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RESEARCH ARTICLE

Spatial Distribution and GIS-Based Optimization of Commercial Egg Producing Farms: A Case Study of Ilaro, Yewa South LGA, Ogun State

Alausa, Akeem Olalekan[1] and Alausa Jubril Oluwadamilare[2]

[1]Department of Surveying and Geoinformatics, The Federal Polytechnic Ilaro.
[2]Department of Animal Health and Production, The Federal Polytechnic Ilaro.

Corresponding email: olalekan.alausa@federalpolyilaro.edu.ng

Abstract

Food security and sustainable agricultural growth are under threat from the steadily increasing population of urbanizing areas, the rising demand for food, and the largely unequal distribution of agricultural services. Poultry egg farms are not exempt from this issue. Even though poultry contributes significantly to local meat production in Nigeria, the commercial egg-producing industry confronts difficulties because of ineffective distribution networks and inadequately planned spaces. This study basically investigates spatial distribution and GIS-based optimization of commercial egg-producing farms in Ilaro, focusing on the spatial pattern of the egg-producing farms, proposing optimal locations for future extension/expansion. Mapping existing poultry farms using a Global Positioning System device and ArcGIS 10.6.1 spatial analysis, such as the nearest to neighbor tool, this research produced a geospatial database, road network map, identified existing distribution patterns, also considered the locational factors influencing the establishment of poultry farms. The findings revealed uneven distribution of poultry farms, with clear implications for access, infrastructure, and resource allocation. Several farms were found to be in sub-optimal areas lacking basic infrastructure, thereby reducing productivity and profitability. The study emphasizes the importance of spatial planning in agricultural development and calls for the establishment of standardized siting guidelines and mandatory environmental impact assessments for poultry farms. These strategies are essential for enhancing production efficiency, minimizing environmental impact, market connectivity and promoting equitable access to agricultural resources. The insights provided by this research contribute to informed policy decisions aimed at optimizing poultry production, improving rural livelihoods, and strengthening food systems in Ilaro.

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1.0 INTRODUCTION

1.1 Background to the Study

The urbanization rate at the global level is on the rise, with the global population corroborating this rate. The global population is expected to be around 8.5 billion by 2030, and by prediction in 2050, it will become 9.7 billion (Alfred et al., 2021; United Nations News Service, 2021). As population expansion continues, food sustainability is threatened by additional challenges such as land allocation/distribution conflict, climatic change, pests and water control, etc. (Khan et al., 2023). Globally, research on agriculture has become imperative, becoming a key stake holder in many nations' economy, in China, agriculture product growth's effect has influenced the country's economic development, to this, there was effective improvement of regional agricultural structure, the government creating aiding parameters for organizations and individuals to further boost agriculture production yet rural areas still suffer insufficient support (Duan et al., 2021; Ma et al., 2021).

Livestock production is an important component of the agricultural industry, instrumental to socioeconomic change, improved income and quality of rural life in any country. It is an important source of animal protein,

presently producing about 36.5% of the total intake of Nigerians. In Nigeria, poultry accounts for 25% of local meat in livestock production (Oyeniyi et al., 2024). Over the past three decades, the poultry sector has grown at more than 5% per year (compared to 3% for pig meat and 1.5% for bovine meat), and its proportion of global meat production has climbed from 15% three decades ago to 30% now (Ohtsu, 2025; Oyeniyi et al., 2024). In recent decades, the chicken business has undergone great adaptations to suit the increasing need for economic and safe supply of meat and eggs, although the changes have yet to be directly seen in the cost rate, as the economic instability stands as a constraint (Nikhila et al., 2025).
In recent years, poultry farming has developed into a commercial enterprise involving thousands of birds.(Ahmad Naseem Ahmad et al., 2025). With the growing demand for efficient strains of meat or egg-type birds, balanced feed, large housing and better poultry equipment, the large poultry units have greatly substituted the backyard poultry units by the farmers (Nikhila et al., 2025). Nevertheless, commercial poultry farming is yet to develop with planned distribution yet ought to in the tropics, unlike the temperate regions (Singh & Hitesh, 2025).

