Thematic Area: Health and Biotechnology

Project Title: Formulation of Sustainable Bio-pesticides from some Selected Plants for Effective Control of Pest Infesting Beans Plant on the Farm.

Executive Summary/ Abstract

This project focuses on developing an eco-friendly bio-pesticide derived from locally sourced plants to combat pests infesting bean crops, thereby enhancing agricultural sustainability and yield. By leveraging green extraction methods and natural insecticidal properties of selected botanicals, the initiative addresses the growing need for alternatives to synthetic pesticides, which often pose environmental and health risks. The project integrates extraction, formulation, and field testing to create a viable solution for small holder farmers facing pest challenges in bean production.

1.0 Introductory Background and Statement of Need

1.1 Research Idea/Innovation

Nigeria is the world's largest producer and consumer of beans, about more than 3.6 million tons of beans is consumed annually, but about 500,000 tons of beans is imported annually to meet up with the local demand (PBR Cowpea,2021).

Beans are one of the most commonly consumed protein-rich foods in Nigerian households; it is usually cooked or made into local delicacies such as akara and moi-moi. The beans market is expected to reach USD 7.69 billion in 2025 and grow at a CAGR of 5.40% to reach USD 10.01 billion by 2030 (Mordintelligence.com). However, the plant suffers from many insect pests during planting and the post-harvesting period, which causes huge economic loss in production, sometimes causing farmers to lose 80 to 100 percent of their crop, limiting beans.

Bio-pesticides can be derived from naturally occurring living organisms such as animals, plants, and can also be obtained from fungi, bacteria and viruses, which are microorganisms that help in the control of plant-damaging pests. The natural occurrence from living organism, microorganism and their non-toxic, eco-friendly mode of actions has made it of great importance, all over the world. Bio-pesticides and their derivatives are mainly utilised for the management of pests deleterious to plants (Mazid *et al*., 2011). Drastic reductions in yield are caused by pests like weeds, fungi and insects in agriculture. The devastating activities of these pests brought about different chemical pesticides. These pesticides resolved the problem to a great extent. But the adverse effect of chemical pesticides on the soil and the environment is a significant concern. Degraded soil, groundwater pollution and food safety have been a huge concern due to the overdependence on these chemical pesticides. Therefore, an eco-friendly alternative is the current need. (Gupta and Dikshit, 2010). Bio-pesticides do not have any residue problem like traditional pesticides, which is a case of significant concern for consumers, mainly for edible fruits and vegetables. When used as a component of insect pest management, the potency of bio-pesticides can be comparable to that of traditional pesticides, especially for crops such as fruits, vegetables, nuts, and flowers. By merging artificial pesticide performance and environmental security, bio-pesticides act effectively with the adjustability of slight application limitations and with high ranking resistance management prospects. (Kumar 2012).

1.2 Project Justification

Investigating the bio-pesticide's efficacy on bean pests will provide evidence-based insights into its potential to control infestations while enhancing crop yield. This will promote an effective, sustainable, and economically viable pest management solution, empowering farmers, enhancing agricultural productivity, and promoting environmental health, which aligns with global sustainable development goals related to responsible consumption, production, and environmental protection.

1.3 Project Goals & Objectives

The goals and objectives of the project are to:

a. Extract the active insecticidal components from the selected plants using green extraction protocols.

b. Formulate bio-pesticide using *Azadirachta indica* leaves, *Azadirachta indica* fruit peel, *Zingiber officinale*, *Allium sativum*, *Adansonia digitata* leaves and *Capsicum frutescens.*

c. Investigate the insecticidal potency of the formulated bio-pesticide on pests infesting beans on the farm and improving the total yield.

