Call for Proposal by: National Agency for Science and Engineering Infrastructure (NASENI)

Proposal Title: Intelligent Detection of Cashew Pests and Mobile Extension System for the Management (IDCaPE)

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Executive Summary

Cashew production is a vital source of income for smallholder farmers in Nigeria and across West Africa, yet its productivity is severely constrained by pests and diseases. Traditional extension systems are unable to adequately support farmers, resulting in significant crop losses and reduced export potential. The Cocoa Research Institute of Nigeria has piloted cashew health map research through a West Africa regional project in the year 2024. The project activities were conducted in 4 cashew major producing states of Nigeria. The field evaluation was based on the physical damages, symptoms and signs of diseases on cashew parts, and catalogue of cashew pests were documented. This project proposes the development of an intelligent-driven digital and mobile platform for the detection, identification, documentation, and management of cashew insect pests and diseases. Through image recognition, mobile extension services, and real-time advisory support, capacity of farmers will be built to identify problems early, apply appropriate control measures, and increase productivity. The platform will link farmers, researchers, and extension officers, thereby strengthening the cashew value chain. The outcome of this project present opportunities to revolutionize cashew pest and disease management, by reducing losses due to pest attack, bridge farmers knowledge gap, encourage young adults in information technology sector and strengthening the value chain through digital innovation.

Background

Cashew production is constrained by lack of research on cashew planting material development, breeding for improved varieties and unavailability of high-quality planting material for farm establishment, low and variable nut yields, nut quality, non-availability of improved seeds were factors limiting production and susceptibility to pests and diseases which is the focus of this research intervention. Cashew faces serious challenges from insect pests and diseases, which significantly reduce yield and quality. Several pathogens and insect pests attack cashew parts, while information on cashew pest index and mapping is rare in Nigeria; activities to achieve this is being developed based on pests of interest (Adeniyi and Asogwa, 2023).

Information dissemination is a key factor in agricultural development. Growth cannot be achieved without knowledge being generated, disseminated and applied. Appropriateness in time and content of the information transferred also determines the quality of development. Insufficient extension agents, and the risk of untimely information delivery have hindered Nigeria's traditional agricultural information dissemination system. Unfortunately, farmers often lack timely information and expertise to correctly identify cashew pests/diseases and apply appropriate management practices. Traditional scouting to detect and identify pests and diseases actually relies on human labour and extension services which can be time consuming, in-efficient, inconsistent and costly (Gupta, et al., 2024). The traditional extension services are limited in reach, while digital technologies particularly artificial intelligence and mobile applications offer innovative solutions. Artificial intelligence-powered early detection allows farmers to intervene before damage escalates saving substantial income that would be lost. The use of machine learning in information dissemination allows farmers to access timely, accurate, and personalized advice, improving their productivity, efficiency, and profitability.

This proposal seeks to develop an intelligent – driven mobile platform for cashew farmers, enabling real-time pest and disease detection and alert system. Documentation of damages, and access to tailored management advice through mobile extension services. The system will work through image recognition, mobile extension services, and real-time advisory support, farmers will be empowered to identify problems early, apply appropriate control measures, and increase productivity. The technology will be focused on the selected major cashew insect pests; *Helopeltis* species, *Analeptes trifasciata, Pseudotheraptus* spp., stem borers, and diseases; Dieback (twig, flowers), Anthracnose (on apple, leaves) and Powdery mildew (on apple, flowers, leaves). This proposal will provide solutions to pest and disease problem through information technology in which young adults are very vast at optimizing this area of technology development.

Problem Statement

Cashew trees have high pest and disease incidences leading to crop losses. *Analeptes trifasciata,* stem borer, *Helopeltis spp.,* and diseases like Dieback, Anthracnose, Powdery mildew cause 20–40% yield losses annually. Knowledge gap exists among cashew farmers on identification of pests through damages and symptoms caused. Farmers often misidentify pests/diseases, leading to incorrect or untimely management practices. Unlike mobile solution developed for crops like maize and rice, cashew lacks specialized digital tools for pest and disease identification and control, creating digital gap in cashew pest management. Current monitoring is manual and slow, with application of GeoAI (GIS + AI) Nigeria can deploy a digital early-warning system for cashew farmers.