Poultry farming provides Ogun State with a promising route for both economic growth and food security, especially in Ilaro, Yewa South Local Government Area (LGA) (Oyebanjo et al., 2020). However, the spatial layout of commercial egg-producing farms is still largely unplanned, leading to inefficiencies in supply chains for production, distribution, and markets. These challenges are made worse by elements like poor infrastructure, poor site selection, and a dearth of integrated support services (Jatto et al., 2021; Oyebanjo et al., 2020). The region's poultry sector, therefore, performs less than it should despite its potential.
Datasets that provide comprehensive information on the geographic distribution of livestock are invaluable for a wide range of applications in various fields. These datasets and detailed knowledge of the distribution of livestock resources are fundamental for a wide range of applications, spanning agriculture, economics, environmental science, public health, and rural development(Jatto et al., 2021). Livestock is central to global food systems and has a multifaceted impact on various aspects of agriculture, livelihoods, and nutrition. It plays a critical role in ensuring food security, sustainable agriculture, and the well-being of communities (FAO, 2011; George et al., 2020).

Spatial analysis is indeed a powerful technique used in geography, geographic information systems (GIS), and various other fields to examine and comprehend the patterns, relationships, and distributions of agricultural enterprises (Alausa et al., 2023; Guo et al., 2023). In the context of egg-producing farms, spatial analysis offers valuable insights into a wide range of factors and helps optimize various aspects of egg production and distribution. Proper spatial planning is indeed paramount for the success and sustainability of agricultural operations. Integrating technology, data analysis, and traditional farming knowledge is essential for creating a well-designed and productive farming system (Chi et al., 2022). Efficient spatial planning is the cornerstone of successful and sustainable agricultural operations. It ensures that farms are designed and managed in a way that maximizes productivity, minimizes environmental impact, and embraces technological advancements all essential components of modern farming practices (Hishammuddin et al., 2024)

Recently, studies have emphasized the relevance of assessing poultry production economics, emphasizing the ongoing challenges of high feed costs, disease outbreaks, and market access constraints (Adepoju et al., 2021; Wale et al., 2020; Yusuf et al., 2023). However, the purpose of this study is to assess the distribution pattern for supply simplicity and identify workable ways to improve locational distribution and supply, as well as poultry production, to boost economic growth and food security. It will further improve poultry company efficiency, offer practical solutions, and recommend well-informed policy choices for the poultry industry's financial sustainability. Despite the obvious importance of poultry farming in Nigeria, not much research has been done to improve the locational efficiency of commercial egg-producing farms, particularly in Ogun State, by combining spatial analysis with GIS-based optimization.

2.0 STUDY AREA

Ilaro is a significant town in Ogun State, Southwestern Nigeria, located in the Yewa South Local Government Area. It is situated approximately 50 kilometres from Abeokuta, the capital of Ogun State, and about 100 kilometres from Ikeja, the capital of Lagos State. Ilaro serves as the headquarters of the Yewa South Local Government Area and is positioned between latitudes 6° 52'9.6" N to 6° 54'49" N and longitudes 3° 00'42.4" E to 3° 01'36.2" E on the globe (Ezeifedi, 2018). It covers an area of approximately 16,762 square kilometres and had a population of 57,850 according to the 2006 census. In 2020, Ilaro's estimated population was around 66,587, projections by 2025, predict an estimation of around 74,000,

showing growth trend which aligns with the Ogun state growth projections (City Facts, 2025; United Nations News Service, 2021) The town is situated on a sedimentary terrain in Southwest Nigeria, characterized by geological features like limestone, clay, and sands. Its climate is typical of the region, with significant rainfall occurring between April and October, which corresponds to the rainy season. The dry season in Ilaro is relatively short and has a limited impact, particularly on agricultural activities in the area (Ojo et al., 2021). The annual rainfall of Ilaro is 2150 mm, the temperature is averagely at 28 ℃, the average humidity is recorded at 62%, and the dew point hovers around 22 ℃ (Oyebanjo et al., 2020). The predominant occupation of the local population is farming, with a notable focus on cassava processing into food products like Gaari and Fufu. This processing activity, especially among women, is carried out in significant quantities (Ojo et al., 2021)

Figure 1.0: Google Map Showing Ilaro Town *(Source: Google Earth, 2024).*

3.0 METHODOLOGY

The integration of GIS in agriculture has been recognized for its ability to improve production efficiency and resource management (Guo et al., 2023). By leveraging GIS, this study aims to provide a comprehensive understanding of egg distribution networks within the study area, contributing to more informed and sustainable agricultural practices.

3.1 Data Collection

The attribute and spatial data were acquired (see Table 1); the attribute data were obtained using a well-structured questionnaire, administered to the farmers (respondents). While the spatial data was captured using a global positioning system (GPS) device to determine the locational coordinates of the poultry farms and downloaded Sentinel-2 imagery covering the study area. Data were collected on Respondents' data, socioeconomic characteristics, poultry type, flock size, and problems encountered.

