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Farmland and geospatial resource survey for food security promotion among farm families in Imo state, Nigeria

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ABSTRACT

This study investigates the crucial role of farmland surveying, geoinformatics, land use planning and evaluation in ensuring the food security of Farm families in Imo State. A total of 140 respondents were randomly chosen from a list of 1400 provided by the ALL Farmers Association of Nigeria, Imo State Office in Owerri (AFAN), all of whom have had their farmlands surveyed. Data was obtained using a well-structured questionnaire and analyzed using frequency tables, means, and percentages. Results showed that 70% of the farmers had their farms surveyed, and 53.6% of them have been engaged in farming for over 21 years. The farmers are educated, with 50% falling within the age range of 51-60 years. They are aware of the advantages of farmland surveying. A significant majority indicated being food secure in their responses to questions, as 64.3% never worry about food running out quickly, 57.1% are not anxious that the food purchased doesn't last, 17.1% have money to buy food, and 55.7% indicated they do not always reduce meal sizes, while 6.4% said they cannot always eat balanced meals, with 100% never experiencing these concerns. Land surveying, planning and evaluation enable farmers to understand land characteristics (72.1%), designate areas for crop irrigation (85.7%), and contribute to mitigating climate change (93.6%), among other benefits. Geoinformatics helps in assessing soil quality for farming (M=2.45), tracking movement of farm animals among others.

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INTRODUCTION

There is a widely accepted understanding that food is essential for human life and survival. The current food economy fails to provide sufficient nutrition to significant portions of the expanding global population, despite rapid growth rates. Food security has emerged as a critical issue in both developing and developed countries, which exposes significant disparities as well as contradictions and tensions between abundance and scarcity. The food system can be viewed as a lens that reflects the relationship between sustainability and equity. It governs our dietary choices; and there is growing concern across various levels of governance, policy sectors, civil society, academia, and business that the food system is unsustainable and threatens both human health and the planet's future. "Food systems include activities related to the production, processing, distribution, preparation, and consumption of food; and the results of these activities affect food security (Dogondaji, 2013). These results also have implications for environmental and other security issues (e.g., income) (Ahsan, 2008).

In recent years, the agricultural sector has shifted from a relatively overlooked position to a central role in discussions about climate change. Adapting agricultural food systems to the impacts of climate change has quickly become one of the primary challenges on the sustainable development agenda. Climate significantly influences the performance of food systems at the farm level, impacting the quantity and variety of food produced and the sufficiency of income generated from production. Extreme weather events can disrupt or obliterate transportation and distribution infrastructure, adversely affecting other non-agricultural aspects of the food system.

The lack of food security and associated coping strategies are increasingly being examined in Africa. Food insecurity is recognized as a major challenge for many African governments, exacerbated by a growing number of individuals experiencing poverty, pervasive corruption, instances of conflict/terrorism, and adverse climate changes in the region. Nigeria has one of the highest numbers of people living in extreme poverty worldwide and is grappling with food insecurity, particularly in the northeastern and north-central states where conflicts/insurgency, kidnapping, armed banditry, cattle rustling, and extreme weather conditions are worsening the food insecurity crisis (Ayinde *et al.*, 2020). To establish a sustainable food system that ensures social equity despite the obstacles posed by climate change, comprehensive and strategic approaches will be necessary. Essential components of this include enhanced collaboration among communities focused on climate, agriculture, and food security, as well as consideration of interdependencies throughout entire food systems and landscapes (Hall and Dorai, 2010).

Food security is essential for the survival of humanity and is fundamental to economic activities, including food production. Food is unique among goods as it is necessary for life and sustenance.

In Nigeria, food insecurity has been prevalent for the past forty years due to a decline in food production, as oil has taken precedence as the main export, along with the impacts of neoliberal economic policies such as naira devaluation, trade liberalization, and government disengagement from economic involvement; additionally, ethnic and religious conflicts, along with disasters like flooding and drought, have further aggravated food insecurity (Alagbe and Adefowope, 2022).

Unlike other goods, food is a universal necessity for survival and a vital element in a nation's pursuit of prosperity. Regrettably, smallholder farmers are responsible for the majority of Nigeria's food supply, but they often lack the capital, skills, energy, and other essential resources needed to produce sufficient quantities of food to meet the demands of a growing population.

