests and insecticides shows that potential hazards vary from low for fish to slightly elevate for livestock. Future researchers can benefit from the present research because it prioritizes the implementation of natural pest-control strategies but allows for the application chemicals like pesticides when necessary. It also encourages an assessment of the ability of a nation or state to handle

the purchasing, managing, implementation, and elimination of bugs control goods, as well as the ability to observe the accuracy of pest management as well as the consequences of pesticide usage. This is due to the fact that rehabilitating the present-day access routes, upgrading the highways within Otta road, developing small-scale watering plans, developing small-scale structures like warehouses and equipment for processing for improving farming production and promotion in manufacturing domains, and rehabilitating the specific institutions is all projected to have minimal to no adverse consequences on the surrounding environment.

1.3 Research methodology

This study aims to provide a detailed description of the pest management method in use at Otta Farm in Ogun State. This approach is appropriate since it is a descriptive research strategy for characterizing the features of the group of individuals or subject under investigation. This descriptive approach emphasizes the "what" of the study's topic more than the reason for the topic (Tripodi & Bender, 2010). The approach is mainly concerned with identifying the characteristics of an ethnic group rather than investigating the reason behind an issue (Kim, et al, 2017). The emphasis will be on how Otta Farm has managed pest in the last five years. In other words, the focus of this study is to define the issue at hand and explain the main causes of insect infestations in Otta Farm, Ogun State.

Also, a deductive approach is considered suitable for this study. According to Tope (2020), the traditional method of scientific inquiry is the deductive approach. This will help the researcher to look at the work of others, reads up on current theories of the subject being investigated, and puts forward suggestions based on what they have learned (Pandey, 2019). However, the term descriptive research then refers to research questions, design of the study, and data analysis conducted on that topic (Pearl, 2014).

On the other hand, the Otta Farm, in Ogun state will represent the case study in this study.

This case study involves in-depth research and study of how the Otta Farm has managed pest in the last five years. This is considered important because case studies lead to a hypothesis and widen a further scope of studying a phenomenon (Pandey, 2019). However, secondary data will be adopted in gathering data for this study. The data sources here will include internet sources, brochures of Otta Farm, its yearly reports, and other essential documents and journals.

SECTION 1: THEORETICAL ASPECTS OF PEST MANAGEMENT SYSTEM

Producing enough food for the world's expanding population, increasing farmers' earnings, and bolstering GDP are three of agriculture's top priorities. The demand for food from the growing urban population, which is not directly involved in agricultural production, has increased in tandem with the rate of urbanisation. Africa is home to a sizable rural population, the vast majority of whom are subsistence farmers whose efforts have a major impact on national economies. However, the damage caused by bugs and diseases, especially arthropods, vertebrates, and weeds, is one of the greatest restrictions in agricultural output in Africa. Pest problems have developed or become more severe in all international economies as a result of new inventions and high technology inputs into agricultural production. Approximately 36 percent of the potential output is lost all across the world due to these pests, and another 14% is lost in storage. Over the past 50 years, advancements in farming techniques, pest and disease control, and crop diversification have led to greater agricultural success across Africa.

1.1 PESTS

Every living thing in the world is in constant dialogue with the biotic and abiotic elements that make up its ecosystem. Interactions between pests and other parts of the environment, including humans, plants, and animals, can take many forms. Problems associated with these interactions include struggle for food and space, the spread of endemic or epidemic illnesses or nuisances, property damage, and animal and plant injuries [2]. Many forces and elements in such an integrated agroecosystem affect the occurrence of pests and the dynamics and management of their populations. Most of these are agroecosystem's destructive forces, like environmental resistance, or its creative forces, like biotic potential.

Insects, rodents, and other critters are called pests when they pose a threat to people, their homes, or their goods. Plants and animals are considered pests when they spread disease, induce disease, or destroy crops [4]. It's possible that these organisms are nematodes, insects, viruses, bacteria, mollusks, rodents, plants, shrubs, mites, or annelids. Insects and other pests can cause significant damage to crops and buildings. A pest can be defined as any adversary to humankind. Pests are bad for agriculture because they lower yields and compromise product quality. They spread sickness and injure humans and animals alike. What is a common pest in one part of the country may not be in another. Mice, cockroaches, termites, bedbugs, fleas, wild birds, spiders, and snakes are all examples of pests that can invade a home [3].

Pests are a major problem because they are disruptive to human life and can spread deadly diseases. Insects like cockroach infestations bed bugs, flies, rats, birds, and mites populate the human environment in vast numbers. Many of these are undesirable due to the negative impact they have on our lives, whether monetarily, medically, or aesthetically [2]. These animals have adapted to the environment and conditions that have arisen as a result of human interference with their native environment or the expansion of agricultural environments. Some areas may experience pest problems because human constructions and activities have disrupted the natural balance of the area, turning previously harmless organisms into pests.

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Weeds, invertebrates, diseases, and vertebrate animals make up the four major classes of pests. Correct identification of the pest is the first stage in any pest management strategy [5]. An understanding of the pest's life cycle, behavior, and characteristic damage, variables that encourage its development, sensitive life stage, and recognised control measures is essential for effective management. Lack of proper identification and information could lead to ineffective pest management.

In general, pests are grouped into four significant classifications, which are: Weeds, Invertebrates, infectious agents or pathogens, mycoplasmas, and vertebral organisms. The host (the plant or creature on which an organism feeds) and geographic location of a pest are often crucial in determining its true identity. Depending on where they are in their life cycles or the season, pest species can take on a wide variety of appearances. Seedlings of weeds, for instance, rarely look like the full plant they'll eventually become. Many insect species go through distinct metamorphoses from their egg to their larval to their adult stages.

1.2 Pest management

Crop failures and human and animal sickness have mysterious origins for millennia. Pulling weeds, clubbing rodents, and plucking beetles from plants were the earliest forms of pest management. In addition to burning, the Egyptians used fishnets over beds to avoid mosquito bites (440 B.C.), while the Romans used rat-proof grain storage barrels (13 B.C.), among other nonchemical control measures. Natural enemies were initially used by cultivators in Arabia about the year 1000 A.D [6]. To combat the nuisance ants that were eating away at their date palms, Arab farmers relocated colons of a predaceous ant species from the adjacent highlands to an oasis. In 2500 B.C., the Sumerians first utilised sulphur compounds as insecticides to combat mites and insects. In 500 B.C., Chinese people treated head and body lice using a mixture of mercury and arsenic chemicals. Hellebore was used to kill body lice, nicotine to kill aphids, and

pyrethrins to kill a broad range of insects; these were early insecticides derived from plants [4]. A French farmer in the late 19th century sprayed grapevines with a solution of lime and copper sulphate to discourage grape plucking. The farmer discovered that the combination was effective in preventing downy mildew, a harmful fungus that attacks grapes. The resulting Bordeaux combination is still commonly used as a fungicide today. Plants and inorganic compounds were the sources of pesticides up to the 1940s.

Many Allied servicemen were protected from deadly insect-borne illnesses by the synthetic pesticide DDT during World War II. A new age in pest control and the contemporary chemical industry were both heralded by the advent of synthetic pesticides. Due to their versatility, low cost, ability to protect crops throughout the growing season, and compatibility with fertilisers and other agricultural practises, pesticides quickly replaced traditional methods of pest control. After finding success in agriculture and in protecting human health, modern pesticides gained widespread acceptability. However, certain disadvantages of relying so heavily on pesticides have been more evident in recent years. Resistance to the pesticide DDT was first reported in 1947. Hundreds of bug species have evolved resistance to many insecticides since then. The Colorado potato beetle stands out because it has become resistant to virtually all classes of pesticides. This considerably complicates efforts to control it and other pests. Many weeds and plant diseases have developed resistance, which is a major problem in farming.

1.2.1 Pest management strategies

Effective detection of the pests that require be handling or managing for the crop being cultivated is the first step before adopting any pest management strategy or approach. Understanding the advantages and disadvantages of each pest management strategy is crucial for making an informed decision. The selected approach needs to be efficient while also being safe for everyone who could come into touch with it [7].

Integrated pest management plans may require the use of one or more complementary approaches. Integrated pest management aims to enhance the probability of successful pest control by focusing on the pests at their most vulnerable stage. Integrated pest control takes into account both pest and outside influences to reduce the likelihood of pests causing unacceptable harm to the crop, people, or property.

1.2.1.1 BIOLOGICAL CONTROL

Most agricultural pests have a wide variety of natural enemies that can successfully control or decrease the pest population. These predatory insects, mites, fungi, and/or weeds will serve as biological control agents [17]. Biological methods of pest control have shown promise. Invasive species of pests are often targets of biological control efforts. In the absence of predators or parasites, populations of these non-native or introduced pests can quickly increase to dangerous levels, threatening the crop being farmed. Finding the native habitat of an invasive pest is the first step in developing a biological management programme. Once these natural enemies are identified, they must undergo rigorous testing and assessment to guarantee that they will not harm the areas where they are released to combat the invasive pest. In order to diminish the introduced/targeted pest populations, the biological control agent will be grown and then distributed across a wide region. Additional discharges may not be necessary if the newly acquired biological pest control is well acclimated to the new region. There are strict rules in place to eliminate the possibility of introducing unwanted organisms [8]. It is crucial to keep natural enemy populations healthy after they have been introduced, and this may be done by avoiding harmful production practises and overusing broad-spectrum insecticides. Selecting pesticides with the least potential for harming natural enemy populations or having an adverse effect on the environment is a top priority when running a farm.

1.2.1.2 MECHANICAL CONTROL

To eliminate or change a pest's natural habitat by the use of devices, traps, machinery, or other purely physical means is known as "mechanical control." These tools are employed to either stop the insect from entering a building or to help in capturing the bug for elimination [16]. Cultivation is a temporary, cost-effective mechanical method of weed management that must be repeated at the first sign of weed growth. Most weeds can be eradicated, their development stifled, or their survival in the soil disrupted by the use of cultivation techniques. Unchecked weed seed generation will increase the soil seed bank and hence the future weed burden if treatment is not performed regularly enough [9]. The roots of the desired crop can be damaged by mechanical cultivation, and it may not be successful for strongly-rooted perennial grasses such as Bermuda, torpedo, or bahia grasses. If the pests are large enough, they can be kept out of an area by a fence or other mechanical device. Screening off windows or sealing up holes are two examples of exclusion devices. As long as the netting material is dense enough to prevent access for the pest in question, fences are an effective way to keep many vertebrate pests out of an area. The pest is physically captured by the trap. A trap can be either a real object or merely a sticky surface that attracts the insect and keeps it there until it is removed. For tiny vertebrate pests, nothing beats the efficiency of a mouse trap.

The elimination of pests' food, water, and shelter sources is an integral part of sanitation as a cultural practise. In areas where weeds are a problem, getting rid of them before they flower and spread their seeds or provide a haven for pest insects may greatly benefit crops and increase their market value.

1.2.1.3 PHYSICAL/ENVIRONMENTAL MODIFICATION

Changing the conditions in which pests thrive is one strategy for managing them. Using environmentally friendly practises like refrigerators is one way we can do this.

The pest- and spoilage-free food storage provided by refrigeration is a major benefit. However, in confined environments like greenhouses or storage bins/silos, the capacity to grow or store crops is significantly impacted by the usage of changed temperature, humidity, and/or air movement.

1.2.1.4 HOST PLANT RESISTANCE

To create a new plant variety with desirable qualities that make it immune or tolerant to a certain pest or disease, plant breeders usually exploit natural host immunity or genetic traits. Maintaining the host plant well is another way to increase its resilience. A lack of water or nutrients can weaken a plant's defences, making it more susceptible to attack by pests.