Justification of the Research Study

This project will leverage artificial intelligence and mobile technologies to close the knowledge and extension gap in cashew production. Real-time and farmer-friendly tools will be provided for pest/disease identification and management. This project will engage young adults in information technology hub for climate-smart agriculture, contribute to food security and poverty reduction. Artificial intelligent can also give predictive insights/early warning signs on diseases outbreak linked to weather.

Project Goal and Objectives

The overall goal of this proposal is to develop a mobile and GIS-based AI system that enables farmers and extension officers to detect cashew diseases and pests in real time, reduce yield losses, and strengthen Nigeria's agricultural competitiveness.

The specific Objectives are:

- Develop an AI-based tool to detect major cashew pests and diseases using image recognition
- Deploy GeoAI dashboards for hotspot monitoring
- Build a mobile application to document damage, log farm data, and provide pest/disease profiles
- Deliver mobile extension services offering personalized, real-time recommendations for integrated pest and disease management (IPDM)
- Create a digital knowledge base for cashew pest/disease management accessible to farmers and researchers
- Pilot, scale, and institutionalize the platform within Nigeria's cashew sector.

Methodology

Phase I: Data collection and intelligent model development: The projected will be conducted in four cashew major growing ecologies of Nigeria, with identified high volume of raw nut production and pest insurgence. The cashew growing states in North Central, South East and South West, will be surveyed at phenological stages of growth for data collection. Intelligent Detection System will be developed by training the artificial intelligent models (machine learning + computer vision) to recognize major cashew pests (e.g., *Helopeltis* spp.*, Analeptes trifasciata*, Stem borers, *Pseudutheraptus, Eteoryctis gemoniella*-leaf miner, *Dysdercus* sp., *Nasutitermes* spp., *Anoplocnemis curvipes*) and diseases (e.g., Diebacks, Anthracnose, Powdery mildew). The dataset of images, damages and symptoms of insect pest and disease will be generated by the Cocoa Research Institute of Nigeria (CRIN), farmers, agricultural extension officers and compendium of the cashew health map regional project. The generated image recognition will be integrated into a farmer-friendly mobile app where farmers can take a photo of affected cashew parts for instant detection.

Phase II: Mobile application development: There will be a photo-based pest/disease identification as the documentation tool to log symptoms, severity, and farm location. There will be generation of database of pest profiles, symptoms, and recommended management options, with the chat/feedback function linking farmers with experts/extension agents. An offline mode of this model will be developed for rural farmers where mobile network connectivity is poor or rare. The model will be an interactive and multilingual interface developed in English and local languages of major cashew growing regions in Nigeria.

Phase III: Generation of mobile extension support system: This system will be developed to provide intelligent-generated recommendations for pest management i.e chemical, biological, cultural measures. Farmers and extensions officers will be connected for real-time online technical support. A service to disseminate pest alerts, weather-based disease predictions, and integrated pest management (IPM) information will be developed. Mechanism will be programmed to collect farmer feedback to improve advisory content.

Phase IV: Pilot testing and scaling the developed system: The developed tools will be piloted with selected cashew farmer groups in study ecological areas. Capacity building for targeted farmers and extension officers' usage of the developed app. Feedback will be harvested on the functionality and accuracy of the developed system before nation-wide rollout.

Deliverables

- Intelligent-enabled detection system capable of identifying major cashew pests and diseases.