Consequently, food insecurity remains a persistent and chronic issue in Nigeria.

Food inflation in Nigeria averaged 12.07 percent from 1996 to 2021, according to 'Trading Economics,' an independent economic forecasting organization, with a peak of 39.54 percent in September 2001 and a low of -17.50 percent in January 2000 insecurity (Alagbe and Adefowope, 2022). In March 2021, it peaked at 22.95 percent before decreasing to 17.76 percent in June. Food insecurity, which is closely associated with malnutrition, creates significant challenges for the underprivileged. Nigeria possesses 70.8 million hectares of agricultural land, but only 34 million hectares are arable (suitable for farming). insecurity (Alagbe and Adefowope, 2022). Many areas of potential agricultural land remain uncultivated, while the population continues to experience hunger and poverty. Although the agricultural sector employs 35% of the population and 70% of households engage in crop farming (Nations Encyclopedia, 2011), agricultural output falls short of feeding the masses, especially when compared to countries like Canada, where only 0.79 percent of the population works in agriculture but the country ranks among the world's largest food producers and exporters. insecurity (Alagbe and Adefowope, 2022). Daily, many individuals face hunger or malnutrition due to lack of access to food or inability to afford it.

Nigeria's growing food crisis is intensified by increasing security threats and weak institutions. While climate change impacts the environment and agricultural communities, conflicts and wars have had devastating recent effects. The ongoing clashes between farmers and herders are frequently mentioned as a primary contributor to food insecurity in the nation. Attacks on farmers have made agriculture dangerous, and the destruction of farmland has worsened the situation. Farmers in the Northeast are particularly hard-hit by the insurgency; 10.6 million people face urgent needs, yet only 7.8 million can be assisted (Alagbe and Adefowope, 2022).

According to a Cadre Harmonisé report from November 2019, around 2.6 million individuals in Adamawa, Borno, and Yobe states experience extreme food insecurity, marking a decrease of over 300,000 people since June 2019. However, without humanitarian intervention, an estimated 3.6 million people in these states are projected to face extreme food insecurity from June to August 2020. The same dire circumstances are reflected in various other states throughout Nigeria, insecurity (Alagbe and Adefowope, 2022).

The growth of the country's population is adversely affecting agro-ecological systems. Serious environmental challenges facing the country include deforestation, desertification, soil degradation, erosion, flooding, widespread habitat loss, and depletion of natural resources. The sandy desert is advancing southward at a speed of 0.6 km annually in the northern part of the country, while the rainforest area in the south has decreased from nearly 10% of the nation's total area in 1934 to only 5% today (Alagbe and Adefowope, 2022). All of these concerns are significant, but they are exacerbated by their effects on the nation's food security. In particular, it has been noted that the country's overall agricultural capabilities are threatened due to rising temperatures and water scarcity linked to heat. This is critical because the repercussions could severely endanger both national and household food security.

Food demand in Nigeria has exceeded food supply (Idrisa *et al.*, 2008), and the CBN (2001) supports this claim by indicating that the annual increase in food production, at 2.5 percent, fails to keep pace with the yearly population growth of 2.8 percent. Many farmers in Nigeria are not well-informed, lack sufficient agricultural inputs, machinery, and extension services, and exhibit high levels of illiteracy and inadequate understanding of modern agricultural methods that could enhance production and yield to satisfy the growing food demands of Nigeria's population. The adoption of modern technologies and practices remains a significant obstacle in Nigerian agriculture. Additionally, food wastage poses a threat to Nigeria's food security. As noted by Igberaese and Okojie-Okoedo (2010), Nigeria faced 0.81 million metric tonnes of food waste from 1995 to 2000, a situation that could be significantly improved with proper storage facilities.

Achieving food security is unattainable in an environment where waste is prevalent. If a coordinated response and solutions are not implemented soon, food security in Nigeria is likely to decline to a very low and problematic status by 2050 (Adebola *et al.*, 2011), impacting not only health but also the economy and social stability. The World Health Organization (WHO) states that food security can be ensured when everyone has consistent access to an adequate amount of safe and nutritious food throughout the year. Achieving food security is feasible as long as we can enhance agricultural production due to advancements in technology over the past few decades. Included in these technologies are land use surveying and planning, geoinformatics, and land evaluation.