1.2.1.5 CHEMICAL CONTROL

The word "pesticide" refers to a wide range of compounds with similar functions. In most cases, pesticides will kill the pest at some step of its life cycle. Insects, nematodes, illnesses, and weeds are all susceptible to treatment with pesticides. Both selective and non-selective pesticides are available. Pesticides that are selective target specific species and leave others alone. There is a wide variety of pests that can be killed by non-selective insecticides [4]. In comparison to alternative methods of control, pesticides are widely employed due to their efficacy, speed of action, and ease of application. Insect pest control measures that work rapidly can stop the harm they do in a matter of hours or days. Preventative spraying with a variety of pesticides (fungicides) may be necessary since these treatments may not be particularly successful after the illness has taken hold. Herbicides are used to kill unwanted plants, fungicides kill off unwanted fungus, and insecticides kill unwanted insects, and so on.

Similar chemical structures, characteristics, or modes of action (MOA) distinguish pesticides into distinct classes [10]. This insecticide has a Mode of Action that makes it

effective. To reduce the likelihood that a pest may acquire resistance to a certain pesticide or pesticide class, it is best to switch across MOA between each application. Systemic pesticides are those that are taken in by the plant and distributed throughout its tissues. To manage pests, plants can use systemic insecticides, which are taken up by the plant via its leaves and/or roots and then distributed throughout its tissues. However, contact insecticides do not enter the plant via absorption or translocation. In order to be effective, contact insecticides must come into physical touch with the bug. The effectiveness of pesticides in keeping pests at bay varies. Pests can be kept at bay for months or even years with the use of persistent insecticides. The effectiveness of non-persistent insecticides in preventing pest infestations may only last for a few hours or days.

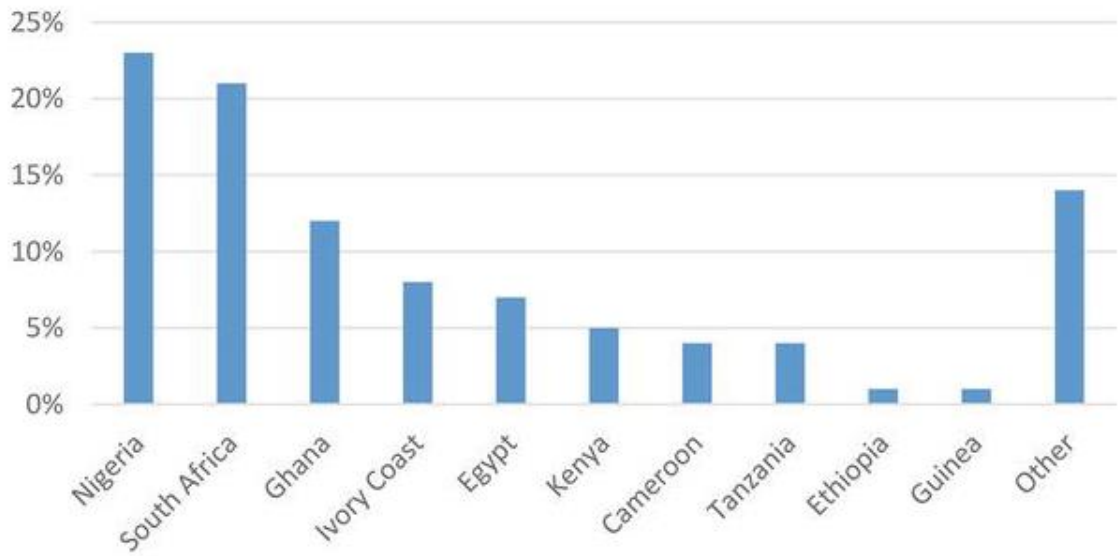
1.2.1.6 REGULATORY METHODS

Local, state, and federal governments would establish regulatory control procedures if a pest posed a significant harm to public health or agricultural crops, animals, forests, or decorative plants. Federal and state regulations prohibit the entry and spread of pests, and these rules form the basis for government agencies' direction of quarantine or eradication programmes. The goal of quarantine is to stop unwanted pests from entering a pest-free zone. Produce and plants in a quarantined region must be fumigated or otherwise treated to eliminate the pest before being sent outside of the quarantined area. The term "eradication" refers to the complete removal of an unwanted insect. Isolating the pest to a small region is essential for successful eradication. This makes it easy to execute pest control procedures and get rid of the problem. Eradication is more challenging, if not impossible, to achieve if the pest is widespread or has a large host range [11]. Government agencies may be given the green light to kill out potentially dangerous weeds, plants, or animals during eradication attempts. In order to efficiently and effectively control pests and to create a safe and ecologically sound product,

growers and agricultural producers are encouraged to adopt all pest management strategies available to them. Everyone using pesticides must take responsibility for their use.

1.3 Importance of pest management

Insects become resistant to pesticides because of poor pest management; as a result, secondary pests, such as whiteflies, emerge as a severe problem when insecticides are sprayed against Helicoverpa armigera. In addition to reducing losses and environmental pollution, pest management also inhibits the recurrence of target pests, such as the BPH of rice increasing when particular OP pesticides are treated [12]. In addition, the risks to human and animal health posed by pests are diminished, and the number of animals that are not targets and natural enemies killed, via effective pest management.

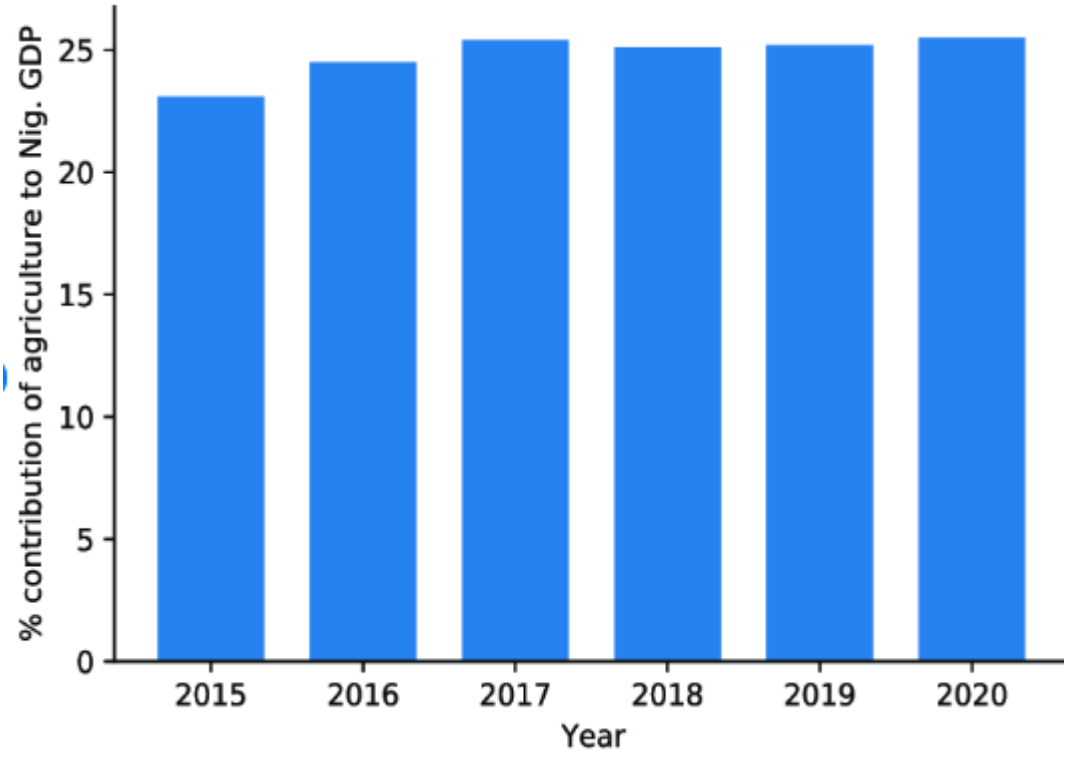


African's use of Pesticides- Bertrand, 2019

1.4 Pest management concerns and control measures in Ogun state

The majority of Nigerians work in agriculture. In terms of size, no other industry in Nigeria comes close. Since its independence in 1960, Nigeria has seen a steady flow

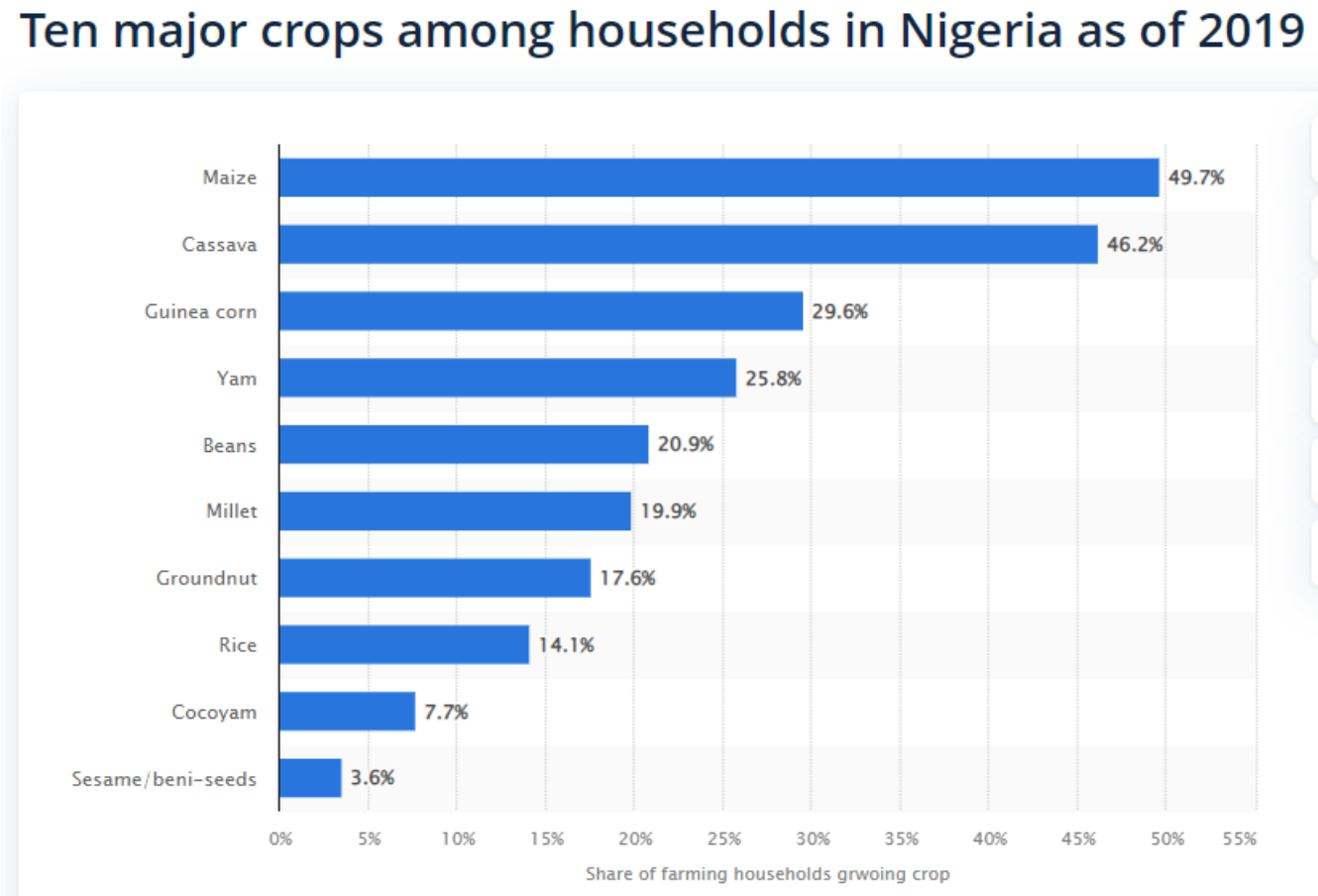
of people from the countryside to the cities. Its urban population has grown rapidly, from 15% of the total in 1960 to 50% in 2018. Although this is the case, 36% of Nigerians are still involved in farming. From 2010 to 2018, agriculture contributed an average of 3,839,502.51 Nigerian Naira (NGN) to the country's GDP (World Bank Group 2019). This represented little over 20 percent of GDP [13].



