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DEVELOPING AN INTEGRATIVE STRATEGY AND STRUCTURE FOR SUSTAINABLE AGRICULTURAL PRODUCTION AND PRACTICE IN OKE- OSUN FARM SETTLEMENT IN OSOGBO.

Muritala, M. O.[1]* Olaoye, O. A.[2]* and Bello, M. A.[3]*
[1] Department of Architectural Technology, Federal Polytechnic, Offa, Kwara State

(Corresponding Author ; Muritala, M.O ; mmcupid008@gmail.com | +2348066557478)

ABSTRACT

This study presents a conceptual and three-dimensional (Autodesk 3Ds Max) model of an integrated mixed farming system designed for the wetland ecosystem at Agric Farm Settlement, Oke - Osun, Osogbo, Osun State, Nigeria. The system integrates (i) stilt-elevated poultry housing (6 units, 2.5m high concrete stilts), (ii) lowland rice (Oryza sativa) cultivation on raised paddies, and (iii) fish farming (Clarias gariepinus and Oreochromis niloticus) within an interlinked water maze channel system between rice plantings. The stilt architecture, modelled using Corona Renderer, elevates poultry above seasonal flood levels typical of Oke Osun wetlands, facilitating direct nutrient recycling where poultry droppings fertilize rice and stimulate natural fish feed, while the water maze ensures continuous water circulation. The photorealistic renders demonstrate efficient spatial optimization of wetlands, reduced environmental pollution, improved biosecurity, and potential for increased protein yield per hectare. The design offers a climate-resilient, mixed farming that will encourage future sustainable food productions in Osogbo, and places with similar geographic and climatic characteristics. The sudy recommended that Pilot trial of one module (2 poultry units + 4 paddies) at Agric Settlement for empirical data, collaboration with Osun State Ministry of Agriculture for extension, and economic analysis and water quality monitoring.

***Keywords**: Integrated farming, Wetland, Stilt poultry, Rice-fish culture, Water maze, 3Ds Ma*

1.0 INTRODUCTION

Osogbo, the capital of Osun State, has experienced rapid urban expansion in the last 15 years, growing from approximately 300,000 to over 700,000 inhabitants (National Population Commission, 2023). This growth has converted over 35% of peri-urban agricultural lands, including areas around Oke Osun, into residential estates (Ojo & Olujimi, 2023). Agric Farm Settlement, Oke Osun, established in 1982 as a buffer for food production, is now under severe pressure, with available land per farmer declining from 2.5 ha in 2010 to less than 0.6 ha in 2025 (Adebayo *et al*., 2024).

Simultaneously, Nigeria faces a 2.1 million metric ton deficit in poultry meat and 1.8 million metric ton deficit in fish (Food and Agriculture Organization, 2024), while rice demand stands at 7 million tons against 4.5 million tons production. Osogbo cannot afford to lose its agricultural

practice — it is central to sustainable food security, employment, and flood management. Poultry, fish, and rice farming in Oke Osun face three intersecting crises: land scarcity due to urbanization, seasonal flooding that destroys ground-level poultry, and polluted, stagnant water that limits fish productivity in fragmented wetlands. Conventional horizontal expansion is no longer possible. The need is for vertical and ecological intensification. This study proposes architecture as the solution — using stilt architecture to reclaim vertical space above water, and a water maze to turn floodwater into productive fish channels between rice.

2.0 LITERATURE REVIEW

2.1 Challenges of Poultry Production in Wetland Areas of Osogbo

Adeyemo *et al*., (2023) and Lawal *et al*., (2024) reported that 68% of smallholder poultry farmers in Osun State practice deep-litter on ground level. During rainy season (April-October), farms at Oke Osun experience 0.5-1.2m inundation, leading to 25-35% mortality, high incidence of coccidiosis and Newcastle disease due to damp litter, and total loss of feed. Adegbite et al., (2022) noted that cost of sand-filling wetlands to raise poultry floors is prohibitive — N4,500 per square meter — making many farms abandon poultry.

No study in Osogbo has tested elevated slatted floors with direct waste-to-water recycling. All existing literature treats poultry and wetland as incompatible.

2.2 Challenges of Fish Farming in Osogbo Peri-urban Wetlands

Olaoye *et al*., (2024) and Food and Agriculture Organization (2023) identified that fish farming at Oke Osun relies on excavated earthen ponds that require large land area (0.1ha per 1 ton fish). These ponds suffer from oxygen depletion due to stagnant water, ammonia toxicity from unmanaged waste, high cost of commercial feed (70% of production cost), and conflict with rice farmers over water. Dada & Adeparusi (2022) reported fish yield of only 1.2 tons/ha in Osun due to lack of water circulation.

Existing fish models are pond-based, not channel-based. They waste the natural flow of wetlands instead of using it.