Land use planning involves a systematic evaluation of land and water potential, alternatives for land use, and economic and social conditions to determine and implement the best land use options. Its goal is to identify and apply land uses that will best fulfill the needs of the people while preserving resources for future generations. The impetus for planning should stem from the necessity for change, the quest for better management, or the requirement for a completely different land use pattern dictated by evolving circumstances. This process encompasses all types of land use: agriculture, forestry, wildlife conservation, urban and industrial development, tourism, and amenities. Planning also offers guidance in situations of conflict among competing uses by highlighting which areas are most valuable for specific land utilizations (Hubert van Lier and De Wrachien, 2002). Land use planning can be understood as an ongoing and iterative process aimed at optimizing land resources by: assessing existing and future needs and determining the land's capacity to meet them; identifying and resolving disputes among competing requirements; exploring alternative solutions and selecting those that align best with established objectives; and gaining insights from prior experiences. Farmland surveying refers to the process of measuring land on farms. Such measurements—conducted through tables, planes, or layouts—are carried out for particular purposes. It can also involve determining and delineating the position, size, and boundaries of a piece of farmland. Conversely, farmand surveying can be described as a series of investigations into rural farmers' value perceptions regarding agricultural production and their attitudes towards adopting technological innovations in agriculture. Farm surveying (also known as agricultural survey) entails a detailed examination of the various stages of development observed within a specified timeframe concerning agricultural growth and the corresponding quantity of produce recorded during that period.

It includes the following aspects: Identifying areas that are suitable for developing agriculture, forestry, range management, wildlife conservation, recreation, urban growth, or industrial projects; Choosing beneficial land use alternatives and appropriate crops for various parts of a project area, along with formulating suitable cropping patterns; Providing land management recommendations that ensure maximum agricultural yields while conserving land resources; Forecasting crop yields and agricultural productivity of a region based on specific management and input levels, along with long-term planning for regional or national food and fiber requirements; Anticipating potential environmental changes or hazards such as soil erosion, drought, salinity, waterlogging, and soil fertility decline, associated with the proposed development in an area or changes in land use (FAO, 1991); Identifying representative locations for agricultural research stations, experimental farms, and pilot initiatives; Applying agricultural research findings in the field and from pilot projects; Estimating land development needs and costs for a selected project area while formulating land development plans; Executing agricultural and land development initiatives; Estimating the anticipated income and financial benefits from an agricultural project's implementation; Assessing water needs for irrigating a project area; Effectively distributing irrigation water resources; Conducting land evaluations for consolidation, exchange, agricultural taxation, and facilitating agricultural financing; Planning for the restoration of degraded lands affected by issues like soil erosion, salinity, and waterlogging; Designing and aligning infrastructure such as roads, railways, irrigation canals, drainage systems, and flood protection structures; Selecting sites for irrigation reservoirs, airstrips, and industrial waste dumps; Identifying locations for agro-based industries; Coordinating internationally in agricultural research and land management technology; Securing development funding from international aid agencies for agricultural initiatives (FAO, 1991).

A geographic information system (GIS) is software designed to document, store, validate, and visualize data regarding locations on Earth's surface (Maguire, 1991). A GIS can present an array of data types, such as streets, buildings, and vegetation, on a single map. This ability allows individuals to perceive, assess, and understand structures and relationships easily. GIS serves as a tool in precision agriculture because of its capability to collect, store, retrieve, and analyze feature and location data, making it particularly useful for data-driven strategies in site-specific management. Unlike traditional maps, digital GIS maps incorporate multiple data layers, each representing specific attributes like yield, pest presence, nutrient levels, soil surveys, and precipitation. Additionally, GIS provides analytical tools to uncover interrelationships between features through statistical methods and geospatial analysis. The insights gained are valuable for making informed management decisions. GIS is crucial for ensuring food security in a world facing challenges such as population growth, resource scarcity, limitations in agricultural land, and climate change (Kumar *et al.*, 2024). The tools offered by GIS are effective in tackling the intricacies of food security by enhancing precision in agriculture, improving resource distribution, and reducing risks. By connecting geographical data with agricultural decision-making, GIS allows farmers to lessen their environmental footprint while optimizing resource use. This technology-driven approach enhances efficiency and productivity by tailoring precision agriculture methods to specific field conditions.