Percentage contribution of agriculture to Nigeria GDP for 2015 -2020 (Q1 -Q3).

Approximately 91 million hectares of land are available for agricultural use in Nigeria. About 81 million of these acres are suitable for farming. These are complimented by favourable meteorological conditions that are widespread across the country. This is a fantastic incentive for a wide variety of agricultural activities all around the country. Agriculture's contribution to national prosperity as a source of food, industrial inputs, and currency cannot be overstated. Of Nigeria's major agricultural exports, cocoa brings in the most money, followed by palm oil and rubber. Livestock and fisheries also make substantial contributions to the economy [14]. Livestock contributed 9.2% on average to the world's animal protein supply between 1960 and

2011. The fishing industry alone accounted for 10.3 per cent of the total development between 1960 and 2011. The average annual contribution of agriculture to the national GDP from fisheries was 4.3% throughout the same time period.



Major crops among households in Nigeria. - Sasu, 2023.

Land ownership has a long history of regional variation in Nigeria. Land in Nigeria was traditionally owned by the community. Nonetheless, continuity and change have occurred throughout these many land tenure systems over time. Land is a shared resource in the southwest Yoruba-speaking regions. The chief of the village maintains land in trust for the villagers and issues land usage permits to those who ask for them. The village chief, after consulting with the elders and receiving their approval, may lease communal land to outside parties. The northern Hausa's (from Nigeria) land tenure system is very similar to that of the southern Yoruba. The community also owns the

land. The Emir has the authority to provide agricultural land to the citizens in exchange for tax. The Emirs and their families are welcome to use uninhabited plots of land. The Igbo people of the southeast have a similar community land ownership structure, although theirs bears the hallmark of patriarchy [15]. Women in Igboland once had little access to land, but that has changed because to urbanisation and modernisation. However, it is difficult for non-Igbos to acquire property in Igboland. The old tenure system has been transformed into a traded commodity as a result of urbanisation, the resulting population growth, capitalist agriculture, cash crops production, and advancements in agricultural technology. Some of the repercussions of this trend include "considerable litigation and communal strife, often resulting in violent confrontation," as stated by the Urban Conflict Resolution Network [33]. Another important consequence of modernization and economic demands is the state's acquisition of community land in the name of development.

Pests and disease vectors pose significant threats to Ogun State's and Nigeria's public health, food security, and general welfare. Over half of the yearly harvest of crops, fruits, decorative plants, vegetables, and animals is lost due to agricultural pests, according to estimates. In Nigeria, disease vectors spread a number of serious illnesses. Food insecurity and poverty have worsened as a result of these illnesses, which have caused widespread population loss in once-thriving farming regions. Heavy applications of pesticides by farmers as a response to insect infestations in crops pose concerns to human and animal health and the quality of the environment [30]. Farmers' failure to comply with trade obstacles on residues of pesticides in export produce is one way in which the irresponsible reliance on chemical pest management alternatives affects economic progress [29].

1.5 Pest Management in Ogun State

Different techniques of pest control are used in different parts of the value chain of agriculture in Ogun State. The value chains also affect the level of pesticide risk associated with the various pest management solutions because most of them entail the use of pesticides. Pesticides were once thought to be the only solution to most pest issues; however, rising environmental and public health concerns, along with rising pest immunity to pesticides and rising financial strains on farming and the culinary Industry, have constantly shown that pesticide use is now seen as merely a single of a range of prevention strategies available [19].

Ogun State has the following insect problems throughout its five primary value chains (vegetables, cassava, rice, fish, animals - beef & poultry) [32]:

- Mammalian pests: Pests on cassava and maize can be managed with poison baits, traps, or even cats (in the case of rodents).
- Herpetological reptiles, in particular snakes. These are predators that prey on poultry. Reptiles are killed to keep the population under control.
- Birds are a serious problem on rice farms and are kept at bay by scare tactics like scarecrows. However, it seems that these are no longer usable.
- Insects, such as termites, lice, mites, ticks, fleas, and so on are all examples of ecto-parasites. Beef and poultry are both susceptible to these parasites. Grasshoppers and caterpillars are both detrimental to crops and vegetables, respectively. Agricultural chemicals such as disinfectants, tick baths, insecticides, etc. are often used for animal control.
- Vaccinations for de-worming animals are used to prevent endo-parasite infestations like worms, which are more commonly seen in cattle (beef).

1.6 Integrated pest management

Effective, low-cost, and risk-free pest management is the ultimate objective of pest management. Integrated Pest Management (IPM) is a method for controlling pests such as insects, weeds, plant diseases, snails, birds, and mammals [4]. Using IPM, you need simply lower insect populations below a point where they might cause harm. It's not essential to get rid of all insects and rodents. Initially, IPM was designed to combat pests in farming. It has been used effectively against pests in landscapes, forests, buildings, and backyard gardens since the 1980s. The use of harmful pesticides can be reduced with the use of IPM. The financial and ecological risks are lowered as a result [20].

IPM, or integrated pest management, is a method of problem-solving that may be used to avoid pest infestations. IPM programmes take into account all available data and potential treatments when addressing pest problems. There should be no negative effects on the economy or the ecosystem as a result of this [21]. [16] explained that the elements of any integrated pest management program include:

1. Prevention: Ecosystems are planned and managed to prevent organisms from becoming a nuisance.

2. Identification: Both harmful and helpful creatures are named.

3. Monitoring: The number of both pests and beneficial, as well as the harm they do to the ecosystem, are monitored.

4. Injury and Action Decision: To decide whether pests need to be treated, doctors look at injury and action thresholds.

5. Treatments: Methods from the fields of culture, biology, physics, mechanics, psychology, and chemistry are employed (sometimes in tandem) as treatments. The objective is to eliminate pests while minimising damage to natural habitats.

6. Evaluation: Plans for controlling pests are evaluated for their efficacy.

Agriculture, forestry, lawn care, and public health all have a stake in the pesticides we use. The use of pesticides has decreased in recent years as an integrated strategy focused on assessment, decision making, and evaluation has become the norm in pest control. The use of less pesticide and fewer cases of pesticide resistance are two ways in which this kind of pest management has helped both pest controllers and the Regulatory control. Integrated pest management is a strategic, well-rounded method of eliminating pests. It lays forth strategies for foreseeing insect invasions and avoiding their destructive effects.

IPM, or Integrated Pest Management, is a form of pest control that makes use of many different approaches, from sanitation and exclusion to chemical and biological procedures. The plan's objective is to stop pest populations from growing to harmful levels while causing as little harm as possible to the natural world. Having access to such pest management software equips the expert to make well-informed, location-specific control decisions.

1.6.1 Importance of Integrated Pest Management

There is a delicate balance between the living and non-living components of every ecosystem, and Integrated Pest Management works to maintain that equilibrium. When chemicals are introduced into the environment, they kill off certain species and provide room for others (often additional pests) to thrive. Unfortunately, chemicals can eliminate natural pest control systems, such as predatory insects [22].

Many insects, plants, and fungus that cause illness have learned to resist popular insecticides. Furthermore, bugs could survive if a substance is washed away, is administered incorrectly, or does not reach them [10].

Loss of crops and landscape or property damage resulting from pests can be avoided with a solid IPM programme. The expense of buying needless pesticides may be avoided if IPM was used instead. In addition, by reducing exposure to asthmatic

triggers, IPM might lessen the financial burden of treating chronic diseases like asthma. Implementing IPM practises lessens damage to ecosystems [14]. The potential for persistent chemicals to cause harm to wildlife and pollute groundwater is reduced when fewer pesticides are used. It also reduces the amount of empty containers and unused insecticides that need to be thrown away.

Integrated pest management (IPM) is a popular method that is often desired. The safety of humans, pets, and animals may all be protected by the application of IPM in agriculture, as well as in the care of homes, companies, and school grounds.

1.6.2 Challenges of Integrated Pest Management

Ignorance: Lack of knowledge about pest species and their accompanying parasites and predators has been a major barrier to sustainable crop protection in Africa. This issue is pervasive throughout Africa and creates novel difficulties for pest control [9]. In addition, many people in Africa live in rural areas and lack basic literacy skills. The scarcity of extension workers compounds the difficulty of disseminating pest-management methods. Agricultural pest taxonomy is an issue throughout Africa, but many research institutions lack the expertise and resources to address it [23]. The main issue, however, is not that nations are simply too poor to provide funding for these kinds of investigations, but rather that governments do not often appreciate the benefits which might emerge from such research. Because of the government's lackadaisical approach to supporting plant protection research, the field suffers from a lack of resources and expertise in the scientific community.

Pest resistance, resurgence and secondary pest outbreaks: Over the past few decades, numerous insect species have evolved resistance to common pesticides. The pesticide acts as a strong selective pressure on the insect population, leading to the evolution of resistance. The fact that there is no method to make a population susceptible to pesticides again is the biggest worry about the phenomenon of pesticide resistance. It is certain that pest resistance will rise as a result of the continuous and

excessive use of pesticides throughout Africa. This means that pesticides, the primary instrument for pest management in agriculture, will always be in short supply due to the high costs of research and development and the pressure from environmental organisations. Therefore, it is even more urgent that Africa adopts new approaches.

By destroying their natural adversaries, which held their populations in check, chemical management has catapulted many pest species from comparatively innocuous to very devastating levels. These "supplementary" pests have developed into a major issue for many agricultural products. Gascardia destructor (Homoptera: Coccidae), a white wax scale, attacks citrus trees in southern Africa. White wax scales are scarce and are kept in check by nature. However, the inherent predators of the white wax scale were eradicated when persistent organophosphate pesticides were employed to control the red scale, the major pest.

Environmental contamination: Since World War II, the usage of numerous chemicals has been drastically reduced in the industrialised world because to the remarkable environmental durability of many synthetic organic insecticides, notably the organochlorines, and the broad-spectrum action of compounds synthesised since then [9]. However, in Africa, the pesticide industry has continued to grow due to the region's persistent food scarcity and the accompanying desire for increased crop yields of cash crops. Toxic leftovers in the environment are a growing cause for worry since they can end up in people's food and endanger humans, wildlife, and livestock. Chronic harm from even low levels of these substances is possible.

Increasing pest problems: One of the biggest obstacles for Africa to achieve food and mineral self-sufficiency is the presence of exotic pests [18]. The bigger grain borer and the cassava green mites are two examples of exotic pests that were introduced unwittingly. Exotic pests may not be readily stopped from entering and spreading over new regions due to a lack of reinforcement of laws and restrictions based on strong scientific understanding, especially of the ecological and biological makeup of the pests

[23]. Therefore, Africa's laws and quarantine practises concerning the control of exotic pests require review. Future quarantine efforts, however, will be more effective if they are designed to safeguard biogeographical regions rather than specific nations. This decision should be founded on the knowledge that a bigger area of the world is protected by standard quarantine laws. Furthermore, the only way to ensure people follow the law is to constantly convince and educate them. "Pesticide treadmill" Pest damage to food and cash crops has decreased during the past fifty years due to the widespread availability of low-cost insecticides. However, extensive application of the same pesticides has led to widespread bug resistance. As a result, there is a growing propensity to use more pesticides in Africa, which may lead to an increase in the frequency and potency of pesticide applications in an effort to control the spread of resistant species. There will be environmental repercussions from this pesticide cycle, including as pollution and subsequent pest outbreaks [24]. This means that in the future, we will need to implement non-chemical methods, such as bio-control, to lessen the impact of chemicals on insect populations.