1.4 Conceptual/ Theoretical Framework

Conceptual Framework

The project is designed to address the challenge of pest infestations in bean crops through a sustainable, eco-friendly approach. The conceptual framework centres on three interconnected components: the green extraction of active insecticidal compounds, the formulation of a bio-pesticide, and the **evaluation of its efficacy and impact on crop yield**. These components are grounded in the principles of sustainable agriculture, environmental conservation, and food security.

a. **Green Extraction of Active Insecticidal Components**: This involves using environmentally friendly extraction techniques, such as solvent-free microwave extraction or ultrasonic-assisted extraction, to isolate bioactive compounds from selected plants (*Azadirachta indica leaves, Azadirachta indica fruit peel, Zingiber officinale, Allium sativum, Adansonia digitata leaves,* and *Capsicum frutescens*). These plants are chosen for their known insect-repellent and insecticidal properties, attributed to compounds like azadirachtin, allicin, and capsaicin. The use of green protocols minimizes environmental impact by reducing energy consumption and eliminating the use of toxic solvents.

b. **Formulation of Bio-Pesticide**: The extracted compounds will be combined to develop a bio-pesticide, optimized for stability, efficacy, and ease of application. The formulation process considers the synergistic effects of bioactive compounds to enhance insecticidal activity while ensuring safety for non-target organisms, maintaining soil health, and ensuring human consumption safety.

c. **Evaluation of Insecticidal Potency and Yield Improvement**: The bio-pesticide will be tested on bean crops to assess its effectiveness against common pests (e.g., bean weevils or aphids) and its impact on total yield. Field trials will measure pest mortality, crop damage reduction, and yield improvements, providing data to validate the bio-pesticide's practical applicability.

The conceptual framework links these components to achieve a sustainable pest management solution that reduces reliance on chemical pesticides, enhances crop productivity, and supports environmental sustainability. The framework assumes that the selected plants' bioactive compounds, when extracted and formulated sustainably, will effectively control pests and improve bean yields without adverse ecological impacts.

Theoretical Framework

The project is underpinned by several theoretical perspectives that guide its design and implementation:

a. **Biopesticide Theory**: This theory posits that naturally derived compounds from plants can serve as effective alternatives to synthetic pesticides. Studies (e.g., Isman, 2006) highlight that plant-based bio-pesticides, such as those derived from Azadirachta indica (neem), exhibit insect-repellent, antifeedant, and growth-disrupting properties. The project leverages this theory by utilizing plants with proven bioactive compounds, such as azadirachtin from neem, allicin from garlic (Allium sativum), and gingerols from Zingiber officinale, to formulate an effective bio-pesticide.

b. **Green Chemistry Principles**: The use of green extraction protocols aligns with the principles of green chemistry (Anastas & Warner, 1998), which emphasize environmentally benign processes. Techniques like ultrasound-assisted or microwave-assisted extraction reduce energy use and eliminate hazardous solvents, ensuring the project's sustainability. This theoretical lens supports the extraction process, ensuring minimal environmental footprint.

c. **Integrated Pest Management (IPM)**: IPM theory advocates for the use of multiple, environmentally friendly strategies to manage pests while minimizing ecological and economic risks (Kogan, 1998). The project aligns with IPM by developing a bio-pesticide that targets specific pests affecting beans, reducing the need for broad-spectrum chemical pesticides and promoting biodiversity.

d. **Sustainable Agriculture Framework**: This framework emphasizes agricultural practices that enhance productivity while preserving environmental resources (Pretty, 2008). The project supports this by developing a bio-pesticide that improves bean yields, reduces chemical pesticide dependency, and promotes soil and ecosystem health, contributing to long-term agricultural sustainability.

e. **Bioactivity Synergy Hypothesis**: This hypothesis suggests that combining bioactive compounds from multiple plants can enhance insecticidal efficacy through synergistic interactions (Miresmailli anad Isman, 2014). The project tests this by formulating a bio-pesticide from multiple plant sources, hypothesizing that the combined effects of compounds like azadirachtin, capsaicin, and allicin will yield superior pest control compared to single-compound formulations.

2.0 Technology Readiness Level (TRL): 3.0

The biopesticide has been formulated and a field trial was carried out to test the potency on some pests affecting beans on the farm,

3.0 Methodology & Technical Approach

. Phase 1: Extraction of Active Insecticidal Components Using Green Extraction Protocols

- **Plant Material Collection and Preparation**

Fresh samples of *Azadirachta indica* leaf, *Azadirachta indica* fruit peel, *Adansonia digitata* leaf will be collected from farms within the premises of NARICT Zaria while *Zingiber officinale* (ginger rhizomes), *Allium sativum* (garlic bulbs) and *Capsicum frutescens* (chili peppers) will be purchased from Samaru Market and shade dried, ground into powder and stored in an air tight container.