3.1.1 Mode of Administration of Questionnaire

Five areas were selected from different geographical corners of Yewa North Local Government Area, including Oke-iganmu, Idogo, Oja-odan, Express, and Alapoka. A purposive random sampling technique was used to select 20 farming households across the study area. A total of 20 questionnaires were administered in all 5 areas mentioned.

Table 1. Data used and sources

S / N	DATA	SOURCE NAME	SOURCE WEBSITE	SOURCE RESOLUTION
1.	Ilaro town boundary shape file	Yewa (Egbado) South boundary shape file	https://sasplanet.geojamal.com/	30m
2.	Villages/towns and road network shape file	SAS planet website	https://sasplanet.geojamal.com/	30m
3.	Land Use / Land Cover	Sentinel-2	https://www.arcgis.com/home/webscene/viewer.html	30m
4.	Poultry Farm Attribute data	Questionnaire	Field data	
5.	Poultry Farm Coordinates	Handheld GPS	Field Data	

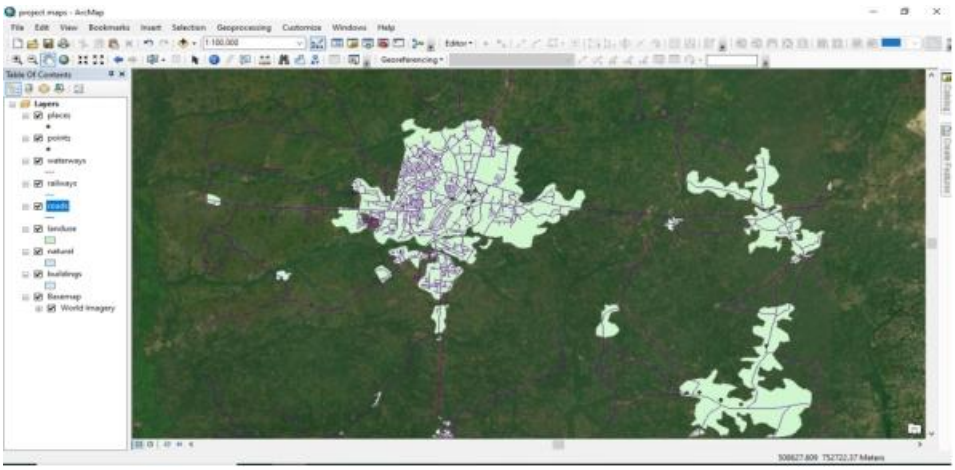

Figure 2: Satellite imagery of the downloaded shapefile with the ArcGIS base map

3.1.2 Questionnaire Populations and Sample

To select a representative subset of respondents for the questionnaire on egg production and distribution, a direct survey method was employed as the sampling strategy. The respondents consisted specifically of poultry farm owners and their staff within the study area. This approach was designed to ensure the collection of accurate and relevant data directly from those involved in the daily operations of egg production and distribution, while also allowing for efficient use of time and resources.

The following questions were asked.

- How many birds are kept on the farm per year?
- What is the current age of your birds (months)?
- How many different age groups of birds do you have?
- What is the age of your replacement birds (months)?
- Where do you purchase your birds?
- What type of housing system do you use?
- Do formulate feed or buy finished feeds
- Do you sell eggs on the farm, or do you transport them outside?
- Do you raise your birds from day, or do you get them at point of lay?
- General problem encountered by poultry farmers?

3.1.3 Statistical Analysis

The data obtained were analyzed using descriptive statistics such as frequency and percentage distribution. Means of some selected variables were tested using Chi-square as contained in SPSS.

3.2 Database Design and Creation

An object-oriented vector data model was utilized in this study to represent the spatial components of egg production infrastructure, including roads, poultry buildings, and distribution routes. Each feature was treated as an object with unique attributes and interactions, enabling a more dynamic and realistic representation of the study environment. The data were organized and inserted into structured tables within ArcCatalog and processed using the ArcMap environment in ArcGIS 10.6.1 as shown in Figure 3. Poultry farm owners and staff provided essential information about farm identities, production capacities, and daily operations, which were used to enrich the spatial data with corresponding non-spatial attributes. These data integrations allowed for the creation of a comprehensive geospatial database that supports the spatial analysis of egg distribution networks. Once layers were digitized, relevant attribute data such as average egg output, number of delivery routes, and market destinations were linked to the spatial features. This method has been recognized in similar agricultural studies for enhancing the planning and management of poultry systems (Chi et al., 2022)**.** The final database enabled a detailed analysis of spatial distribution patterns and provided a robust foundation for planning optimal egg production and distribution strategies within the study area.