1.6.3 Future developments in pest management technologies

New pesticides and application techniques: There is a need for new insecticides to replace those that have proven ineffective against resistant pest species or are harmful to the environment in other ways. The high price of pesticides, such as synthetic pyrethroids, may be a significant factor that restricts their application. New application approaches that attempt to reduce the amounts sprayed and boost selectivity on the targeted insects are warranted, however, because of the high costs associated with producing new chemicals [25]. It is also important to find ways to control pests that won't harm the ecosystem too much. With such forethought, we may avoid the pitfalls of using some pesticides and instead achieve the benefits of effective, safe, and cost-effective pest control.

Pheromones: There are several functions for pheromones in insects. The locust's swarming behaviour is only one example; additional examples include the house cricket's (Acheta domesticus) dispersal, the bee's cohesion, the armyworm's (Spodoptera exempta) sex behaviour, and the locust's ability to regulate its own development. Successful applications are more likely to occur in the following settings: Aggregation pheromones, which draw individuals together for mating, eating places, and colony defence; Sex pheromones, which attract the opposing sex in traps; It may be possible to avoid swarming by interfering with the development and proliferation of the pheromones of locusts when they transition from isolated to gregarious forms. The main drawback of utilising pheromones is the potential for resistance to develop, especially when just one element of the pheromone is utilised. The correct concentration, timing, and distance of pheromone emission can prevent this from happening [26]. To avoid rejection by the intended insect population, the synthesised pheromone needs to be almost identical to the natural one.

Materials of botanical origin: Many pesticidal plant alkaloids are underutilised because of their limited current use. The pyrethrins are the most efficient substances of botanical extraction for insect control. However, the substances are not photostable and are therefore not particularly effective for pest management in field crops. There is significant promise for the use of novel materials, such as Azadiractin and Tephrosin (derived from Tephrosia vogellii), in Africa's pest control. Therefore, this area of study has the potential to play a significant role in the study of plant biodiversity. Analogues might be generated to get around some of the constraints of the organic chemicals, and the toxicity of the powerful botanicals with desirable qualities could be tested on the target pests [27].

Biological control: Parasites, predators, and diseases all contribute to biological control by keeping average population densities lower than they otherwise would be. Human efforts to lower insect populations by controlling their natural enemies have met

with some success in the field of biological management. Biological pest management against red scale (Anidiella aurantii; Homoptera: Diaspididae) on citrus trees in South Africa began with the emergence of the Australian predatory beetle Lindorus lophanthae (Coleoptera: Coccinnelidae) [21].

Other biological control operations have focused on cassava, with the first sighting in Uganda of a kind of spider mite that targets cassava occurring in 1971. The green cassava mite, or Mononychelus tanajoa Bondar, is a pest that originated in South America. With the right conditions and no predators, this mite population exploded to catastrophic levels. Since then, the mite has expanded over the whole cassava belt in Africa, posing a serious danger to a crop that is vital during times of famine because it can thrive on poor soils [28]. To combat M. tanajoa, we have settled on using exotic phytoseiids as our main biological control agents. As early as 1984, over 2 million eggs and active operations of seven species of the phytoseeiids were released in Benin, Nigeria, Ghana, the Congo, Gabon, Zambia, and Uganda.

1.6.4 Future of chemical control of pests

Future chemical pest control methods will need to refine their usage of bioactive compounds and narrow their emphasis to specific species of pests in order to lessen their negative impacts on non-target ecosystem components and beneficial organisms like natural enemies. Sprays, granules, dusts, baits, and fumigants have historically been the mainstays of application technique. One important drawback of these formulations is that the insect may not consume all of the administered substance. Thus, in the future, there has to be a greater emphasis on the delivery paths of novel compounds to target pests. The best strategy is to create a formulation or controlled delivery method that can be used against the pests of interest, keeping the active components safe until they are needed. In Europe and the United States, a select number of pests can now be treated with microencapsulation-based formulations made from polymetric matrices like lignin, saw dust, bark, and waste paper [31]. The controlled release method is useful for pest

management since the release of chemicals by the matrix coincides with the infection pattern for a long enough period of time to safeguard the crop. No one pest control chemical can be anticipated to address all issues related to food production and public health, despite the on-going research into novel compounds. It's quite evident that we require a wide variety of effective pest control weapons. In light of this, the pesticides of the future will need to exhibit a wide range of properties, including versatility in formulation and application, specificity of target, inertness, and low toxicity to the environment.

Use of pathogenic microbial and hormone mimics: Infectious microorganism's Insect population dynamics and natural regulation rely heavily on the activities of viruses, bacteria, protozoa, fungus, rickettsia, and nematodes. Bacterial and fungal diseases can kill insects outright or stunt their growth, reducing their offspring and making them more vulnerable to predation and parasitism. Insects' sensitivity to insecticides may potentially be affected by microbes. Commercial success has been achieved in the management of Lepidoptera larvae with the use of microorganisms like Bacillus thurungiensis. Despite the discovery of many different microbes linked with other insect species, none of them have yet been commercially used for the purpose of insect pest management. In the field, most research has been done with microorganisms like viruses and bacteria [24]. However, because they are so sensitive to their surroundings, fungi, rickettsia, protozoa, and nematodes have not been employed to the same extent. This, however, does not preclude the possibility of their application in the control of insect pests in Africa in the future.

Metarhizium anisopliae is effective against C. sordidus and various other pests; Beauveria bassiana is effective against banana weevil (Cosmopolites sordidus); Venticillium lecannii is effective against sweet potato white fly (Bemisia tabaci); and so on. Most of these microbes' efficacy is determined by parameters that govern their pathogenicity and their ability to spread. Infected hosts, animal hosts, the elements, and

even their own actions can all play a role in their spread [32]. For this reason, it will be crucial going forward to comprehend the dynamics of the parasite infections of the pests.

Hormone mimics: Hormones have an important role in the regulation of behaviour and physiology in insects. Insect pest management strategies have focused on hormones, including the juvenile hormone that regulates the transition to adulthood. Juvenile hormone analogues have been used to kill insects by causing them to develop defects that ultimately lead to death. The main drawback to employing juvenile hormones is that the death is gradual, so the larvae keep wreaking havoc for some time until they finally perish. Insects can undergo an early metamorphosis when exposed to certain plant-based chemicals. Finding these chemicals, called precocenes, may broaden the types of bioactive substances that can be used to combat pests that are already at our disposal. Innovative methods for controlling pests

Use of recombinant DNA technology: Genetically altered seed and horticultural goods are the result of recent advances in crop genetic engineering. With this breakthrough, it may soon be possible to cultivate almost any sort of plant using this method, provided that it possesses some combination of desired traits. However, if genetically altered crops escape the usual farming system's oversight, they could become pests and cause issues comparable to those we are attempting to alleviate [33]. The genetically altered crop's resilience to adversity, such as drought and disease, or its ability to thrive in low-fertility environments, increases the likelihood of this happening. Before we can confidently employ genetically altered crops to boost yields, such unintended consequences must be adequately addressed. Crop plants and livestock could be engineered with built-in defences against pests through genetic engineering. Another strategy could be to utilise genetic engineering to mass-produce an agent in microorganisms, then extract the agent and apply it to specific pests [17]. However, the general public's unwillingness to embrace genetically altered crops is the main disadvantage of these crops. The public has to be educated on this issue.

Cloning to produce resistant crop plants: This suggests that cells could be replicated via mutations to make a resistant plant that otherwise keeps the original plant's features. Chemical defences are now active. This method of pest/disease control can be compared to vaccination in animals. This method employs a wide range of virulent and avirulent antigens to stimulate the plant's immune response [32]. The theory holds that pathogens can prompt the local accumulation of antibiotic-like metabolites near the site of infection, where they can quickly reach quantities sufficient to stymie the spread of disease. Chemically resistant breeding If a plant or animal has the genetic predisposition to biosynthesize increased quantities of the resistance chemicals sooner after infections than under normal conditions, this strategy may be used to effectively manage infectious diseases [34]. The expenses of protecting plants with pesticides may be reduced if plants were bred for greatest disease resistance instead of maximum yield, similar to schemes for comprehensive pest control against insects. Controlling pests through the law. The purpose of anti-pest legislation is to prevent the spread of a pest infestation.

Plant resistance: To avoid, withstand, or recover from attacks by pests under environments that usually result in injury to other crops of the same species is what is meant by "plant resistance." Against several prominent insect pests, there have been substantial advances in breeding for plant resistance. The role of pest-resistant plants in Africa's future pest management is certain to grow. Some sorghum varieties, for instance, have shown resistance to insects that attack both field crops and stored goods.

1.6.5 Ecological approaches and Integrated Pest Management

The best informed decisions on pesticide use can be made only with access to comprehensive ecological data. Many African pests cannot be effectively managed due to a lack of sufficient data. In order to undertake effective management with minimal or no use of chemicals, it is necessary to generate and disseminate information, particularly

on pest ecology [18]. Management of most pests requires knowledge of insect biology and bionomics. Any comprehensive pest management plan worth its salt will incorporate biological, chemical, and cultural methods.

The field of crop security has recently taken a fresh turn towards integrated pest management (IPM). Integrated insect Management (IPM) is the practise of preserving and bolstering parasites, predators, and other inherent limiting factors to keep insect populations below the point of economic damage. Chemical treatments be used carefully, and only when the other methods have not been successful to keep the number of pests below levels that are acceptable [9]. The drawbacks of relying solely on chemicals to manage pest populations highlight the importance of integrating cultural and biological practises into pest management strategies whenever possible [9]. Knowing the economic damage thresholds and the overall impact of the natural mortality variables is crucial for effective integrated pest management (IPM), which operates in the context of the related environmental and demographic dynamics of the pest species.

The lack of adequate agricultural research, training, and extension services in Africa is a key barrier to the development of IPM systems in the region. Successful IPM programmes in other regions cannot be transposed into the current context [6]. This suggests that investigations on IPM should be conducted on a regional scale. It also requires a greater degree of collaboration and communication than has previously existed among scientists, extension agents, and farmers. In addition, it will be critical to provide additional instruction on IPM strategies at all levels. North America and Europe were the birthplaces of IPM techniques, but they quickly gained popularity elsewhere. Integrated pest management (IPM) strategies have been implemented in several African countries as the best method of dealing with pest problems [15]. The control of Spodoptera littoralis and Heliothis armigera in cotton; Sesamia cretica, Chilo agamenon, Ostinia nubilalis, Spodoptera littoralis, and Rhopalosiphum maidis) in maize; and Chilo

agamenon and tabamid Atylotus agrestis maggots in rice are only a few examples of effective programmes.

Because agricultural products are so popular in Africa, the success of these schemes bodes well. Since many nations face comparable insect challenges, the IPM strategy for these crops may be easily adapted.

1.7 PEST MANAGEMENT STRATEGIES

The first step in developing an effective pest control plan is to correctly identify the pest in question. Only after this can you move on to exploring the various management options and their relative merits and drawbacks. Once that's done, you may go on to choosing pest control measures that won't cause as much harm to humans and nature. Abiotic forces are environmental controls that harm or kill organisms, especially plants and animals that are considered pests. Topographical characteristics (rivers, lakes, and mountains) and climatic elements (wind, temperature, sunshine, and rain) are all examples of environmental influences on pest migration [4]. In the absence of such natural barriers, human intervention in the form of pest management is required. Methods such as mechanical/physical, chemical, regulatory, cultural, genetic, and biological controls are also employed.