The sustainability of agricultural production systems has thus become a significant concern for agricultural researchers and policymakers in both developed and developing nations (Rossister, 1994; Medugu, 2006; IIIA, 2008; Alademerin and Adedeji, 2012). To develop an effective sustainable plan for agricultural growth, it is crucial to identify the available potential through land and land use planning. Land evaluation refers to assessing land performance for a specific purpose, which includes executing and interpreting surveys and studies of landforms, soils, vegetation, climate, and other land aspects to identify and compare promising land use types based on the evaluation's goals (FAO, 1976). Several scholars in Nigeria have focused on land evaluation (Mbajiorgu and Anyadika, 1997; Akinbol *et al,* 2008; Babalola *et al*, 2011; Uchua and Nduke, 2011; Uchua *et al,* 2012). These studies have employed the mapping capabilities of GIS and remote sensing to examine agricultural systems. Nonetheless, contemporary factors such as climate change, population growth, HIV/AIDS and related diseases, rural-urban migration, and the availability of hybrid species affect agricultural contributions to economic growth in Nigeria (Anthony, 2010). These factors have not been sufficiently addressed in land evaluation studies within Nigeria.

The global demand for land for agricultural purposes is rising, indicating a scarcity of land resources. This situation has prompted the need for decisions that lead to the most advantageous use of limited land resources. Evidence-based decisions made for the optimal utilization of land resources have significant implications for conserving land for future use. The role of land evaluation in this context is to enhance understanding of the connections between land conditions and their uses while providing planners with comparisons and promising alternative options (Njar *et al.,* 2012). The insights and recommendations derived from land evaluation are vital for the land use planning process that typically follows the evaluation (George, 1997). Land use evaluation identifies land use alternatives essential for land use planning. Van Diepen *et al.* (1991) define land use planning as the distribution of land into various categories based on criteria established during the land evaluation process. When determining land use options, it is crucial to take management-related attributes into account (George, 1997). This is important because management-related attributes, including inputs and socioeconomic contexts, influence production levels.

Land-use planning can be an effective approach to avert or address land degradation before, during, and after agricultural activities. When implemented prior to any agricultural investment or action, land-use planning aids in pinpointing appropriate regions for particular activities. This analytical process, which forecasts the land's productivity based on specific usage types over time and space, is referred to as agricultural land suitability evaluation (Sonneveld *et al.* 2010; Elsheikh *et al.,* 2013). It highlights the land's strengths and constraints regarding crop production (Pan and Pan, 2012), especially in the context where prolonged agricultural use and climate change continually degrade land productivity and resources (Elsheikh *et al.*, 2013; FAO, 2007). Therefore, agricultural land-use planning presents viable solutions to the challenges of land quality, the choice of suitable cultivation methods, and the overall decision-making and identification of optimal land management practices. In this context, land-use planning enhances the efficient utilization of water, enabling the ongoing use of farming systems throughout both the rainy and dry seasons. Its role in food security thus depends on the steady availability of food resources.

Once agricultural practices have been carried out, land-use planning also offers a framework for land restoration. This field of land system science can provide sustainable solutions through an integrated examination of land availability and the evaluation of the trade-offs linked to agricultural growth and intensified land use (Verburg *et al.*, 2013). Consequently, land-use planning delineates precise actions for appropriate investment. It will significantly aid in "doubling the agricultural productivity and incomes of small-scale food producers, particularly women, indigenous peoples, family farmers, pastoralists, and fishers, including through secure and equitable access to land, other productive resources and inputs, knowledge, financial services, markets, and opportunities for value addition and non-farm employment by 2030" (SDG2). From an environmental perspective, land-use planning supports the preservation of ecosystem services and functions. Low fertilizer usage helps reduce pollution, while a comprehensive approach to food systems would markedly enhance the diversity of food sources and their availability. This will contribute to “ensuring sustainable food production systems and implementing resilient agricultural practices that enhance productivity and production, help maintain ecosystems, bolster capacity for adapting to climate change, extreme weather, drought, flooding, and other disasters, and progressively improve land and soil quality” as aimed for by 2030 (SDG2). However, no empirical study exist in the study area on how farmland Resource Surveying, Geoinformatics, Land Use Planning and Evaluation promote Food Security Among Farm Families In Imo State, Nigeria. The topic therefore becomes necessary. This study investigates the food security roles of land survey, geoinformatics, land use planning and evaluation among crop farmers.