- **Extraction Procedure**:

Ultrasound-Assisted Extraction:

10 g of each plant powder will be dissolved in 500 ml of distilled water in an ultrasonic bath at 40 kHz and 40°C for 30 minutes, sonication time and solvent ratio time will be optimized to maximize yield.

Microwave-Assisted Extraction:

10 g of each plant powder will be dissolved in 500 ml of distilled water in a microwave extractor at 300 W for 10 minutes, at a temperature of 40℃ to avoid degradation of thermolabile compounds.

Filtration and Concentration: The extract will be filtered using Whatman No. 1 filter paper to remove solid residues. The filtrate will be further filtered using a rotary evaporator at 50°C to obtain crude extracts.

Analysis of Bioactive Compounds: High-performance liquid chromatography (HPLC) will be used to identify and quantify key insecticidal compounds such as azadirachtin, allicin, capsaicin, and gingerol in each extract.

Phase 2: Formulation of Bio-Pesticide

- **Formulation Design**

Component Mixing: The crude extracts from *Azadirachta indica* leaves, *Azadirachta indica* fruit peel, *Zingiber officinale*, *Allium sativum, Adansonia digitata* leaves, and *Capsicum frutescens* will be combined in varying ratios (2:2:1:2:1:2 or optimized based on HPLC results) to make up 50g of the formulated powder to maximize synergistic insecticidal effects.

Emulsification: An oil-in-water emulsion will be prepared to enhance stability and application. 5% (v/v) natural emulsifiers (soy lecithin) and 10% (v/v) carrier oils (neem oil) will be added to the extract mixture. Homogenization will be done using a high-speed mixer at 10,000 rpm for 10 minutes.

Stabilization: Natural stabilizers (glycerol) will be incorporated to prevent phase separation and extend shelf life. The pH will be adjusted to 5.5–6.0 using citric acid to ensure compatibility with plant surfaces and pest physiology.

Formulation Testing: Stability tests will be conducted under varying temperatures (4°C, 25°C, 40°C) and light conditions for 30 days to assess the shelf life. The physical properties, such as viscosity and particle size, will be evaluated using a viscometer and dynamic light scattering.

- **Laboratory Bioassays**

Insect Selection: Common bean pests (*Acanthoscelides obtectus* or *Callosobruchus maculatus*) will be sourced from an infested bean farm or laboratory cultures.

Bioassay Design: The formulated bio-pesticide will be tested at different concentrations (1%, 5%, 10% v/v) in Petri dish assays. 20 adult pests per replicate will be exposed to treated filter paper or bean seeds, with water and synthetic pesticide as controls. Mortality, repellency, and feeding deterrence will be monitored after 24, 48, and 72 hours.

Phase 3: Investigation of Insecticidal Potency and Yield Improvement in Field Trials

- **Field Trial Setup**

Land Preparation, Sowing and Weeding.

The experimental plot within NARICT premises will be cleared and ridged, three seeds of beans will be sown per hole to avoid germination failure with intra-row spacing and inter-row spacing of 20cm and 75cm, respectively. Randomized block design with at least three replicate plots (10 m x 10 m) will be used per treatment.

Treatments: The formulated bio-pesticide will be applied at the optimal concentration (determined from bioassays) using a knapsack sprayer. The farm will be shared into three treatment groups: group A will be treated with the formulated bio-pesticide, group B will be treated with a synthetic pesticide (positive control), and group C will be untreated (negative control). The treatments will be applied at weeks 5, 7 and 9 during the growing season.

Application Protocol: Bio-pesticide will be applied uniformly on bean foliage at a rate of 500 L/ha, ensuring coverage of leaves and stems, the application dates, weather conditions, and pest populations before and after treatments will be recorded.