1.7.1 Biological Control

Most species have at least one natural enemy or rival in an unaltered ecosystem, preventing them from reaching economically significant numbers. Moving an organism from one ecosystem to another can throw off this delicate balance [2]. When the organism's natural predators don't follow it to its new home, it can quickly become a nuisance. Bringing back a newly arrived pest with its native enemies is one approach to pest management. The term "biological control" refers to the practise of reducing pests and their effects by releasing natural enemies such as predators, parasites, viruses, and

competitors [26]. Pests such as insects, mites, fungi, fish, and weeds are easier to deal with thanks to the employment of these biological management (biocontrol) agents. In order to make sure that natural enemies of an introduced pest won't become a problem in their new environment, it's important to do rigorous testing and evaluation after finding potential natural enemies in the native habitat of the pest. The importation of any organism, including biological control agents, is carefully regulated by Nigerian law. Selected natural adversaries are brought in, raised in captivity, and then released. When these biocontrol agents are effective, they spread across broad regions [28]. They will gradually reduce the population of the targeted pests without any further assistance from humans.

The discharge of an enormous amount of indigenous predators into fields, apple orchards greenhouses, and other sites is a second biological management strategy used to manage certain pests. Since this strategy rarely produces lasting results, the natural enemies need to be released on a regular basis. Spider mites, which eat on plants, can be managed with the help of predatory mites. In a greenhouse or garden, parasitic wasps can control particular pests, while praying mantis, beetles, and lacewings are effective all-around predators. Researchers are exploring the potential of nematodes and fungus as biological pesticides for specific weeds and insects.

Keeping native natural enemy populations robust is also an important part of biological management. This could involve cultivating crops or laying down ground cover to increase the variety of flowering plants available as pollen and nectar for adult insects. This strategy also calls for the use of pesticides that are gentler on the ecosystem's built-in defences [13]. To further reduce the negative influence on beneficial insects, pesticides should be used at lower rates than specified on the label (if effective).

1.7.2 Chemical Control

In the context of pest management, "chemical control" refers to the use of both naturally produced and synthesised chemicals. These substances are commonly referred to as pesticides. Any substance used to kill, attract, repel, control, or stop the development and mating of pests, or to regulate plant growth, whether used on plants, soil, water, collected crops, structures, clothes and furnishings, or animals, is considered a pesticide. In many cases, pesticides are the best and only option for getting rid of unwanted pests.

The efficiency, rapidity, and simplicity of pesticide application, as well as their relatively low cost in comparison to alternative control measures, are three major advantages. There is a broad variety of compounds used as pesticides, each with its own unique name and purpose. Common classification schemes for these pest-fighting tools include: Repelling or killing unwanted birds is what avicides are for. Bactericides kill microorganisms; Insecticides and vertebrate pesticides are chemosterilants. The application of defoliants results in the loss of plant foliage [7]. Desiccants work by drawing moisture out of living organisms like plants and insects. Antimicrobials (also known as disinfectants) prevent the spread of germs; Insecticides kill insects; fungicides kill fungus; growth regulators affect how plants and animals develop. Weeds can be managed with the help of herbicides; Bug sprays are effective against a wide variety of pests; Different pesticides are used for different pests: miticides (acaricides) kill mites, molluscicides (slug and snail killers), nematicides (roundworm killers), and ovicide (egg killers) get rid of eggs. Insects are drawn to pheromones; A piscicide can kill off unwanted fish; Pesticides kill unwanted insects, mites, ticks, and mammals; rodenticides kill rodents; and predatoricides kill predatory vertebrates. Several different classes or families of pesticides make up each category [4].

Organophosphates, organochlorines, carbamates, pyrethroids, botanicals, insecticidal soaps, and microorganisms are only few of the pesticide classes available

[6]. Pesticides are categorised into classes based on their shared chemical qualities, mode of action (how they kill the pest), or site of action (which biological system in the insect is impacted). There are differences in how each chemical category functions and in the associated dangers and issues they provide. Selective pesticides are chemicals that kill some pests but have little or no impact on others. Some selective herbicides, for instance, are effective against broadleaf weeds but have no effect on grasses, while ovicides are lethal exclusively to the eggs of specific insects and mites. Unlike selective pesticides, fumigants are effective against a wide range of unwanted species [16]. Nonselective herbicides, when used in large enough quantities, can kill any plant they are effective against. After interaction with a host, pesticides may go in a number of different directions. Pesticides that are systemic are taken in by a plant or animal and moved about inside of it. Herbicides that are systemic are taken up by the plant and distributed throughout it in various ways. Systemic insecticides, which work in a similar fashion, can be fed to animals or injected into them to reduce insect populations.

However, treated plants and animals do not absorb contact insecticides. To be effective, these insecticides need to come into contact with either the bug itself or the area that pest frequent. The length of time that a certain pesticide continues to be effective varies widely across different brands. Some pests can be kept at bay for months at a time with the use of residual insecticides. Some of these only give temporary relief, usually for no more than a few hours [29]. Management of Culture Cultural controls are measures taken by a community to lessen the likelihood of a pest population establishing and spreading. Sanitation and cultural practises are two examples of how culture may have influence over society. The longevity of pests can be affected by a variety of cultural practises. Healthy grass may be produced and insect populations can be reduced by regular maintenance practises include mowing, watering, aerating, and fertilising. The populations of weeds, microbes, insects, mites, and other pests can be reduced by

cultivation, selection of crop plant types, timing of cultivation and harvesting, managing irrigation and timing, crop rotation, and the use of trap crops [19].

One of the best ways to manage weeds is through cultivation. Some insects and other pests that live in the soil can also be controlled using this method. Common weed-control tools include ploughs, discs, mowers, cultivators, and bed conditioners. Pesticides absorbed into the plant's system Use contact pesticides on the plant's foliage to slow its expansion. Soil conditions favourable to the life of some microbes and insects are also disrupted by these instruments. Mulch (plastic, straw, powdered bark, or wood pieces) and cover crops are two other methods for weed control. Eliminating the bug's food, water, and shelter sources is an important part of pest control [0]. Sanitation in agricultural production is the elimination of weeds that provide shelter for insects that are harmful or rodents, the destruction of damaged plant material or crop wastes, and the maintenance of pest-free field margins or surrounding regions.

Fly issues in poultry and livestock businesses can be prevented or mitigated via proper animal waste management. Standing water has to be drained if mosquitoes are to be kept at bay. Garbage cans should be sealed and collected regularly to prevent insects, rats, and flies from breeding there. Reduce termite and fungal rot damage by cleaning up the area surrounding and under structures. Genomic Regulation Pest-resistant varieties of crops and livestock can sometimes be produced or selected for. Some cattle breeds, for instance, have been selectively bred for physical traits that make them resistant to pest attacks and illness and parasites. Some plant species have evolved defences against pests, diseases, and nematodes [11]. The presence of poisonous compounds in some plants makes them effective insect repellents. Some insect-killing bacteria have genes that may be transferred to hybrid seed, giving those plants a natural defence against insect pests. Genetic modification and control has been utilised extensively in the past and has the potential to be a useful tool going forward. Examples of genetic control include Bacillus thuringiensis (Bt) corn and potatoes and herbicide-resistant corn (such

as Roundup Ready corn and Liberty Link corn), cotton (such as Roundup Ready cotton), and soybeans (such as Roundup Ready soybeans). Through the use of molecular methods, a little quantity of genetic material from other creatures is introduced into the plant. Insect resistance (like in Bt crops, which generate a protein that kills caterpillars), herbicide tolerance, and enhanced quality are only some of the benefits of incorporating genetic features [26].

1.7.3 Mechanical/Physical Control

Pests can be eliminated by direct physical contact or by creating an environment in which the pest cannot thrive. Mechanical methods of regulation include the use of rodent traps. Multiple varieties of traps are frequently employed. Others use traps to capture animals, which they then either release somewhere or kill. Traps can be sticky surfaces or mechanical devices, and some even use pheromones to boost their effectiveness. Mulches may be used to manage weeds, steam can sterilise soil to prevent illness, fences can keep out animals and insects, and textile mesh can keep birds away from fruit trees. Insects, rodents, bats, birds, and squirrels can be kept out of structures by preventing them from entering through small holes like cracks and fissures. Crawling insects are stopped in their tracks by a strip of sticky substance painted around the tree trunks. Changing the environment around confined spaces can sometimes reduce the number of pests there. Water, air flow, temperature, light, and humidity are all examples of physical and environmental factors that may be manipulated mechanically using a sticky trap. Food, furs, and other commodities stored in refrigerators, for instance, are safe from insect damage. The insects die off, stop eating, and their eggs don't hatch or develop because the temperature is too low [5]. Bats can be deterred from attics where strong lights have been installed. Storing food items in cooler, drier conditions protects them against mould and insect damage. Increasing the flow of air in greenhouses is a common practise for preventing the spread of fungal infections among plants.

1.7.4 Regulatory Control

Some insect issues just cannot be solved at the individual or community level. Pests that threaten public health or are predicted to cause extensive harm to agricultural products, livestock, forests, and decorative plants are to blame for these issues. Governmental authorities, following federal and state legislation, implement quarantine or eradication programmes to prevent the spread and introduction of such pests. Quarantine is a method of controlling pests that works by limiting access to previously pest-free areas. Some countries have inspection stations set up at all major entrance ports to prevent the introduction of unwanted pests or things that may harbour them. Airports and seaports are subject to oversight by regulatory bodies [18]. The spread of some pests inside a state can also be stopped by quarantining them. Items leaving a quarantine zone must be treated to kill any insects or other pests on them.

The movement of plant material used for budding and grafting as well as nursery stock and plant cuttings is monitored for the purpose of preventing the spread of pests. The term "eradication" refers to the complete removal of a pest from a region. Quarantine laws are frequently in place for these unwanted creatures. When eradication is necessary, the affected region is first mapped out so that appropriate actions may be implemented to eradicate the pest. Methods include spraying the entire affected area, releasing sterile insects, and keeping a close eye on the pest situation in and around the perimeter. Fire dangers, disease harborage, and toxicity to humans and cattle are only some of the reasons why government agencies are allowed to eradicate weeds and plants in and around farms [20]. Weeds and pest plants in homes, businesses, and industrial sectors are subject to the same regulations. Eliminating mosquito populations is a vital service provided by pest control companies in the interest of public health. State authorities can drain or treat stagnant water to eliminate mosquito breeding grounds in accordance with mosquito abatement legislation.

SECTION 2: PRACTICAL ASPECTS OF PEST MANAGEMENT SYSTEM AT OTTA FARM OGUN STATE

2.1. Organizational and economic characteristics of the Otta Farm Ogun State

On October 1, 1979, Obasanjo surrendered authority to a civilian administration; a week later, on October 8, 1979, the massive farm opened to the public for the first time. The farm was launched under the name Temperance Enterprises Limited (Farming Venture). Obasanjo Farms Nigeria Limited is the company's new name. The success of Obasanjo Farms proved that Nigeria's ex-president was serious about doing business. Given its humble beginnings and current status, this likely explains the farm's meteoric rise, expansion, sustainability, and consolidation. Two layer houses with 100,000 birds each, five grill houses with 12,000 birds each and two feed mills with three tonnes per hour got the farm off the ground. Four bulldozer operators were the first to join the vast farm that now employs as many as seven thousand people.

Obasanjo's Ota Farm now includes locations in both Ibadan and Igbo-Ora, Oyo State, and generates up to N34 million in daily revenue for him. For a man whose farm has contributed so much to modern agriculture and food production, this is certainly not a little sum.

Obasanjo farms' goal is to promote agriculture as an important and lucrative business that may improve people's lives in many ways. The implementation of technology and the structuring of entrepreneurial endeavours are both necessary in agriculture. It helps raise standards of life and it should provide for future generations as well as the current one. Olusegun The Obasanjo Farms may be found all throughout the United States. They are overseen by top-tier professionals in the agriculture industry. Their operations also engage experts from other economic fields relating to agriculture.

More than 30,000 acres of land are used for crop production, and more than 5,500 people are working in the agricultural sector.

The scope of Obasanjo Farms' operations Obasanjo Farms produces a variety of farm items, including incubator eggs, young and old chickens, and other poultry. Grassland crop production; swine and poultry farming; beef and dairy cattle development; rabbit and fish farming; forage grass cultivation; To agro-industrialization via the chicken industry. Products sold include poultry, swine, grass trimmers, rabbits, processed goods, and agricultural machinery.