3.2.1 Average nearest Neighbourhood Analysis of Poultry Farms

The nearest neighbor analysis was used to establish whether the distribution in the research area was regular, random, or clustered. Being that point distributions are unpredictable, the model illustrates the extent to which any actual distribution deviates from what may be expected and reveals a random distribution for the study. The NNR has indices that range from zero to 1.65 see figure 4.

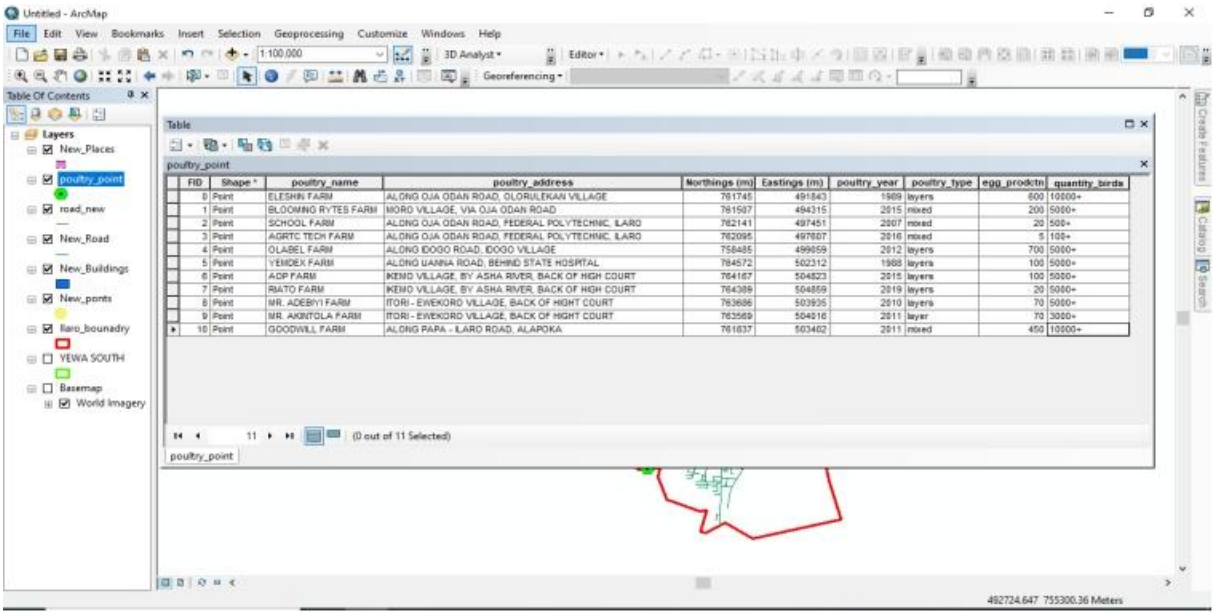

Figure 3: Acquired Data from Egg Producing Farms in Ilaro Town

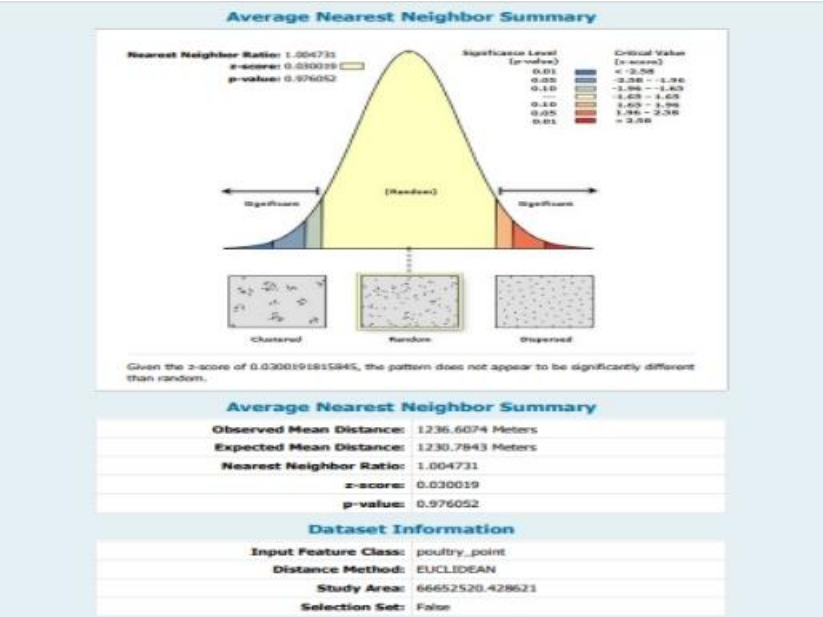

Figure 4: Showing the Average Nearest Neighborhood Analysis of poultry farms.