Greeen house study will also be conducted under controlled conditons

Fig 1: The formulated biopesticide

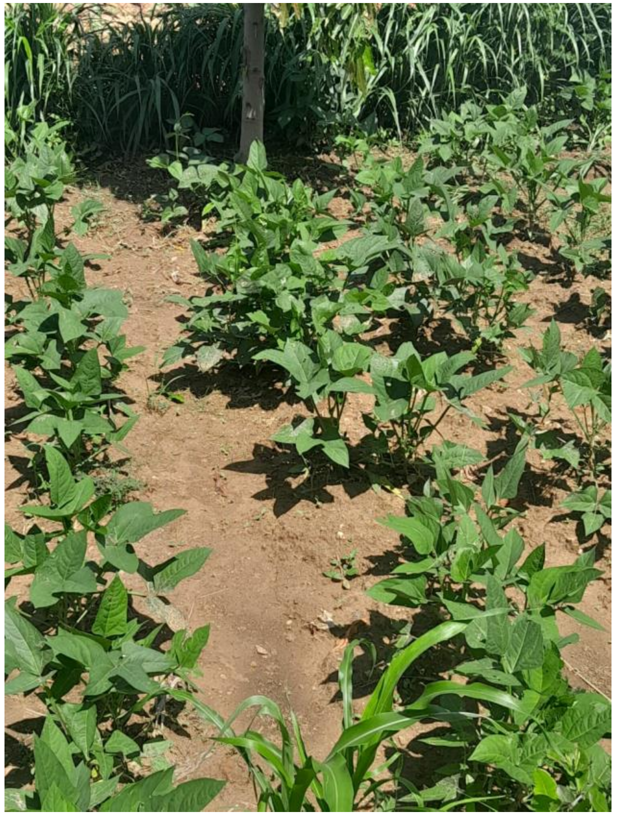

Figure 2: the experimental farm

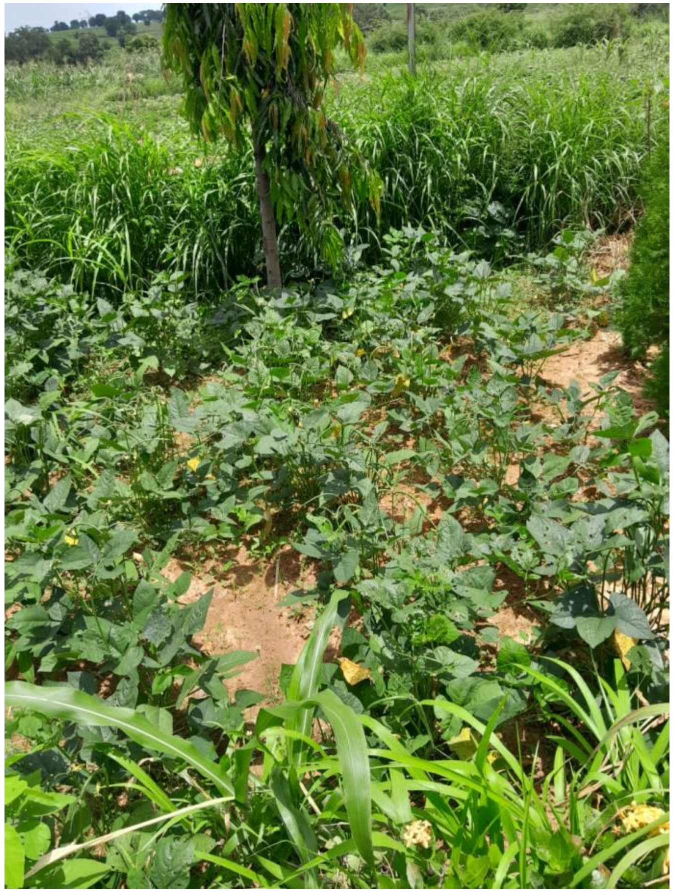

Fig 3: The infested Farm

Figure 4: Apids on the leaves

Fig 5: Cowpea Apids on the stem

Fig 6: Cowpea Stem maggot

Fig 7 : Infestation by foliage beetles

Fig 8: Infestation by leaf miners

Fig 10: Infestation by Cowpea leaf miners

Fig 11: Infestation by Cowpea leaf miners

Fig 12: Cowpea Pods from the Control

Fig 13: Cowpea seeds from the Control

Figure 14: Cowpea Pods from the synthetic group   Figure15: Cowpea seeds from the synthetic group

Fig 16: Cowpea Pods from the biopesticide group   Fig 17: Cowpea seeds from the biopesticide group

- **Data Collection**

Pest Infestation: Pest populations will be monitored weekly using sticky traps and visual counts, pest damage will be assed by measuring the percentage of affected leaves, pods, or seeds per plant.

Crop Yield: Beans will be harvested at maturity and total yield (kg/ha) will be measured per plot, the seed weight, pod count, and quality (e.g., seed size, marketability) will be recorded.