In addition to pig, rabbit, and grasscutter, the farm produces some of the finest chicken items available. Obasanjo farms can assist with the expansion of your agricultural enterprise by supplying you with the necessary resources. Our reputation was established on the back of our ability to supply families with healthy, delicious chicken. There's so much more that Obasanjo Farms Nigeria can do now. Because of the shift in priorities and eating habits, the farm is dedicated to exploring new methods of doing things. The farm is in a prime location to revolutionise the way its target consumer views food production. Obasanjo not only has the most rapidly expanding brand portfolio centred on protein, but they also provide unprecedented visibility into their operations. The chicken raised on the farm is of such high quality and flavour that it should be able to sell itself. The farm is also quite proud of the fact that it only ever sends out the cleanest, healthiest chickens.

Obasanjo Farm has come a long way from its humble beginnings in Ota to become one of Nigeria's premier farms in the agricultural sector. Although it has faced economic and political difficulties, the farm has always come out on top, much like its founder, Chief Olusegun Obasanjo. This has been crucial in keeping the farm motivated in the face of the difficulties inherent in meeting the growing demand for food in Africa.

The second half is based only on data from a single company's archives. Here we take a look back at the company's financial health during the last three to five years on

the market. The enterprise's subject matter, a brief description of its markets and immediate environment (customers, partners, competitors, intermediaries, etc.), an evaluation of the enterprise's resources and infrastructure, and the outcomes of economic activity all contribute to this quality. The purpose of this part is to introduce the company.

Agriculture is crucial to a country's economic growth and overall prosperity. The majority of the world's hardworking but impoverished population works in agriculture and lives in rural regions. 68 million hectares of cultivable land, 12.6 million hectares of water resources, 960 kilometres of coastline, and ecological diversity allow Nigeria to generate an extensive range of crops, livestock, forestry, and fishery products, making it a large agricultural nation. The rural populations in Nigeria are still underdeveloped, and many challenging problems regarding the creation, execution, tracking, and evaluation remain pending, despite the formulation of government plans, strategies, and programmes and the dedication of Government and supporters to the larger framework of environmentally friendly farming and pro-poor rural development.

It is impossible to overstate agriculture's importance in changing a country's societal and economic foundations. It provides the manufacturing sector with food and raw materials. It is also crucial for boosting industrialisation and reducing the strain on the balance of payment, as well as for increasing work opportunities, decreasing poverty, and raising people's income contributions. According to a World Bank report from 2014, agriculture is crucial to the economies of many nations around the world because it provides necessities like food and income for workers, as well as export earnings, raw materials for domestic manufacturing, and tax revenue for the government. Output contribution, component contribution, trade contribution, and exchange rate contribution are the four main ways in which the agriculture industry contributes to economic growth. Nigeria's government recognises the importance of this industry and has developed a number of policies and plans to help it thrive. Because of

the country's varied topography and climate, Nigeria is able to cultivate a broad variety of food crops. Consequently, agriculture is a vital part of the economy. The agriculture industry in Nigeria has been developing at a fairly slow rate despite the country's abundant natural resources. Neither output nor input are particularly high. Most farming is still done on a subsistence level, and the weather has a huge role in the success or failure of these often-tiny operations. Many agricultural initiatives have failed, either because they were poorly conceived or because their effects were drowned out by those of broader macro policies influencing things like inflation, currency rates, and the value of capital. Commercialization and investment in agriculture are widely acknowledged as effective means of hastening the sector's modernisation, fostering its growth and development, and, ultimately, reducing poverty. The empirical link between agricultural production and economic expansion in Nigeria and the policy issues it engenders in Nigeria must be investigated, however, if the country is to draw investment into agriculture.

Agriculture's contribution to national income has been extensively documented for developed as well as developing nations. Agriculture refers to both the study and practise of farming, which includes the cultivation of land for the production of crops and livestock for human use, as well as the processing and distribution of these goods. The value of agricultural production is the sum of all raw materials and finished goods generated in an agricultural sector during the time frame of accounting and accessible for export and consumption. The term "economic growth" refers to a rise in the monetary worth of a country's output during a certain time period, often a fiscal year.

The connection between agricultural and economic expansion has been the subject of several studies. The results of this research are inconsistent. However, other research has shown the opposite, showing that agriculture really contributes to economic expansion. This section examines the contradictory research on agriculture's impact on GDP growth and the variables that explain these results. An analysis of the impact of

rising agricultural productivity on a made-up nation's economy found that the two main contributors to this trend were higher input utilisation and technological advancements. Increases in productivity in the agricultural sector, they argued, contribute to national economic development and growth in three main ways: (i) by providing an economic surplus for both production and consumption in agriculture or for capital formation; (ii) by freeing up employees and other resources for use in non-agricultural sectors; and (iii) by raising the standard of living of rural residents, increasing demand for industrial goods, and facilitating the necessary structural changes.

Higher productivity in agriculture generates positive growth via income generation that outweighs the negative growth effect through competitive advantage, according to a similar but more recent study which employed a modified version of Matsuyama that integrated government taxation and systems expenditure.

According to Syed, Muhammad, and Rana (2015), Japan's agricultural sector played a less role in driving economic growth than was previously believed. He said that this was because of how slowly people's eating habits were changing, which stifled the expansion of the food industry. The effect of agricultural exports on Pakistan's macroeconomic performance was studied by Syed, Muhammad, and Rana in 2015. The study indicated that exporting agricultural goods had a negative effect on economic growth, whereas exporting non-agricultural goods had a favourable effect. Based on the data, the research concluded that Pakistan should make structural adjustments to its agricultural exports by shifting towards the export of value-added products. In contrast to their findings, which reveal a negative association between exported agricultural products and economic growth, the Nigerian economy can benefit from the practise of transforming exports of raw materials into finished goods. Using yearly data from the Central Bank of Nigeria, Ideba, Iniobong, Otu, and Itoro (2014) studied the connection between agriculture public capital spending and economic development in Nigeria from 1961 to 2010. Three statistical methods—the Augmented Dickey- Fuller test, the

Johansen maximum likelihood test, and the Granger Causality test—were used to examine the data. There is a long-run link between all of the explanation variables and the variable being explained, as shown by the Johansen co-integration test.

A unidirectional link between public investment in agriculture and GDP expansion was also shown via the Granger Causality test. This suggests that increases in agricultural public capital spending contribute to agricultural economic growth rather than being a result of growth in the agricultural sector. The importance of adjusting policies as a means to stimulate economic expansion is highlighted in this study. Sustainable agriculture and rural growth in Nigeria were the focus of Bakare's (2013) research. The empirical research made use of the analytical method of Vector Auto Regression (VAR). Sustainable agriculture is thought to have a favourable effect on rural growth in Nigeria. The research shows that rural growth in Nigeria may be forecasted using historical values of agricultural output. The study's primary finding was that despite agriculture's continued dominance in the economy of Nigeria, it is unsustainable since the country's food supply fails to meet the nutritional needs of its people at cost-effective prices. The study concluded that policymakers should encourage agriculture through pushing rural development, which was supported by the data. Odetola and Etumnu (2013) used the growth accountancy paradigm along with time series information from 1960 to 2011 to analyse the role that agriculture played in Nigeria's economic growth. The study's findings confirm the significance of Nigeria's agricultural sector by showing that it has made good and consistent contributions to the country's economic growth. A causation test confirmed agriculture's importance by showing a positive correlation between agricultural expansion and GDP growth, but no inverse association was discovered. The sector's resilience is demonstrated by the speed with which it has recovered from adversities such as the civil war (1967–1970) and the economic slump (1981–1985). Additionally, the study discovered that the expansion of

the agricultural sector is excessively reliant on the expansion of the agricultural production subsector.

To determine whether or not there was a structural break in the Nigerian economy between 1960 and 2010, Aminu and Anono (2012) used the Augmented Dickey-Fuller technique to test a unit root assets of the series, and then they used the Chow breakpoint test to look for evidence of a break. All model variables appear to be first-difference stationary according to the unit root test, and the Chow discontinuity test indicates that no structural break occurred during the time period under consideration. In addition, the findings showed that the agriculture sector is contributing more to the growth of the economy than the petroleum sector.

A strong agriculture sector may help explain why some economies fare well in terms of per capita growth. Abogan, Akinola, and Baruwa (2014) used the co integration method to study the effect of exports other than oil on growth in the economy in Nigeria from 1980 to 2010. Cointegration between the variables is found to be positive evidence for the presence of a long-run equilibrium connection between them. This indicates that in the long run, all factors tend to shift together. A single rise in non-oil export increased productive capacity by 26%, hence its effect on the economy was mild.

According to the literature assessment, the link between agricultural and economic growth is murky and has to be looked at empirically. To measure agriculture's impact on GDP expansion, previous research had to rely on disaggregated factors. Therefore, this research is distinct from others since it will utilise the whole value of agricultural production to represent agriculture's contribution to economic growth, and because the time period being studied is more recent.

2.2. Analysis of pest management system at the Otta Farm Ogun State

The tactics that are implemented as part of Ogun State's system for the management of pests change depending on the type of pest that is at hand and the point

in the value chain at which agriculture is involved. Because the majority of pest control solutions include the use of pesticides, the value chains also have an effect on the amount of pesticide risk that is connected with the various solutions. Pesticides were once thought to be the only solution to most pest problems; however, growing environmental and public health concerns, as well as pesticide resistance and the accompanying economic pressures on agriculture and the food industry, have shown that pesticides are now just one tool in a toolbox of potential solutions that can be utilised. During discussions that took place in Ogun State, the following problems with the state's pest control system were recognised as being widespread across the state's five key value chains. Taking measures to eliminate animal predators such as rodents, grass-eaters, and others.

Cassava and maize are both susceptible to the same kinds of pests, and eliminating them may be accomplished in the same way that one eliminates rodents: by employing poisonous baits, traps, or cats. Taking measures to manage troublesome reptiles, with a particular focus on snakes. This is a kind of parasite that may be found on poultry. The only way to keep the population of the reptiles under control is to kill them. The employment of scare methods, such as the erection of buildings meant to deceive birds away from rice fields, is an important component of bird management. On the other hand, it has been asserted that they are no longer effective. Control of ectoparasites, which can include insects such as termites or mites, lice, ticks, fleas, and so on, which are commonly seen on chickens, requires pest control. These parasites may infect a variety of animals, including beef as well as poultry. Both grasshoppers and caterpillars cause damage to crops and vegetables. Grasshoppers tend to do more damage. Animal control sometimes involves the application of agricultural chemicals such as disinfectants, tick baths, insecticides, and other similar products. Internal parasites, such as parasites, which are more frequent in cattle (beef), can be managed by

administering regular vaccinations to animals in order to deworm them. This practise is also known as "worming."

Pests and disease vectors pose a significant risk to the well-being of the people of Ogun State and Nigeria as a whole, particularly with regard to their health, food security, and overall well-being. According to estimates, agricultural pests cause the loss of more than half of the annual harvest of crops, fruits, ornamental plants, vegetables, and animals. These losses can be attributed to a variety of different types of damage. In Nigeria, a variety of potentially fatal diseases are transmitted via vectors. As a result of these diseases, which have caused extensive population loss in once-thriving farming regions, food insecurity and poverty have deteriorated. This has led to an increase in the number of people living in extreme poverty. The use of pesticides, which may be toxic to both people and animals if they are used in excessive amounts, is normally the solution that farmers turn to in the event that they discover pests in their crops. Two examples of the pesticides that are used in vegetable agro-ecosystems are the chemicals parathion and furadan/carbofuran. Both of these types of pesticides are categorised as WHO toxicity Class 1b substances.