4.0 RESULTS AND DISCUSSION

4.1 Land Use Classification

Table 2 and Figures 4&5 show the analysis and distribution of land use or land cover within the specified study area. The land use/land cover in the figure below shows that 14.85% is represented by vegetation, 19.21% is represented by bushy areas, 27.89% is represented by the built-up area, and 38.05% is represented by bare land. Land use-land covers of the study area are produced to show the proximity of settlement / built-up areas where people reside to access the poultry farms.

Table 2. Showing the land use/cover categories.

LANDUSE / LAND COVER CATEGORIES	2023	
	Area (Ha.)	Area (%)
Bare land	20.64	14.85
Bushy area	26.70	19.21
Built–up Area	38.77	27.89
vegetation	52.90	38.05
Total	139.01	100

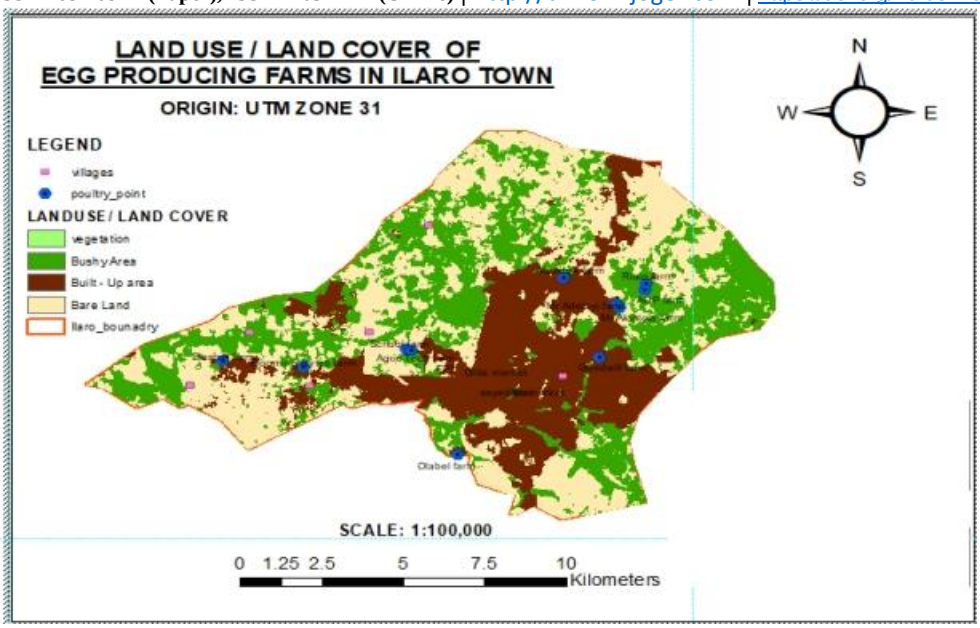

Figure 5: Land Use in Ilaro Town

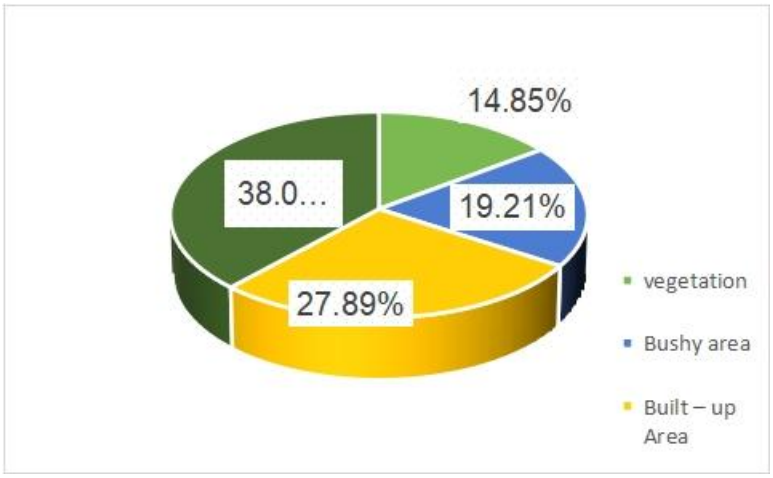

Figure 6: Pie chart showing the percentile ratio of Land use and Land cover

4.2 Socio-economic and demographic data of respondents and the General Management and Performance of flocks in Ilaro.

The socio-economic characteristics of respondents showed that the majority (80%) of the respondents were males. Most of the respondents (60.0%) were married. Only 20% were single, while 15% were widows and 9.0% were widowers. The age distribution of the respondents was between 41-50 and 50 and above, representing 35% and 25%, respectively. Ages between 31- 40 constituted 30% of the population, while respondents less than 30 years were 10%. The educational level of the correspondents shows that the majority of them are C.E.O/farm attendants/IT students who went to a tertiary institution (81.8%), while Primary / Secondary education (9.1%) respectively. This means that educated people are involved in poultry families. About 27.3% of the respondents have a family size of 1 -2, 45.5% of the respondents have a family size of 3 – 5 sizes which means the majority of the respondents fall within this family size. Also, 18.1% of the respondents have a family size of 6 – 8 and 9.1% of the respondents have a family size of 9 & above. It was also discovered that 36.3% of the respondents have a working experience between 1 – 3 years, which implies that most of the farmers have been in the poultry farming profession for quite some time, compared to the other levels of working experience. 54.5% of the correspondents do not have special

farm training, which means that it could cause some of the problems faced by the farming industry/businesses, and makes it important to organize training, which could be expensive.
In the performance analysis shown in Table 3, 70% of the respondents feed their birds commercial feeds, while 25% formulate their feeds by themselves. The discovery also revealed that 55% of the respondents feed their birds three times per day, while only 10% of the respondents feed once daily. It was also observed that 45% of the respondents pick eggs twice daily, 35% pick eggs once per day, and 25% of the respondents pick eggs more than twice daily. Judging the general performance of the birds, 30% of the respondents adjudged their flocks to have above 80% hen-day, 45% adjudged their flock's hen-day performance as within 70-79%, while 25% had below 69% hen-day performance.