Environmental Impact: Non-target effects will be evaluated by monitoring beneficial insects (pollinators) using sweep nets and assessing soil health through microbial activity tests.

- **Data Analysis**

Lethal concentration for 50 % mortality and Effective concentration for 50 % repellency) will be calculated using probit analysis to determine potency, ANOVA will be used to compare pest mortality, damage reduction, and yield across treatments and post-hoc tests (Tukey's HSD) will be performed to identify significant differences ($p < 0.05$).

4.0 Expected Outputs and Method of Dissemination

- Identification and quantification of insecticidal compounds from selected plants.
- A stable effective bio-pesticide formulation with synergistic activity against bean pests.
- Field trial data demonstrating reduced pest infestation, lower crop damage, and increased bean yield compared to controls.

5.0 Expected Impact

The expected impact includes agricultural, environmental, economic, and social benefits, contributing to sustainable development and food security.

a. Agricultural Impact

- **Enhanced Pest Control**: The bio-pesticide, formulated from bioactive compounds like azadirachtin, allicin, gingerols, and capsaicin, is expected to effectively control common bean pests (e.g., *Acanthoscelides obtectus* or *Callosobruchus maculatus*).
- **Improved Crop Yield**: By reducing pest-related damage to bean crops, the project is expected to increase total yield by 20–40% compared to farms using no pest control or chemical pesticides.
- **Sustainable Farming Practices**: The use of a plant-based bio-pesticide will promote integrated pest management (IPM), reducing reliance on synthetic pesticides and fostering long-term soil and crop health.

b. Environmental Impact

- **Reduced Chemical Pollution**: The adoption of green extraction protocols (e.g., ultrasound- or microwave-assisted extraction) minimizes the use of hazardous solvents and energy, lowering the environmental footprint of the extraction process.
- **Biodiversity Preservation**: Tthe project is expected to minimize adverse effects on beneficial insects, soil ecosystems, and water bodies, contributing to biodiversity conservation.
- **Climate Resilience**: The use of locally sourced plants for bio-pesticide production will reduce the carbon footprint associated with importing chemical pesticides, aligning with climate-smart agriculture principles.

c. Economic Impact

- **Cost-Effective Pest Management**: It will reduce input costs for farmers by an estimated 30–50%. This is particularly significant for smallholder farmers in resource-constrained regions.
- **Increased Farmer Income**: Higher bean yields and improved crop quality are anticipated to boost farmers' revenue, potentially increasing household income by 15–30% in regions dependent on bean production.
- **Scalable Production**: The green extraction and formulation processes are designed to be scalable, enabling local production of the bio-pesticide. This could create opportunities for small-scale enterprises, generating jobs in rural communities for plant collection, processing, and distribution.

d. Social Impact

- **Food Security**: Improved bean yield will enhance food availability and access, particularly in communities where beans are a staple crop. This is expected to contribute to household nutrition and reduce food insecurity in target regions.
- **Farmer Empowerment**: By providing an accessible and effective bio-pesticide, the project empowers farmers with sustainable pest management tools, increasing their resilience to pest-related crop losses and reducing dependency on external inputs.
- **Knowledge Transfer**: Training programs and field demonstrations associated with the project will educate farmers on bio-pesticide application and green agricultural practices, fostering community-led innovation and knowledge sharing.

6.0 Project Team Members and Specialization

Dr Saheed Ademola Ibrahim- **Principal investigator** (PhD Biochemistry)- He is vast in enzyme and protein analysis, with a very good understanding of the biochemical pathways of the active components of biopesticides, the mode of action on target pests and metabolite identification.

Onyeyirichi Esew-**Member** (MSc Biochemistry)-Expert in selecting appropriate carriers, surfactants and stabilizers to enhance shelf life, UV resistance and delivery of the biopesticide. Possesses a deep understanding of target pests and their life cycles to design biopesticides that effectively disrupt them

Uduakobong Ime Idio- **Member** (MSc Microbiology) – Experience genetic engineering and knowledge of microorganisms used as active ingredients in biopesticides.

Husaina Achau Garba-**Member** (MSc Biochemistry)- she is proficient in analytical techniques like HPLC, FTIR, GC-MS to analyse the chemical composition and stability of biopesticide formulations

Francis Iyeh-**Member** (BSc Microbiology)-Experienced in assessing the environmental impact of biopesticides on non target organisms, soil and water system.