The reckless dependence on chemical pest management options hinders economic development in a number of different ways. One of these ways is the inability of farmers to comply with trade hurdles on the presence of pesticide residues in exported goods. For example, PMP is a fast emerging trade policy concern, and in accordance with EC directive 91/414, more than eighty percent of the active components that are utilised in Africa will be forbidden for use in Europe.

2.3 Circumstances of Use Of Pesticides And Competence to Handle Products

Ogun State has a long history of using cultural practises as physical control techniques for pest management, dating back numerous agricultural generations.

However, not all of these practises have been proven to be effective and ecologically acceptable. Traditional chemical management has been the main method utilised by the State's various agricultural programmes to combat pest infestations of crops. Since there are already PMS-based programmes in Ogun State's agricultural sector, sharing information about best practises for applying pesticides would be crucial in raising farmers' levels of expertise with their usage.

Assessment of risks to the environment, population health and the economy

The environment and society are both affected by some of the hazards that have been identified and appropriately described. Direct respiration, consuming crops and vegetation produced under chemical control of pests, which may pose dangers to individuals and pets both inside and outside the project site; the development of skin, eye, and nose discomfort; the likelihood of cancers; and neurologic, hormonal, and reproductive problems as a result of exposure, both directly and indirectly; these are all issues that have been identified as potentially negative impacts on the environment. Indirect exposure may also cause these issues.

IPM employs a combination of biological, cultural, physical, and chemical approaches to pest management in order to achieve results that are less hazardous to both humans and the surrounding environment. (Association for the Management of Insects and Other Pests) National Network.

In accordance with the National IPM Roadmap, "Integrated Pest Management" (IPM) is defined as "a well-established, science-based decision-making process that focuses on reducing risks associated with pests and pest management." The goal of integrated pest management (IPM) is to eliminate intolerable levels of damage caused by pests in the most cost-effective manner possible, while also offering the least potential harm to humans, assets, resources, and the environment. This is accomplished by combining the use of data on the environment, data on the biology of the pests, and current technology. IPM is an effective method of pest management in both cultivated

and uncultivated habitats. It may also be used on wild environments. IPM is an umbrella word that refers to a collection of strategies that may be implemented as a system to protect both persons and property from various kinds of unwanted guests.

Another approach to explain integrated pest management (IPM) is as crop protection that is socially acceptable, ecologically responsible, and commercially practical. An integrated strategy is what we call the situation in which many management techniques are combined into a single system in a way that is consistent with the scientific principles that govern crop protection. There will be a need for a plan in order to exterminate the unwanted bugs. Examples of strategies include methods from a variety of domains, including chemical, biological, cultural, physical, genetic, and regulatory work, amongst others.

Any organism that lowers the production of the crop is considered to be a pest, according to the traditional definition. Recently, there has been an upheaval in the direction of integrated pest management (IPM), which might be translated as "integrated crop protection." The objective of integrated pest management, often known as IPM, is to maintain pest populations at a level below that at which they may cause considerable economic damage. This is accomplished by maintaining and augmenting natural predators and parasites. It is best to integrate cultural and biological practises with chemical management wherever feasible, and to use chemicals only when they are absolutely necessary (Getz and Gutierrez 1982). This will help you avoid the negative effects that might arise from relying solely on chemical treatments for pest control. Chemical control is only used as a last resort in this approach, and only after other approaches have been tried and found to be ineffectual in lowering insect populations to acceptable levels. It is essential for efficient integrated pest management (IPM) to have a thorough understanding of the financial impact thresholds as well as the total value of the inherent mortality variables. This is due to the function that these factors play in the ecosystem that is connected to the pest species in question as well as the population

patterns of the pest species. In Africa, one of the most significant obstacles to the establishment of IPM systems in the region is the dearth of resources dedicated to agricultural research, training, and extension activities. It is not possible to import the IPM initiatives that were successful in other areas into the current setting. This provides support for the idea that research into IPM ought to be carried out on a regional basis. In addition to this, it is necessary for there to be improved collaboration and communication between farmers, extension agents, and scientists than in the past. In addition to this, it will be required to increase the amount of training that staff at all levels get on IPM approaches.

The rest of the world caught on quite fast to the benefits of integrated pest management practises, which had their beginnings in North America and Europe. IPM programmes, which are generally considered to be the most effective method have been put into practise as a method of controlling pest problems in a number of African countries. It is likely that these initiatives will be successful since the African population places a high value on these commodities. Because many countries face difficulties with insects that are similar to one another, the IPM method for these crops may be simply adapted.

Insects, diseases, and weeds are all examples of common types of pests; however, there are many more kinds of pests as well, such as nematodes, non-insect arthropods, and even vertebrates. Pests are becoming an increasing concern in a wide variety of fields outside of agriculture, such as human health and comfort, buildings, and other sectors. Management is the process by which decisions are made to maintain populations of pests at levels that are economically manageable. This is done in order to keep such populations at economically manageable levels.

SECTION 3: IMPROVEMENT OF PEST MANAGEMENT SYSTEM AT THE OTTA FARM OGUN STATE

3.1 Ways to overcome weaknesses of pest management system at the Otta Farm Ogun State

The Pest Management Plan (PMP) harmonizes the best practice approach from a combination of the best strategies of all control methods that pertain to a given concern created by the activities of pests. The use of microbials such as Bacillus thurungiensis has reached commercial success in the control of Lepidoptera larvae [64] this is because many other microbial have been found to be associated with several species of insects, but these have not been exploited commercially in insect pest management.

Most field studies have been conducted with viruses and bacteria; however, fungi, rickettsia, protozoa and nematodes have not been used as extensively because of their extreme dependence on environmental conditions [62]. This does not however, rule out their potential use for future management of insect pests at the Otta Farm Ogun State. Fungi are limited in the field because of their great dependence on stringent humidity conditions although the genus Beauveria appears to be the most promising for some pests at the Otta Farm Ogun State because of its high toxicity [37].

At the Otta Farm Ogun State, it is believed that protozoa offer considerable promise in microbial control in view of the large number of species found on insects. Their potential is however, limited by the relative difficulties of identifying and producing them in large quantities [38]. However, nematodes could eventually become significantly effective agents because large numbers of them are internal parasites of insects [40]. On the other hand, it has been argued that certain microbials used elsewhere for pest management have great potential for future control of some important agricultural pests in Nigeria. These include Beauveria bassiana against banana weevil (Cosmopolites sordidus), Venticillium lecannii against the sweet potato white fly

(Bemisia tabaci), Metarhizium anisopliae against C. sordidus, and several other pests [37]. This is why the effectiveness of most of these microbial depends to a large extent on factors that govern their dispersal capacity and pathogenicity [38].

Nevertheless, dispersal may be through infested hosts, on bodies of animals, climatic and physical factors or their own activity [41]. Therefore, in future, it is of utmost importance to understand the dynamics of infections of the pests by their parasites. Corroborating this, [43] suggested that studies should focus on identity, pathogenicity, host resistance and dispersal mechanisms and whether control by microbial pathogens can be used alone or in combination with other control measures for effective management of the target insect pests.[35] added that studies should also focus on the specificity of the pathogen. For example, polyhedrosis viruses are only infectious on only one group of insects. This is however not the case with non-inclusion viruses [41].

Among the hormones which have been the target for use in insect pest management is the juvenile hormone that controls the process of maturation to the adult form [46]. Analogues of the juvenile hormone have been used against certain pests whereby the insect dies because of morphological abnormalities. However, the major disadvantage of using juvenile hormones is that the death is slow and therefore, the larvae continue to cause damage for some time before they die. This is because some compounds originating from plants cause precocious metamorphosis in insects. Hence, the search for such compounds, commonly referred to as preciseness, could increase the available range of bioactive materials against pests [48].

On the otherhand, it is suggested that genetic engineering could be used by the Otta Farm management to build-in protective mechanisms against pests in crop plants or animals. For example, genes of chrysanthemum, which produce pyrethrins could be introduced into crop plants such as maize or sorghum, then these crops would produce the pyrethrins for protection against various insect pests [48]. Another approach could

be producing a certain agent through genetic engineering in microbial organisms, harvest the agent and use it against certain pests [57]. According to [60] the major drawback of genetically engineered crop, however, is their acceptance by the general public. This needs to be addressed through public education. Primarily, pest-resistant crops are produced by breeding. Therefore, it is likely that through mutations cells could be cloned so that a plant with resistant capability, but which retains all the other properties of original plant is produced [57].

It has been ascertained that activation of chemical defence this approach in pest/disease management is analogous to immunisation in animals. The technique in view of Pandey, (2019) activates the defence systems in plants by treating them with a variety of antigens which are either virulent or avirulent. The idea is that the infectious agents will elicit the accumulation of metabolites similar to antibiotics around the site of infection and rapidly attain concentrations that inhibit the development of the infectious agent [64].

Nevertheless, another approach is breeding for chemical host resistance. Here, disease control could be achieved if the plant or animal would possess an inherited capability to biosynthesise larger amounts of the resistance compounds more quickly following infection than under normal circumstances [65]. An example could be cotton plants which produce chemicals that resist infections by fungi or bacteria. Similar to strategies for integrated pest management against insects, the development of plants for maximum disease resistance rather than for maximum production may be more desirable because the costs for plant protection by pesticides would be lower.

3.2 Rationale for the improvement program of pest management system at the Otta Farm Ogun State

One major constraint that the the Otta Farm had experienced, which serves as rationale for the improvement program of pest management system in the firm is the

lack of persistence. It is believed that when the pathogens are highly efficient they will normally kill the whole population of hosts, which will necessitate re-application in new outbreaks of the pest [43]. Therefore, a good pathogen should have both good persistence and spread and should be self-perpetuating in order to control a re-occurring pest problem [57]. Hence, insects produce different types of hormones that control certain behavioural and physiological processes. The fact that the recent developments in genetic engineering of crops have produced genetically engineered seed and horticultural products, also serves as rationale for the improvement program of pest management system at Otta Farm, Ogun State. It has however been argued that this new development suggests that it is now potentially possible to use this technology to produce virtually every type of crop with a few or several desirable properties (Lopez, et al, 2020). It is in this vein that the greatest uncertainty about genetically engineered crops, however, is that they could become pests themselves and leads to problems similar to those the firm is trying to resolve, especially if they are out of control of the normal farming system [66]. This is especially likely to happen if the genetically engineered crop is resistant to drought and diseases or it survives under stressful conditions such as low fertility. Hence, such adverse consequences have to be properly addressed before we make use with confidence of genetically engineered crops to increase yields.

Furthermore, legislation aims at keeping pests from entering a non-infested area. In many cases however, the legislative measures merely succeed in delaying the entry of pests, but ultimately, they may gain entry [60]. This is an indication Otta Farm, Ogun state is going through a period of economic liberalisation, which implies removal of restrictions that may result to free transfer of plant and animal materials across borders. The dangers of introduction of new pests to non-infested areas are therefore likely to increase [52]. This calls for more stringent cross border checks and where legislation has failed to keep pests out, quarantine measures have to be introduced. An effectively

implemented pesticide legislation is essential, particularly to prevent haphazard uses of pesticides. This according to [56] will reduce chances of environmental degradation, development of resistant populations of the pests, and of other associated problems.

In addition, plant resistance is generally defined as the ability of a plant to avoid, tolerate or recover from attacks of pests under conditions that would normally cause injury to other plants of the same species. There have been significant developments in breeding for plant resistance to some important insect pests (e.g. against bean maggots or stem borers). Plant resistance to pests will definitely play an increasingly important role in future pest management in Africa [44]. For example, some sorghum cultivars are known to be resistant to both field and stored products pests be made. Adequate information is lacking in the control of many pests in Africa. The formulation of an effective management package for any particular pest complex will require the integration of biological, chemical and cultural practices.