MATERIALS AND METHODS

The study was conducted in Imo State. Imo State is located in the Southeast region of Nigeria. It spans an area of approximately 5,530 square kilometers, making it relatively small by Nigerian standards. However, its limited size is compensated by its stunning natural landscapes and rich cultural heritage. Imo is regarded as the heart of the Igbo ethnicity, one of Nigeria's largest cultural groups. The local language, customs, and lifestyle are deeply rooted in the identity of the state. From lively masquerade celebrations to elaborate arts and crafts, Imo provides an immersive glimpse into Igbo culture. Although agriculture remains essential, industries such as palm oil production, mining, and manufacturing are propelling the economy of Imo forward. The state is also famous for its talented artisans, particularly in woodwork and textile production.

With a youthful and dynamic population, Imo is on track for even more significant economic development. As of 2024, Imo State has an estimated population of approximately 5 million residents (IMSG, 2010a; IMSG, 2010b). The Igbos are the predominant ethnic group, constituting over 95% of the state’s populace. Other minority ethnic communities include the Hausas, Yorubas, and Ibibios. The state boasts a relatively young demographic, with a median age of around 24 years. More than 40% of the population is under 15 years old, while only about 4% are aged 65 or older. Despite being one of the most densely populated states in Nigeria, about 60% of its inhabitants still reside in rural areas (IMSG, 2010a; IMSG, 2010b). The capital city, Owerri, along with urban centers like Orlu and Okigwe, are significant population hubs.

Poverty levels in Imo are high, with over 50% of the individuals living beneath the national poverty threshold. Nonetheless, income disparity is comparatively low when matched with other states in Nigeria. The primary economic activities encompass agriculture, trade, and public sector jobs (IMSG, 2010a; IMSG, 2010b). A quantitative survey was conducted among all registered crop farmers, utilizing a purposive random sampling technique to select 140 registered farmers who surveyed their farms from a pool of 1,400 farmers listed by the All Farmers Association of Nigeria (AFAN) in Owerri, Imo State. Data was gathered through questionnaires and in-depth discussions with the farmers. The results were analyzed using percentages, means, and standard deviations. Objectives 1, 2, 3and 4 were accomplished using percentages presented in frequency tables. Objectives 5,6 (perceived effects of geoinformatics on food security and) agricultural land use planning, were evaluated using a 3-point Likert scale consisting of strongly agree, agree, disagree, assigned weights of 3, 2, and 1, respectively. The resulting values were summed and divided by 4 to establish a discriminating mean value of 2.50. Any mean value that equaled or exceeded 2.50 was deemed acceptable when we gather data froms among crop farmers.

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

Table 1 demonstrates that 50% of the participants fall within the age group of 51-60 years, making them the largest segment. This is followed by 28.6% who are aged between 41-50 years. Meanwhile, 14.3% are within the 31-40 years bracket, and 7.1% are 61 years and older. The average age is 55, indicating that the respondents are not children or young individuals who might lack understanding of the study's subject matter. Their experience and exposure can contribute to generalizations. It is stated that education equates to knowledge, as it imparts the critical thinking skills necessary for in-depth investigation. A total of 46.4% of the respondents attended primary school, 32.1% completed secondary school, and 21.4% pursued higher education. Their educational background has equipped them to grasp the significance of farmland surveying and its connection to food security. They possess farming experience and are not newcomers, as evidenced by 53.6% who have been farming for over 21 years, 41.2% who have farmed for 11-20 years, and only 32.1% who have 1-10 years of experience. Furthermore, 45.7% (the majority) own 2-3 hectares of land, 32.1% have 3-4 hectares, while 11.4% own more than 4 hectares. Approximately 70% have conducted a survey of their farmland (70%), 92.1% understand the value of their land, and 91.4% are able to invest in and sell their land with ease.