Mas'ud Jafaar Musa-**Member** (BSc. Industrial Chemistry)- He is experienced in formulation chemistry

Buhari Basawa-**Member** (BSc.Glass Technology)-knowledge of glass chemistry, coatings and material compatibility to create durable non reactive containers.

Ibrahim Abubarkar-**Member** (MSc Biochemistry)- Experience in design delivery systems that optimise the application of biopesticides

6.1 Track Record and Demonstration of Expertise

- The biopesticide has been formulated at laboratory scale
- Field trial was carried out on a research farm
- The findings were presented at NCCT conference 2024 and published in the book of proceeding.

7.0 **Sustainability & Commercialization Plan**

a. Sustainability Plan

Sustainability will be embedded in every phase of the project, aligning with global trends toward eco-friendly agriculture. The formulated biopesticide will promote sustainable agriculture by offering targeted pest control with minimal environmental impact. The plan will focus on environmental, economic, and social dimensions.

- **Environmental Sustainability**

- **Green Extraction and Production**: The use of ultrasound- and microwave-assisted extraction minimizes solvent use and energy consumption, reducing the carbon footprint compared to conventional methods.
- **Biodegradability and Reduced Pollution**: The bio-pesticide, derived from natural plant sources, is biodegradable and less harmful to non-target organisms, soil, and water bodies. It supports biodiversity preservation and reduces chemical residues in ecosystems.
- **Integrated Pest Management (IPM) Integration**: The bio-pesticide will be promoted as part of IPM strategies, which will balance pest control with ecological health, minimizing resistance development and enhancing long-term sustainability.

b. Economic Sustainability

- **Cost-Effective Alternatives**: By utilizing abundant local plants, production costs will be lowered, making the bio-pesticide affordable for smallholder farmers. This fosters economic productivity in farming communities.
- **Yield Improvement and Market Access**: Expected yield increases of 20–40% will boost farmer incomes, while residue-free produce enhances export opportunities, reducing trade barriers associated with chemical pesticides.
- **Scalable Model**: The plan will include life-cycle assessments to optimize resource use, ensuring economic viability through efficient scaling and minimal waste.

c. Social Sustainability

- **Community Engagement**: Training programs for farmers on bio-pesticide application and sustainable farming will promote knowledge transfer and adoption.
- **Health and Safety**: Reducing exposure to synthetic chemicals improves farmer and consumer health, aligning with social acceptability in sustainable agriculture.
- **Monitoring and Adaptation**: Annual sustainability audits will incorporate stakeholder feedback to refine practices, ensuring ongoing social benefits.

Commercialization Plan

The commercialization strategy leverages the growing bio-pesticide market, projected to reach USD 15.66 billion by 2029 with a CAGR of 15.2%_The plan outlines key steps for market entry, scaling, and profitability.

Market Analysis

- **Demand Drivers**: Increasing consumer preference for organic produce and regulatory pressures on chemical pesticides drive demand. The market is expected to grow at 14.50% CAGR from 2025 to 2032.
- **Target Segments**: Initial focus on bean farmers in developing regions, expanding to other crops. Competitive advantages include local sourcing and synergy of multiple plant extracts.
- **Opportunities and Challenges**: High growth in sustainable agriculture sectors, but challenges like regulatory hurdles and market education will be addressed through partnerships.

Commercialization Steps

- **Product Development and Validation**: Complete formulation and field trials to gather efficacy data, as outlined in the project objectives
- **Regulatory Approval**: Seek registration with bodies like the NAFDAC, which regulates biopesticides for safety and efficacy
- **Scale-Up and Manufacturing**: Partner with local cooperatives for pilot production, optimizing processes for commercial scale Implement quality control to ensure consistency.

- **Marketing and Distribution**: Launch with farmer cooperatives and agricultural extension services. Use digital platforms for education and sales, emphasizing sustainability benefits.
- **Business Model**: Adopt a hybrid model of direct sales and licensing to agribusiness firms. Revenue streams include product sales, consulting, and carbon credits from sustainable practices.
- **Intellectual Property and Partnerships**: Secure patents for the formulation and collaborate with NGOs, governments, and private sectors for funding and market access.
- **Timeline and Milestones**: Regulatory submission by Year 2, pilot commercialization by Year 3, full market entry by Year 5, with ongoing monitoring for adaptations.