Table 3: Management Practice and General Performance of the flock in the study area

General Management and Performance	Frequency	Percentage (%)
How often do you feed per day?		
Once	2	10.0
Twice	7	35.0
Thrice	11	55.0
Total	20	100
What type of feed do you feed your birds?		
Commercial feed	14	70.0
Local feed	1	5.0
Self-formulated feed	5	25.0
Total	20	100
How many times per day do you pick eggs?		
Once	7	35.0
Twice	8	45.0
More than twice	5	25.0
Total	20	100
How often do you give medications?		
Monthly	8	40.0
Every 2 months	5	25.0
Symptomatically	7	35.0
Total	20	100
What is your Hen-day egg production?		
69% and below	5	25.0
70-79%	9	45.0
Above 80%	6	30.0
Total	20	100

4.2.1. Flock Size of the Poultry Farms.
The flock size varies with respondents. Of the respondents, 55% had a capacity of 1000-5000 birds, while 5% had less than 500 birds' capacity. 15% of the respondents had between 500 – 1000 birds, and 15% had between 5000-10000 birds, while 10% had over 10000 birds in the study area.

4.2.2. General Problem Encountered by the Poultry Farmers
The major challenges encountered by the poultry farmers in the study area are shown in Table 4. These include diseases, feeding, and pilfering. The problem due to feeding remained the major challenge encountered by the respondents, and 50% of the respondents reported this. Other problems encountered were pilfering (35%) and disease condition (15%).

Table 4: General Problems Encountered by the Poultry Farmers

General Problem Encountered	Frequency	Percentage (%)
Disease	3	15.0
Pilfering	7	35.0
Feeding	10	50.0
Total	20	100

4.3 Discussion 1

The result of this study showed that men are more involved in commercial poultry production than their female counterparts. This result did not support the observations of (Alawode et al., 2022; Musa et al., 2023; and Ochieng et al., 2021) who reported that women are the major owners and are more knowledgeable about poultry farming. Although, (Chimonyo, 2020) Observed that poultry keeping is traditionally the role of women in many developing countries, the results of this study observed that men own the poultry business and make use of men as the workforce force than women because it is believed that men tend to do the hard part of the business. The age of the respondents is an important factor that affects the level of productivity and overall coping ability within the business. Age is believed to influence the level of physical work. Findings showed that the age distribution of the respondents shows that the majority (65% combined) of farmers head in the study area have the age of their household heads (farmers) falling between 31 and 50 years, and 60% of the household heads were married, as expected.

