FEASIBILITY STUDY REPORT

ON

AI-DRIVEN PRECISION HYDROPONICS WATER MANAGEMENT SYSTEM FOR SUSTAINABLE HIGH-VALUE HORTICULTURE

BY

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1. Introduction

The feasibility study assesses the technical, economic, environmental, and market viability of developing and commercializing a locally fabricated AI-enabled hydroponics water management system for high-value crops such as tomato and bell pepper. The technology integrates Internet of Things (IoT) sensors, predictive Artificial Intelligence (AI) algorithms, and mobile applications for precise irrigation scheduling and crop monitoring. The study evaluates the readiness of NCAM to develop the prototype, the cost-benefit potential, environmental sustainability, and commercialization prospects in Nigeria and the ECOWAS region.

2. Technical Feasibility

The project leverages NCAM's existing infrastructure and expertise in irrigation engineering, automation, and prototype fabrication.

Hardware: Locally sourced PVC-based hydroponic channels, pumps, and sensor units (pH, EC, temperature, humidity).

Software: AI-driven predictive algorithm integrated into a cloud-based mobile app.

Control System: Automated irrigation and nutrient delivery system governed by IoT feedback loops.

The design is technically feasible using available local resources, and NCAM's engineering workshops can fabricate the components to NASENI standards. Technology Readiness Level (TRL) is projected to advance from TRL 4 (laboratory validation) to TRL 7 (field-tested prototype) within 24 months.

3. Economic Feasibility

The total estimated project cost is ₦96 million, spread over two years. Cost–benefit analysis indicates significant potential for profitability and scalability:

- Projected unit cost of production: ₦1.5 – ₦3 million (versus ₦6 – ₦10 million for imported systems).
- Water-use efficiency: 90% reduction compared to open-field irrigation.

- Yield increase: 25–30%.
- Payback period: 2 years.
- Five-year ROI: approximately 150%.

The commercialization will focus on direct sales, subscription services for AI dashboards, and training packages. The local manufacturing model ensures economic sustainability through value retention within Nigeria's economy.

4. Market Feasibility

The target market includes:

- Urban and peri-urban farmers
- Greenhouse operators and SMEs
- State agricultural programs
- Research institutions and agritech startups

Nigeria's hydroponics and smart agriculture market is projected to exceed ₦100 billion by 2028. Growing demand for water-efficient, climate-resilient systems ensures strong adoption potential. Local production reduces import costs and improves accessibility for small and medium-scale farmers. Additionally, the export potential to ECOWAS countries is estimated to generate ₦150–₦180 million in annual foreign exchange earnings after commercialization.

5. Environmental Feasibility

The system is environmentally sustainable as it minimizes water and fertilizer waste, eliminates soil degradation, and supports renewable energy integration through solar-powered control units. By promoting soilless farming and resource efficiency, it contributes directly to climate-smart agriculture and aligns with national and global environmental goals (SDG 2 and SDG 13). No significant adverse environmental impacts are anticipated.

6. Operational Feasibility

NCAM possesses the technical personnel, fabrication facilities, and research environment required for implementation. The project team includes experts in AI modeling, irrigation systems, and agricultural machinery design. Partnerships with NASENI's Engineering

Development Institutes (EDIs) and private agritech firms will support pilot deployment, market testing, and subsequent scale-up. The system's modular design allows for easy installation, operation, and maintenance, enhancing user adoption and long-term sustainability.

7. Financial Feasibility

Projected financial performance indicates a commercially viable venture:

Revenue (Year 1): ₦55 million

Revenue (Year 2): ₦120 million

Cumulative profit (Year 2): ₦80 million

Breakeven: End of Year 2

The project demonstrates strong financial sustainability with high ROI and export potential, ensuring attractive returns for both NASENI and commercialization partners.

8. Institutional and Legal Feasibility

NCAM, as a government-owned R&D institution under the Federal Ministry of Science, Technology, and Innovation, has the institutional capacity and statutory backing to execute this project. Intellectual Property (IP) protection will be sought for the AI control algorithm and system design under Nigeria's IP laws. The project complies with NASENI's policies on indigenous innovation, environmental safety, and commercialization framework.

9. Risk Assessment and Mitigation

Potential risks and mitigation strategies include:

Technical risks: Component failure or calibration errors – mitigated by local spare parts and redundancy design.

Market risks: Slow adoption – mitigated through demonstration farms and government extension partnerships.

Financial risks: Inflation and material cost variation – mitigated by flexible budgeting and local sourcing.

Regulatory risks: IP or import certification delays – mitigated by early patent registration and NASENI liaison support.

10. Conclusion

The feasibility analysis confirms that the AI-driven hydroponics water management system is technically viable, economically profitable, environmentally sustainable, and operationally achievable within the Nigerian context. The project aligns directly with NASENI's mandate to promote indigenous technology development, commercialization, and industrial growth. With NASENI's support, the initiative will establish Nigeria as a regional leader in smart, sustainable agricultural engineering.