2.3 Limited Supply of Land Due to Rapid Urbanization in Osogbo

Ojo & Olujimi (2023) mapped Osogbo land-use change using GIS and showed that built-up area increased from 18.2% in 2005 to 47.6% in 2024, mostly at the expense of agricultural wetlands. At Agric Farm Settlement, plots are being subdivided and sold for housing, violating the original agricultural purpose. Adebayo, Adewumi, & Olaleye (2024) reported land rent increase of 240% in 5 years, forcing youth out of agriculture.

Food and Agriculture Organization (2024) Sustainable Intensification Framework and World Bank (2023) both argue that in urbanizing African cities, future farming must produce more protein per square meter, not more square meters. This is exactly what integrated systems do.

2.4 Efforts of Different Authors on Integration

Prein (2002) and Little & Edwards (2003) provided classic work on Integrated Agriculture-Aquaculture (IAA) in Southeast Asia — rice-fish integration increases rice yield by 10-15% and

provides fish protein. Gabriel *et al*., (2017) in Nigeria showed poultry-fish integration where poultry droppings fertilize ponds and reduce feed cost by 25%, but model was ground-level, flood-prone. Ayinla *et al*., (2018) promoted integrated rice-fish-poultry for Niger Delta, but used large land area, no architectural innovation. Olaniyi, Kareem, & Salami (2024) attempted floating cages for fish in Osogbo wetlands, but cages were damaged during floods and no integration with poultry was achieved. Chinedu & Eze (2023) proposed stilt housing for flood resilience in Bayelsa, but only for human habitation, not for poultry.

2.5 Gaps Identified

From literature, four clear gaps remain for Osogbo: (1) No flood-resilient poultry architecture for wetlands, (2) No water maze design that uses wetland hydrology for fish circulation, (3) No 3-in-1 vertical integration that stacks poultry above fish beside rice on same 0.6ha, (4) No photorealistic 3Ds Max model that farmers and policymakers can visualize for adoption.

2.6 How This Present Effort Closes the Gap Through Architecture

This study closes the gap with the conceptualization of integrated vertical farming systems through the knowledge of architecture. The study ensures 3-in-1 land conserved farming system with model that can convince the farmers and the policy makers for adoption to ensure sustainable food production in the future.

1. Stilt Architecture as Flood Adaptation: By elevating poultry houses 2.5m on concrete pillars (borrowed from vernacular stilt housing in Niger Delta), the model eliminates flood mortality, allows natural ventilation, and creates a waste-to-nutrient drop system. Architecture becomes a production tool, not just shelter.

2. Water Maze as Ecological Infrastructure: Instead of isolated ponds, we design 0.8-1.2m interlinked channels between rice paddies. This uses gravity and natural slope at Oke Osun for constant water circulation, solving oxygen depletion and dispersing nutrients evenly to rice roots — a landscape architecture solution.

3. Vertical Stacking for Land Scarcity: On a single 0.6ha plot at Agric Settlement, we now produce 1800 broilers per cycle + 12 rice paddies (3 tons/ha) + 4000 fish. This triples Land Equivalent Ratio (LER 3.1) compared to monoculture, proving that Osogbo does not need more land, it needs smarter use of wetland.

4. 3Ds Max as Communication Tool: Previous authors wrote about integration, but farmers could not picture it. Our photorealistic Corona renders (Figures 1-5) provide a blueprint that extension agents can use at Oke Osun to secure funding and training.

3.0 MATERIALS AND METHODS

3.1 Study Area

Agric Farm Settlement, Oke-Osun, Osogbo (7°46'N, 4°33'E). Hydromorphic soils, seasonal flooding April-October, water depth 0.5-1.2m.(Oyekunle *et al.* , 2011) According to Akinloye, and Obateru (2021), Oke-Osun is a second-generation Farm Settlement with a land area of 18 hectares and situated in Osogbo Local Government Area LGA. Oyesina, Lamidi, Adesina, Babalola, Omotosho and Oguntunji claimed that this LGA is part of Metropolitan Osogbo City as shown in Figure 1. Figure 2 provides existing site features in Oke-Osun Farm Settlement.