However, this requires a thorough analysis of the agro-ecosystem in its proper ecological, sociological and environmental setting [61]. Among factors that need to be understood include: density dependent factors, behaviour patterns and spatial distribution [61]. One essential consideration in the ecological approach is the capability to forecast pest outbreaks knowledge of the population dynamics and ecology of the pest has a particularly important function in the development of models to predict outbreaks. [52] For example studies in rodents have enabled formulation of ecologically based management systems for multi-mammate rats in Eastern Africa that are aimed at reducing crop losses and disease prevention.

Unfortunately, it is understood that relatively little of the ecology and population dynamics of many crop pests [45]. What is especially lacking is information on pest history, including the factors which in the past have led to outbreaks. For example, weather changes can contribute a lot in the control of pests because of its influence on

the pest population size, rate of growth or migration patterns [61]. A good example of the influence of weather patterns can be found in relation to arthropod pests and rodents.

However, it could be said that the fact that very few studies have been conducted in Africa to show the influence of climatic conditions on vertebrate pests, also served as a motivation for embarking on this study to ascertain the damage that has been caused by pests to farm produce in Otta Farm Ogun State. However, in recent years such studies have been reported in Ogun state that shows the influence of rainfall on rodent species. In future therefore, there is need for a better understanding of the mechanisms influencing the occurrence of outbreaks and on the basis of this knowledge, build models that can be used for their prediction. Therefore, the way forward is to create and make available information, especially on pest ecology, in order to implement a sound management with little or no reliance on chemicals. An understanding of insect biology and bionomics is essential for management of most pests.

3.3. Effectiveness the improvement program implementation of pest management system at the Otta Farm Ogun State

A number of the safety and ecological problems of applying pesticides and the issue of resistance to pesticides are targeted by the approaches and practices that make up integrated pest management (IPM). These dangers are mitigated by using IPM strategies. Environmental IPM, or Integrated Pest Management, is a method of pest control that is gentle on the planet, employing a variety of tried-and-true methods founded in farmers' traditional wisdom. The growth of Otta Farm and the surrounding rural community is dependent on raising productivity [72]. As a result of the interdependence of psychological issues genetic, and interpersonal variables in farming, optimising both quality and quantity requires striking an appropriate equilibrium between these aspects [70].

Implementing IPM to Control Pests Otta Farm Ogun State's successful improvements initiatives of the programme demonstrates the power of instructional and implemented productive programmes to broaden farmer understanding of IPM, agricultural ecology, the entire lifespan of pests and their natural competitors, and to promote personal creativity [65]. Sustainable cultivation, protecting the natural predators of invaders routine farm surveillance, and transforming farmers into professionals through focus on their contribution are the four fundamental tenets of this strategy. Farm agroecology involvement, agricultural environment examination, and summarising and presenting results are the three key tasks upon which this strategy rests [67].

By delivering a worldwide expert, the FAO's IPM international establishment part has shown its full backing for the Otta Farm Ogun State's efforts to implement collaborative highlighting strategies and maximise the application of synthetic pesticides [45]. Information about how to educate farmers to the point where they can grow and produce food and animals with fewer or no herbicides has expanded greatly over the past decade. The guiding concepts are to keep or grow productivity in agriculture while reducing or completely removing environmental impact by finding suitable approaches to strengthen the unavoidable, societal and economic capital in environments [70].

Since the late 1980s, when Farmer Field Schools (FFS) were first implemented, the industry has seen its single most important change. By enhancing farmers' knowledge and skills through learning, co-learning, and hands-on experiences, we hope to make farming more resilient to the problems of the present and in the years to come. Agroecological expertise, problem-solving abilities, social cohesion, and governmental authority are all bolstered through FFS, making them more than merely a supplement tool [66]. Video, the airwaves, market booths, pop-ups, and music are just some of the newer forms of extension that have been added to FFS in the past few decades [54]. These work best when there are clear, easy-to-understand statements or heuristics that have been proved to improve outcomes. Some economies of various nations have been

affected by FFS and IPM. However, rhe use of pesticides by Filipino rice farmers decreased by 70% between 1994 and 2007, resulting in higher yields (by 12%) and greater consistency from year to year [45].

The country's rice output increased from 10.5 to 16.8 Mt throughout this time timeframe. Certain areas in Ogun state, especially Abeokuta, employ as much as forty to fifty treatments of pesticides per summer on legumes and as many as one hundred and fifty to two hundred on the plant, occasionally every day [70]. A lot of farmers simply spray their commercial crops, allowing their own use crops to remain untreated. FFS has assisted farmers in adopting and increasing pesticide application to rice while guaranteeing that aquatic mammals and amphibian remain safe in areas of Nigeria where there are currently a significant lack of rural manpower due to the growing garment industry drawing young individuals away from farming [47]. Two integrated pest management (IPM) programmes in Sichuan, China were evaluated, and the results showed that yields improved marginally while the application of pesticides decreased by 40-50%. This can also be inculcated by the Otta Far, Ogun state [63].

Sixty-four per cent of the bugs and insects in wet rice agroecosystems were determined to be carnivores and parasitic organisms, nineteen per cent were neutral detritivores because and seventeen per cent were agricultural pests. Prior to the introduction of herbicides, helpful were the most efficient means of pest management [38]. However, it is challenging to dispel the concerns of farmers, which are sometimes fuelled by a pesticide business. Concerns about crop loss, insecticide resistance, and the spread of insect pests from sprayed to untreated areas are all obstacles that farmers must surmount. Some farmers have reported anxiety about ruining their reputations by spraying their crops at night. Where farmers did participate in FFS, nevertheless, the usage of pesticides dropped dramatically, from an average of 1.9 treatments per season of planting to just 0.3 [49].

In this light, it is suggested that agriculture may and ought to assist with a wide range of issues, including climate change adaptation, carbon capture and storage, energy generation, controlling pests, water both quantity and quality, and variety of food. This type of IPM project closes "nature gaps" to provide a wide range of human and environmental advantages [55]. The traditional approach of controlling insects, on the other hand, is a reaction to "nature gaps" that ultimately enlarges them. The push-pull system, created in Otta farm, is an excellent illustration of innovation in action. To encourage beneficial insects to visit crops, farmers might use a technique called "push-pull" that involves manipulating the behaviour of pest insects and their natural foes. The ingredients are typically safe to consume.

Visual lures, non-host volatiles (such citronella or eucalyptus), aggregation-preventing perfumes, warning and sex smells, and neem-derived anti-feedants are all part of the push-pull strategy, which was developed in Australia. Investigation into the functions of herbivore-induced plant volatiles (HIPVs), the chemical compounds produced by seedlings in response to predators has contributed to the development of effective push-pull strategies in integrated pest management [45].

Vegetables and reeds are planted in Ogun state to both entice and deter maize diseases and insects. The very first breakthrough in science of the role of semiochemicals that produced by crops as well as how they influenced insect conduct paved the way for the widespread adoption of such systems, which are now used on more than 30,000 farms. In Abeokuta, it was discovered that modern hybrids of maize lack some semiochemical properties that were present in their ancestors. When the corn rootworm feeds on the roots of a maize plant, the plant releases aromatic chemical substances (such as -caryophyllene), which in turn attracted soil-dwelling helminth. Root destruction is mitigated when this biological capability is restored (69). This is commonly referred to as changing the "signal environment" of agricultural productivity.

Plant diversity, crossover to move hosts around, HIPV-repelling desmodium legumes, parasitoid-attracting molasses greenery, and napier and sudan grass trap crops are all part of the Otta Farm model. As a result, the non-host inter cropping drive the grain crop's stem-boring pest into the trapped crops, in which it lays its eggs in large numbers and the grassy plants produce sticky chemicals that kill the developing larvae. The growth of Striga (witchweed) is also inhibited by the desmodium. Positive outcomes from push-pull include enhanced soil quality and higher output from animals due to more readily available forage. Push-pull farming has been used by certain farmers for 15 years, during which time various improvements have been made (such as rice from the mountains being interspersed with desmodium). Certain initiatives do not intend to deal with a pest problem, but through altering agroecological ecosystems, they are able to achieve pest reduction.

CONCLUSIONS

Ogun State uses a variety of strategies for the management of pests, and these strategies change according to the nature of the pests that need to be controlled and the stage that they are at in the agricultural value chain. The majority of approaches to pest management rely on the use of chemicals, each of which has its own unique set of risks associated with the application of pesticides. Pesticides were once thought to be the only solution to the majority of pest problems; however, growing environmental and public health concerns, growing pest resistance to pesticides, and growing economic pressures on farming and the food industry have shown that the use of pesticides is now frequently seen as just one of several possible control measures. We require new insecticides to take the place of those that have been shown to be ineffectual against pest species that have developed resistance to them or that are detrimental to the environment in some other manner. It is possible that one key element that limits the use of pesticides, such as synthetic pyrethroids, is the high cost of these chemicals.

Due to the high cost of research and development, there is an urgent need for the development of novel approaches to the administration of pesticides. These approaches should minimise the amount of unnecessary dosage while simultaneously improving selectivity against pest insects. It is also essential to develop ways of pest management that have a minimal negative impact on the environment. As a consequence of this, it may be possible to avoid the challenges connected with the use of specific pesticides, and it may also be possible to realise the promise for efficient pest management that is also safe and cost-effective.

Pheromones that are employed for aggregation serve several purposes, including reproduction, food acquisition, and the protection of the colony. P. truncatus, also known as the larger grain borer, is responsible for producing an aggregation pheromone. This pheromone is being used to track pest populations in warehouses so that more efficient pest treatment may be carried out.

Interfering with the creation and expansion of locust pheromones as they transition from solitary to social forms might be one way to prevent locusts from swarming. This would require observing the locusts as they make the shift. In the future, chemical techniques of pest control will need to modify their approach to specific pest species in order to decrease the harmful effects that these approaches have on non-target ecosystem components and organisms that are useful to the ecosystem, such as natural enemies. Throughout the course of application technology's development, the majority of its components have historically been comprised of sprays, granules and dusts, baits, and fumigants. There is a significant disadvantage associated with this sort of composition, and that is the possibility that the insect will not ingest all of the material that has been sprayed. As a consequence of this, it will be essential in the not too distant future to pay greater attention to the pathways that new poisons travel in order to achieve their intended effect on pests. The most effective course of action is to develop a formulation or a technique of controlled delivery that may be utilised against the pests of interest while keeping the active components secure until such time as they are required.

Furthermore, utilising microencapsulation methods, there are now accessible for certain kinds of pests in Africa (Wilkins 1978). With the controlled release method, the release of chemicals by the matrix coincides with the infestation trend for a long enough period of time to safeguard the crop (McFarlane and Pedley 1978). It is clear that no one form of pest control chemical shall be anticipated to tackle all problems related to food production and maintaining good public health standards, notwithstanding the quest for novel compounds. It's quite evident that we require a wide variety of effective pest control weapons. So, the next generation of pesticides will need to exhibit characteristics such as versatility in terms of formulation, application, target specificity, non-persistence, and minimal toxicity to the environment. Reducing reliance on pesticides to avoid the limits identified over the past 50 years is one of the primary issues in pest management in agriculture in Africa. educating the public on the harmful effects of pest

species and the parasites and predators that coexist with them; preventing the introduction of exotic pests that can ruin a harvest; Making available to farmers materials for pest management that are cheap, safe, effective, and environmentally friendly (such as microbials, botanicals, pheromones, genetically modified products, etc.) is an important step in creating and bolstering locally made technologies for pest management (IPM, biocontrol).

Quarantine and legislation will play important roles in the future of pest management, but only if applied over a larger region. How we learn about and implement pest control techniques will change as a result of advancements in information and communication technologies. Therefore, Africa must boost pest control across the continent by developing and enhancing its ICT infrastructure and skills.

If a continent is going to be able to feed its growing population, it has to invest in research facilities and the training of researchers, extension agents, and farmers to combat the threats presented by pests in agriculture.

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