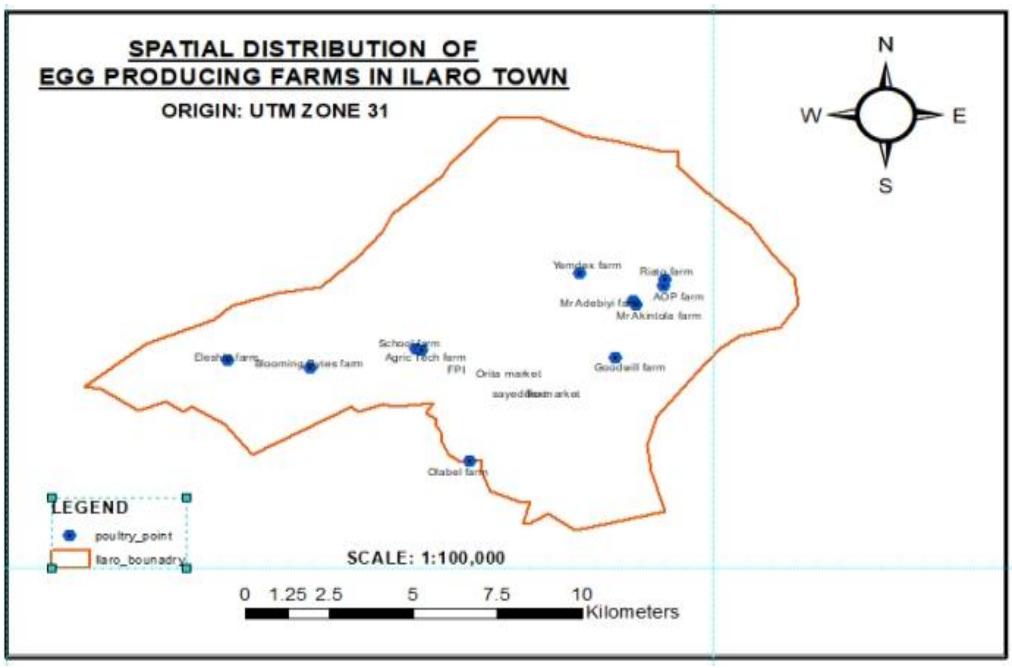

Figure 7: Spatial Distribution of Egg Producing Farms in Ilaro Town

4.4 Discussion 2

Egg production and distribution are pivotal to the agricultural economy of Ilaro, situated in Yewa South Local Government Area of Ogun State, Nigeria. The region's semi-urban landscape offers a strategic advantage for poultry farming due to its blend of rural land availability and proximity to burgeoning markets. However, the success of egg production in this area hinges on strategic location and access to essential infrastructure. From figures 6&7, poultry farms in Ilaro are located in an area with affordable land cost, but other factors such as road networks, electricity supply, and access to veterinary services and feed suppliers are discovered to be a challenge. These infrastructural deficiencies can escalate operational costs and impede efficient egg distribution to nearby towns and cities. Establishing a poultry farm in Ilaro involves several cost considerations, starting with land acquisition, which is relatively more affordable compared to urban centres. However, expenses related to constructing poultry housing, installing ventilation systems, and procuring feeding equipment can be substantial. Operational expenses particularly feed make up a significant portion of running costs, directly affecting egg yield and bird health. Hence, a clear planned

distribution analysis where all of this factor is duly considered will greatly influence the cost of egg production.

Farm-related data, as revealed in Table 5, 54.5% of the respondents are involved in rearing layers (birds). This suggests a preference for layer farming, likely due to its focus on egg production. Additionally, the table indicates that 54.5% of the respondents opt for a capital investment in the range of 1,000,000 to 2,000,000 naira to initiate a poultry business. This implies that, to establish a successful poultry farm, a minimum capital investment of 2,000,000 naira is recommended, assuming other essential elements such as land and a water source are already in place. Also, the table shows that 100% of the correspondents owned and established the farm on their own, while 90.9% of the correspondents take the poultry farm business as their main occupation. It was also discovered from the table that 36.6% of the correspondents' startup birds fall within the range of 5001 – 10,000 birds, and the same percentage for their current number of birds. The data from the table revealed that 36.3% of the correspondents have 2 – 3 workers, which means they are short of manpower compared to the number of current birds in their poultry.