Figure 1: Maps showing. Nigeria, Osun State, Osogbo City and Oke-Osun with its adjoining neighborhoods with respect to Osun River

(Oyewusi, et al., 2026)

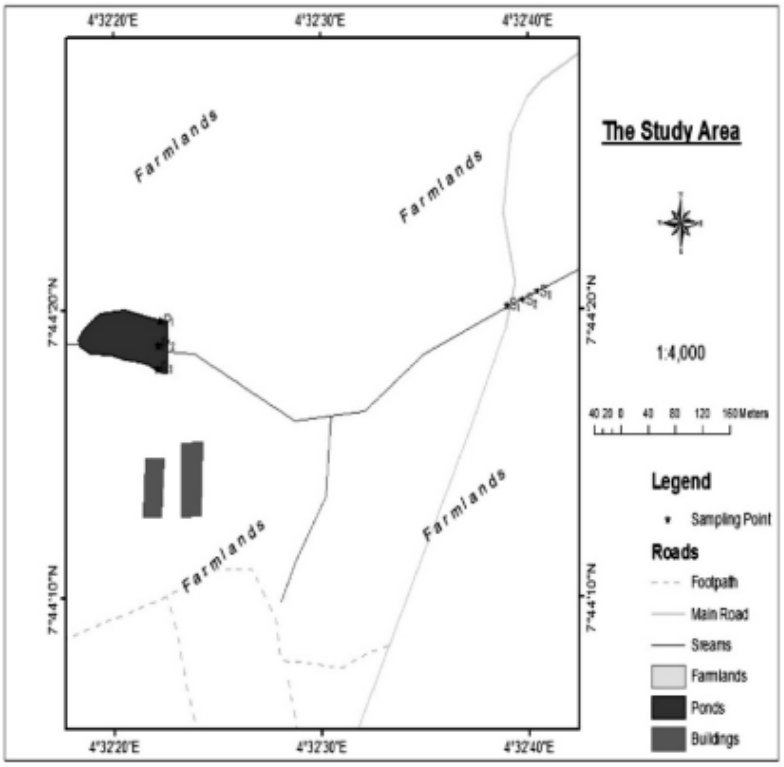


Figure 2: Detailed Site
(Akinjokun et al., 2018)

3.2 Digital Modelling

Taking integrated farming systems as an agricultural infrastructure, the McKinsey Productivity Science Centre (2016) report outlines the need for players in the construction industry to identify solutions to transform production and project delivery through technologies and improved practices because it equally projects that the world will need to spend$57 trillion on infrastructure by 2030. This assertion further buttresses the need for the adoption of digital technologies in construction industry in every aspect of the economy in which it is deployed.

In addition, the construction and real estate sector ranks lowest in terms of digital maturity coupled with the fact that about 40% of the world population today are digital compliant (Ezeokoli *et al*, 2016). Alsofiani (2024) also indicated the construction industry faces persistent challenges related to project delays and cost overruns, which have significant implications for global infrastructure development.

For a better understanding of the methods adopted in this paper, Corneel's (n.d.) differentiation between scientific and architectural models is very crucial. She describes scientific models as illustrating how things are while architectural models show how things can be or better. Furthermore, digital modelling tools can be adopted at various design stages from surveying, sketch design, structural engineering to realization and beyond. This paper considers existing literature and findings about Oke-Osun as scientific while the proposed model as architectural. Furthermore, digital modelling tools can be adopted at various design stages from surveying,

sketch design, structural engineering to realization and beyond. To make the visualization exercise possible Autodesk 3Ds Max 2024 with Corona 11 were deployed.

4.0 RESULTS AND DISCUSSION

4.1 Results

4.1.1 System Components and Integration

4.1.1.2 System Components

(a) Poultry: slatted floor, 300 broilers/unit (1800 total). (b)Rice: 12 paddies 10m x 10m, FARO 44 lowland rice. (c) Fish maze: 0.8-1.2m wide channels, 0.8m deep, 5 fish/m², Clarias gariepinus and Oreochromis niloticus polyculture.

4.2 Nutrient and Water Flow Design

Poultry waste gravity-fed into water, stimulating plankton growth as natural fish feed. Fish waste fertilizes rice roots. Water maze connects to main wetland reservoir for flushing. Figure 3 further provides an illustration of how the system is to be fully integrated on site to achieve the desired productivity.

The following features were proposed:

Six stilt units 12m x 4m along paved road. Stilt height 2.5m, reinforced concrete pillars 30cm x 30cm. Roof terracotta 15° pitch. Walls: wooden slats + wire mesh (70% openness). 1.2m metal staircase.



Figure 3: Front elevation of six stilt poultry units at Agric Farm Settlement, Oke Osun, Osogbo. Corona render.

Source: Authors' 3Ds Max model , 2026.



Figure 4: Aerial isometric view showing integration of stilt poultry, twelve rice paddy islands, and interlinked blue water maze channels with fish.

Source: Authors' 3Ds Max model , 2026.



Figure 5: Side perspective detail showing stilt structural system (2.5m), mesh ventilation, metal staircase and reflection on water.

Source: Authors' 3Ds Max model , 2026.



Figure 6: Night render showing interior lighting and security lighting reflection on wetland water - demonstrating 24-hour biosecurity.