- First cashew pest/disease dataset in Nigeria
- Mobile app that documents and diagnoses pest/disease symptoms

Expected outcome

- Reduction of 30-40% yield losses and improved cashew productivity
- Farmers receive timely, customized advisory services for effective management
- Increased farmer income and export competitiveness
- Long-term intelligent-driven re-training using farmer-contributed data
- Strengthened cashew research-extension-farmer linkage through digital platforms

Expected output and performance indicators

Output	**Means of verification**	**Assumption**	**Indicator**
Intelligent detection system developed	AI model reports, test results	Sufficient image datasets available	Detection accuracy ≥ 85%
Mobile app designed and launched	App successfully download	Farmers have access to Android phones	App functional on Google Play Store
Capacity building for EAs/Farmers on usage	Training documentation and records	Farmers readiness to adopt digital tools	≥10,000 farmers trained
Extension services integrated	Advisory logs, farmer feedback	Strong partnership with State ADPs	≥500 extension interactions

Implementation plan and timeline

Phase I: Data collection (imagery of insects/diseases) and intelligent model training: 6 months

Phase II: Mobile App design and development: 4 months

Phase III: Pilot testing with farmers group: 6 months

Phase IV: Refinement and scaling of technology in cashew producing states: 8 months

Budget (Indicative)

- Tools, gadgets and equipment – 27,865,000.00
- Data collection and annotation/dataset creation – ₦115,750,700.00
- AI model and mobile app development (Android) – ₦73,250,850.00
- GeoAI dashboard and GIS integration – ₦25,450,550.00
- Training & capacity building – ₦37,500,800.00

- Pilot testing & field validation – ₦60,700,300.00
- Extension services integration – N32,350,700.00
- Monitoring & Evaluation – ₦ 22,350,100.00

Total – ₦395,219,000.00

Conclusion

The proposed intelligent detection and mobile extension service will revolutionize cashew farming by reducing pest and disease losses by 30 to 40%, improve farmers` knowledge, and strengthening the cashew value chain through digital innovation. By leveraging artificial intelligence and mobile technology, farmers will gain timely, affordable, and accessible solutions to enhance productivity and sustainability in cashew production. The outcome will also engage and empower the youth on technology development for agricultural productivity.

Annex I: Research publications on previous relevant activities on cashew pest and AI

Adeniyi, D.O., Mneney, E.E. and Majune, D.J. (2025). Report of Powdery Mildew Disease Condition on Cashew in Nigeria. BIO Web of Conferences 158, 03020 (2025). https://doi.org/10.1051/bioconf/202515803020.

Adeniyi, D.O., Adebola, P. O., Asogwa, E. U., Adeji, A. O., Onifade, E. O., Olorunfemi, G.T.B. and Adedoyin, A. O. (2024). Cashew Tree Health Status in Nigeria: Survey of Diseases and Insect Species. Innovations in Cashew Production in Africa. *3rd CICC/ACA Research Proceeding, 2024 Edition.* 50-62pp.

Adeniyi, D.O. and Asogwa, E.U. (2023). Dynamics of diseases and insect pests of cashew tree. In: Complex diseases of economically important trees (case examples). Tree Diseases and Pests. https://doi.org/10.1016/B978-0-443-18694-3.00019-5 Copyright © 2023 Elsevier Inc. pp. 256 – 284.

Ogunfolaji, D. and Adeniyi, A. (2023). Assessment of the level of human security in Ilorin Kwara State, Nigeria. International Journal of Security Studies & Practice, 3(1), Article 5. http://ijssp.ung.edu

Ogunfolaji D. and Adeniyi A., (2022): Spatio-Temporal Analysis of Igbo traders and their Socio-Economic Activities in Ilorin Metropolis. Osun Geographical Review, 5: 45-52

Ogunfolaji D., and Orire I.O., (2021): Imperative of Spatial Database in achieving Intelligence-Led Policing in Nigeria: A case study of Ilorin Metropolis. In: Perspectives in Regional Development in Nigeria: A Festschrift in Honour of Professor Adebisi Funsho Adedayo. Olawepo, R.A., Ajibade. L.T., and Ifabiyi, I.P., (Eds). 306-333. Published by Department of Geography and Environmental Management, University of Ilorin, Ilorin Nigeria.

Orire I.O and Ogunfolaji D., (2021): Dimensions of Human Security and Socio-Economic Development in Ilorin Metropolis, Kwara State, Nigeria. Ghana Journal of GeographyVol.13(3), p42-65 DOI: https://dx.dox.org/10.4314/gig.vI3i3.3

Annex II: Field photography of previous relevant research activities