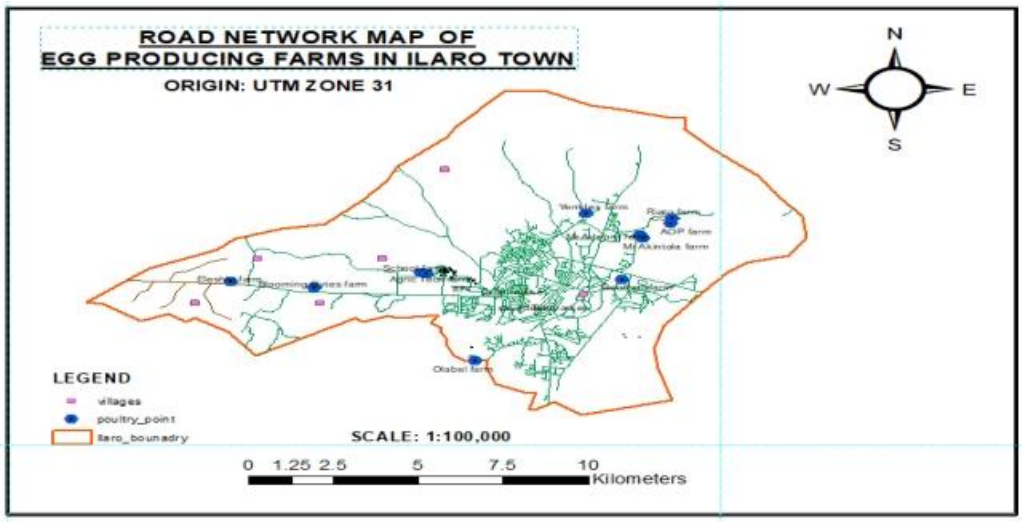

Figure 8: Road Network Map

Table 5: Showing the farm-related data

Responses	Frequency	Percentage (%)
Poultry Type		
Layers	011	54.5
Mixed	09	45.5
Total	20	100
Range of Capital	02	09.1
<500,000		
500,000 – 1,000,000	07	36.4
1,000,001 – 2,000,000	11	54.5
>2,000,000	00	0.0
Total	20	100
Farm Established by Self	20	100
Heredity	00	0.0
Total	20	100
Farm ownership		
Sole Proprietorship	20	100
Partnership	00	0.0
Total	20	100
Poultry		
Farming		
Main Occupation	18	90.9
Auxiliary Occupation	02	09.1
Total	20	100
Startup No of birds		
100 - 500	04	18.2
501 – 1000	02	09.1

Responses	Frequency	Percentage (%)
1001 – 3000	02	09.1
3001 – 5000	05	27.3
5001 – 10,000	07	36.3
>10,000	00	0.0
Total	20	100
Current number of birds		
100 - 500	04	18.2
501 – 1000	02	09.1
1001 – 3000	00	0.0
3001 – 5000	02	09.1
5001 – 10,000	07	36.3
>10,000	05	27.3
Total	20	100
No of workers		
0 - 1	02	09.1
2 – 3	07	36.3
5 – 7	04	18.2
8 – 10	02	09.1
11 – 20	04	18.2
Above 20	01	09.1
Total	20	100

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The results indicate the presence of 20 poultry farms in the study area, collectively hosting a population of about 74,000, as predicted. These farms exhibit a random distribution based on their locations. A detailed database has been created, capturing essential information about each poultry farm. The land use/land cover analysis in Figure 5 reveals that these farms are situated away from built-up areas and are arranged in a random pattern, as shown in Figure 7. The incorporation of geospatial techniques facilitates the identification of poultry farms close to residential areas. Operated mainly by individuals with agricultural-related education, these poultry farms predominantly focus on egg production. The eggs, exceeding 10,000 crates per day, are sold both within and outside Ilaro, considering the estimated population, the question of sufficiency is raised. Cages are commonly used for bird housing, and borehole water serves as the primary source for drinking. External factors affecting the poultry business include manpower and industrial expertise, while internal factors encompass skills and individual characteristics. Socio-economic factors involve employment opportunities, an increase in the standard of living, and opportunities for auxiliary businesses. Environmental factors include climatic conditions and seasonal diseases, and management factors encompass feed quality, chick quality, and medical care.

The poultry industry faces production challenges due to the absence of modernization and government-informed policies. Marketing hurdles include tough competition and transportation issues (road network), while financial constraints involve a lack of capital and high-interest rates. Climatic problems include air composition, temperature variations, air speed, and labour-related challenges encompass the non-availability of skilled labor, absenteeism, and demands for higher wages.

5.2 Recommendations

The following recommendations are proposed to improve poultry farming efficiency and sustainability in the region:

- Improve Infrastructure: The government should prioritize the development of rural infrastructure, especially roads, electricity, and water supply. Good road networks will ease the transportation of eggs to markets and reduce spoilage and cost, while stable electricity and water are critical for poultry health and productivity.
- Land Use Policy and Regulation: There should be clear, farmer-friendly land use policies that make it easier for genuine poultry farmers to acquire land in suitable locations. Environmental regulations should also be enforced to guide the siting of farms in a way that prevents pollution and ensures sustainability.
- Strengthening Market Linkages: Efforts should be made to connect poultry farmers with institutional buyers such as schools, bakeries, supermarkets, and food processors. This will help stabilize demand and ensure a more structured egg supply chain.

- Engage Geospatial Expert: When geolocating a poultry farm, a geospatial expert can be engaged to utilize geospatial tools for improved road network analysis for improved services, and enhanced geolocation.

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