8.0. Timeline

Activities **Months**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Plant Collection and preparation																								
Green Extraction and Analysis																								
Formulation Development																								
Laboratory Bioassay																								
Formulation Refinement																								

Field Trial Setup																								
Field Trials																								
Data Analysis																								
Disemination and Reporting																								

9.0 Monitoring and Evaluation

9.1 KPIs and how you will measure them.

KPIs and Measurement Methods

Phase 1: Extraction of Active Insecticidal Components (Months 1–6)

Plant Material Collection and Authentication

- The plant materials *Azadirachta indica leaves, fruit peel, Zingiber officinale, Allium sativum, Adansonia digitata* leaves, *Capsicum frutescens* collected and authenticated at the herbarium in the Department of Botany.

Bioactive Compound Yield

- Insecticidal compounds (azadirachtin ≥ 0.5 mg/g from *Azadirachta indic*a, allicin ≥ 1 mg/g from *Allium sativum*, capsaicin ≥ 0.2 mg/g from *Capsicum frutescen*s) by Month 5.

Measurement Method:

- High-performance liquid chromatography (HPLC) will be used to quantify bioactive compounds in crude extracts from ultrasound-assisted extraction (UAE) and microwave-assisted extraction (MAE).
- The yield (mg/g of dry plant material) for each compound will be recorded and compared against literature benchmarks.
- Extraction parameters (e.g., solvent ratio, time) will be optimized to meet or exceed target yields. Development of Green Extraction Protocols

Phase 2: Bio-Pesticide Formulation (Months 7–12)

Formulation Development

Three stable bio-pesticide formulations with varying extract ratio will be developed by Month 9.

Insecticidal Efficacy in Laboratory Bioassays

The formulated biopesticide should be able to give ≥70% pest mortality and ≥50% repellency at a bio-pesticide concentration of ≤5% v/v in laboratory bioassays by Month 11.

Phase 3: Field Trials and Impact Assessment (Months 13–24)

Pest Population Reduction

The biopesticides should give a result ≥50% reduction in pest populations (e.g., bean weevils, aphids) compared to water control in field trials by Month 21

Crop Damage Reduction

There should be reduction in crop damage (e.g., affected leaves, pods, or seeds) by ≥40% compared to water control by Month 21.

Yield Improvement

Increase bean yield by ≥20% (kg/ha) compared to water control by Month 21.

Environmental Safety

It is expected that there will be <10% reduction in beneficial insect populations (pollinators) and no significant adverse effects on soil microbial activity by Month 21.

9.2 Risk management plan.

Risk Management Framework

Risk	Phase	Likelihood	Impact	Mitigation Strategy	Monitoring Method
Insufficient compound yield	Phase 1	Medium	High	Optimize protocols, source diverse plants	Bi-weekly HPLC data
Limited plant availability	Phase 1	Low	Medium	Secure supplier agreements, cultivate plants	Monthly procurement logs
Equipment failures	Phase 1	Low	Medium	Maintain equipment, train staff	Monthly equipment logs
Ineffective formulation	Phase 2	Medium	High	Test multiple formulations, refine based on bioassays	Bi-weekly stability/bioassay data
Limited lab capacity	Phase 2	Low	Medium	Confirm equipment access, train staff	Monthly resource checks
Variable field conditions	Phase 3	High	High	Use randomized designs, multiple sites	Weekly field data, statistical analysis
Low farmer engagement	Phase 3	Medium	Medium	Train farmers, provide demonstrations	Monthly engagement reports
Adverse environmental impact	Phase 3	Low	High	Monitor non-target effects, adjust formulation	Weekly environmental data
Regulatory issues	Phase 3	Medium	High	Secure permits, ensure compliance	Pre-trial permit checks, final report

10.0 Project Budget and Justification

Budget

A total Budget of **143,951,262.50** is required to execute the project, the breakdown is given below.