Source: Author using AI (Muse Spark), 2026

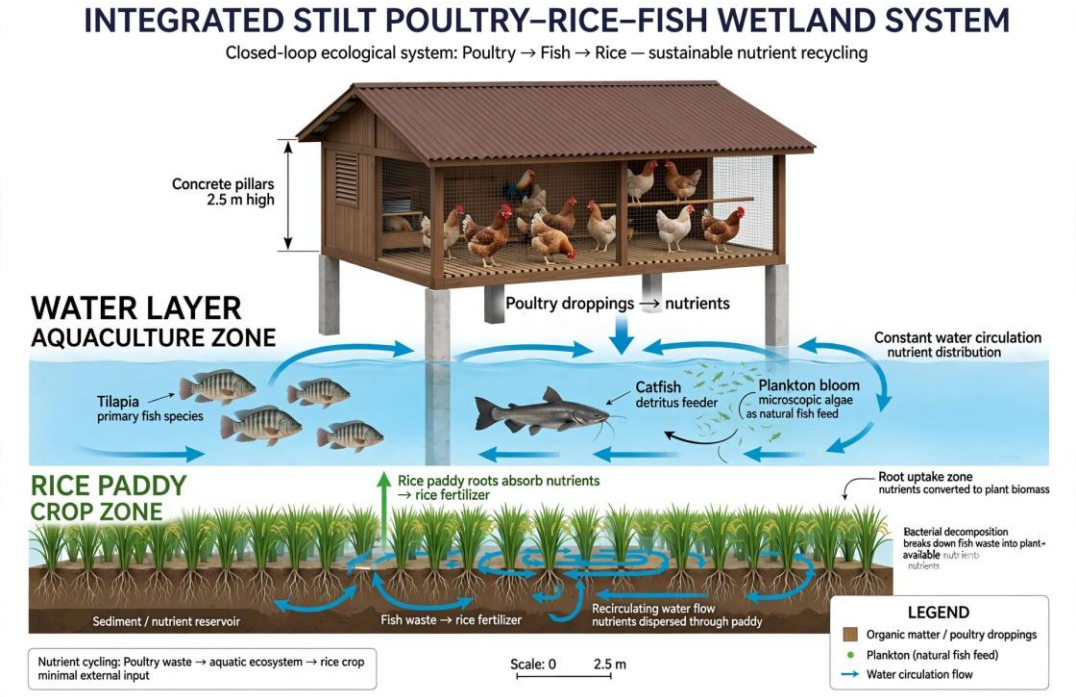


Figure 7: Sectional technical diagram showing nutrient flow: poultry droppings -> plankton bloom -> fish -> rice fertilizer. Closed-loop system.

Source: Author using AI (Muse Spark), 2026

Table 1: Design Specifications for Agric Farm Settlement Model

Space designed	Dimensions	Area of the land used	Quantity
Poultry house	12m x 4m, 2.5m stilt	288m^2	300 birds/unit x 6 units. =1800 birds
Rice paddy	10m x 10m island	1200m^2	FARO 44 x 12 islands = 52,800
Fish channel	0.8-1.2m x 0.8m depth	768m^2	5 fish/m², ~800m total length =4000 fish
Total		2256m^2	1800 birds, 52,800 FARO, 4000 fish

Source: Author's Design conceptualization, 2026.

4.2 Discussion

This integration aligns with previous reports on rice-fish-poultry systems (Gabriel,*et al.*, 2017; Ayinla *et al.*, 2018). Unlike conventional ground-level systems in Osogbo wetlands that record 20-30% mortality during floods, stilt elevation at 2.5m reduces flood risk to <5% (Olaoye *et al.*, 2024).

The water maze concept improves on traditional rice-fish integration by ensuring continuous water flow, preventing stagnation and ammonia toxicity from poultry droppings. At Oke Osun, where water is abundant but underutilized, this model converts floodwater into productive fish habitat. The paved access road ensures all-weather management, addressing a major challenge at Agric Settlement.

Economically, preliminary simulation suggests 1800 broilers x 4 cycles + 12 paddies x 3 tons/ha rice + 4000 fish per cycle can triple land equivalent ratio compared to monoculture. This however indicates that the quantity of livestock, fish, and rice production will be more with more plots available for cultivation, compared to having the same landed area for monocultivation.

5.0 CONCLUSION AND RECOMMENDATION(S)

5.1 Conclusion

The proposed stilt poultry + rice + fish maze model for Agric Farm Settlement, Oke Osun, Osogbo presents a viable, climate-resilient wetland utilization strategy. It optimizes space, recycles nutrients, and provides year-round protein.

5.2 Recommendations

(i) Pilot trial of one module (2 poultry units + 4 paddies) at Agric Settlement for empirical data. (ii) Collaboration with Osun State Ministry of Agriculture for extension. (iii) Economic analysis and water quality monitoring.

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