1. Chemicals

S/NO	Name	**Unit Qty**	**Qty**	**Unit Price(₦)**	**Cost(₦)**
1.	Methanol	2.5 L	2	26,350.00	22,700.00
2.	Acetone	2.5 L	5	24,187.50	70,937.50
3.	Ethanol	2.5 L	5	27,025.00	85,125.00
4.	Galex R herbicide	1L	50	10,000.00	500,000.00
5.	Cypermethrin 10%	1L	20	15,000.00	300,000.00
6.	Tween 80	500ml	5	20,500.00	102,500.00

7	Glycerol	500ml	5	2,000.00	10,000.00
8.	Starch	50kg	2	80,000.00	160,000.00
				TOTAL	**1,250,762.50**

2. Equipment

S/No	**Name**	**Qty**	**Cost (₦)**
1	Commercial wet and dry grinder	1	2,000,000.00
2	2 in 1Rechargeable (Hand/ battery powered) knapsack sprayer	5	1,000,000.00
3	Ultrasonic bath	1	1,500,000.00
4	Microwave extractor	1	1,500,000.00
5	Green house		1,000,000.00
		TOTAL	**6,000,000.00**

3. Characterization

	Characterization	Cost (₦)
1	Chemical Characterization	1,200,000.00
	Total	**1,200,000.00**

4. Materials and consumables

S/N	Item	Qty	Unit Cost	Cost (₦)
1.	Ginger	100 bags	570,000.00	57,000,000.00
2	Pepper	100 bags	200,000.00	20,000,000.00
3	Gartlic	100 bags	300,000.00	30,000,000.00
4	Babobab leave	100 Bags	50,0000	5,000,000.00
5	Neem leaves	100 bags	80,000.00	8,000,000.00
6	Neem fruits	100 bags	80,000.00	8,000,000.00
7	Beans	2	200,0000.00	400,0000.00

8	250 ml glass beakers	30	2,000.00	60,000.00
9	Sieve	10	5,000.00	50,000.00
10	100 ml conical flasks	25	2,000.00	50,000.00
11	100 ml measuring cylinder	10	2,000.00	20,000.00
12	250 ml measuring cylinder	5	2,500.00	12,500.00
13	Pack of disposable nose masks	5	6,000.00	30,000.00
	TOTAL			**128,622,500**

5. Administrative costs

S/No	Items	Qty	Unit Cost	Cost (₦)
1	Hp EliteBook 840 G5 Touchscreen Core I7-16GB RAM/1TB SSD / Backlit Keyboard/FP Reader WIN 11 Pro+BAG	2	862,500.00	1,725,000.00
2	HP Hp Laserjet M211dw Printer	1	500,000.00	500,000.00
3	Printer ink cartridges	2	100,000.00	100,000.00
4	Diesel (2 drums)	200L	1,500.00	300,000.00

5	Slide binders			6,000.00
6	Slider binder covers			10,000.00
7	Staplers, pins, tags			10,000.00
8	Communications and logistics			120,000.00
TOTAL				**2,771,000.00**

6. Conferences

	Item	Cost	Number of people	Total
1	Conference fees	40,000.00	7	360,000.00
2	DTA (5 days)	 37,500.00 25,000.00 17,500.00	1 1 2 4	 187,500.00 250,000.00 340,000.00
3	Local runs	50,000.00	7	350,000.00
4	Transportation	100,000.00	7	700,000.00
	TOTAL			**2,387,500.00**

7. Researcher and Admin Data Allowances

1.	Dr. Saheed Ademola Ibrahim	120,000.00
2.	Mrs Onyeyirichi Esew	100,000.00
3	Mrs Uduakobong Ime Idio	100,000.00
4	Mrs. Husaina Garba Anchau	100,000.00
5	Mr. Ibrahim Abubakar	100,000.00
6	Mr Francis Iyeh	100,000.00
7.	Mr. Macus Kasai	100,000.00
8.	Mr. Ja'far Masaud	100,000.00
9	Mr. Buhari Basawa	100,000.00
	TOTAL	**920,000.00**

8. Research Allowance for (5) external collaborators ₦1,000,000.00

Budget Summary

S/No	**Item**	**Cost**
1	Chemicals	1,250,762..50

2	Equipment	6,000,000.00
3	Characterization	1,200,000.00
4	Materials and Consumables	128,622,500.00
5	Administrative Costs	2,771,000.00
6	Conferences	2,387,500.00
7	Researcher Allowances	920,000.00
8	Allowance for (5) external collaborators	1,000,000.00
	GRAND TOTAL	**143,951,262.5**

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