Table 1. Personal characteristics of respondents

Characteristics	Frequency	Percentage
Age		
31 – 40	20	14.3
41 – 50	40	28.6
51 - 60	70	50.0
61 and above	10	7.1
Education level		
Primary	65	46.4
Secondary	45	32.1
Tertiary	30	21.4
Farming expenses (years)		
1 - 10	45	32.1
11 – 20	20	14.2
21 and above	75	53.6
Farm size(hectares)		
Less than 1.5	15	10.7
2 – 3	64	45.7
3 – 4	45	32.1
4 and above	16	11.4
Is your farmland surveyed		
Yes	98	70.0
No	42	30.0
Is surveying beneficial		
Yes	128	91.4
No	12	8.6
*Which of the following benefits do you see		
Know my boundary well	98	70.0
Know the value of my land	120	92.1
Can develop my farm anytime I like	110	78.5
Can sell it easily and freely	128	91.4
Can undertake anytime of farm investment	134	95.7
Can collect loan with my land	127	90.7

*Multiple responses

The respondents are acutely aware of the significant advantages of farmland surveying, as 70% are familiar with their farm boundaries, 92.1% recognize their land value, 78.5% can develop their farmland at any time, 95.7% can pursue any investment opportunities, and 91.4% can sell their land freely and effortlessly.

Table 2. Food security status of respondents

Food security statement	Often times	Sometimes	Never
We worried our food will finish quickly	10(7.12)	40(28.6)	90(64.3)
The food we bought did not last	15(10.7)	45(32.1)	80(57.1)
We hadn't money to buy another food	24(17.1)	46(32.8)	70(50)
We couldn't afford to eat balanced meal	09(6.4)	31(22.1)	100(71.4)
We cut size of our meals at times	17(12.1)	45(32.1)	78(55.7)
Did you cut meal size every time?	14(10)	55(39.3)	71(50.7)
Do you eat less food?, you would have eaten	20(14.2)	74(32.8)	46(32.8)
Did you miss meals or skip meals for lack of food?	12(8.5)	60(42.8)	68(32.8)
Did you ever lose weight due to no food to each?	6(3.6)	24(17.1)	110(78.5)
Did the adult person go hungry due to no food?	4(2.8)	6(3.6)	130(73.5)
We relied on low cost food to feed the children	7(5.0)	80(57.1)	53(37.8)
We couldn't feed the children balances meals	10(7.1)	60(42.0)	70(50.0)
The children do not eat enough due to lack of food	8(5.7)	63(45.0)	69(49.3)
Did the children ever skip meal due to lack of food?	8(5.7)	38(27.1)	94(67.1)

Note: Figures in parentheses are percentages

Food security status of respondents

Table 2 illustrated the food security situation of the respondents. Analyzing the responses from the 14-item scale based on the options of often, sometimes, and never, we find that only 12 statements received a positive response indicating that the respondents NEVER encountered food-related concerns, while the remainder reflected food insecurity. The table revealed that 64.3% indicated they never worried about running out of food. However, 28.6% reported that they sometimes worried about food supplies depleting. Additionally, 57.1% stated that they never experienced the issue of purchased food not lasting, while 32.8% mentioned that, at times, they lacked money to buy food. Half of the respondents reported having sufficient money all the time, whereas 22.1% acknowledged that there were times when they could not afford a balanced diet, although 71.4% reported never experiencing this issue within the past year. Moreover, 32.1% sometimes reduced their meal sizes during the year, while 55.7% claimed to have never done so. Due to insufficient quantity, 32.8% indicated they consumed less food than they would have preferred, while 52.8% never did, and 14.2% reported doing so frequently. Furthermore, 48.6% stated they never missed a meal, 42.8% admitted to missing meals sometimes, and 8.5% missed meals frequently. Regarding weight loss from inadequate food intake, 78.5% never experienced weight loss, 17.1% did so sometimes, and 3.6% frequently lost weight. Adults reported going hungry due to unavailability of food sometimes (3.6%), often (2.8%), while a significant 73.5% never went hungry. Additionally, 57.1% agreed to purchasing inexpensive food to feed children sometimes, while 37.8% never did, and 5% did so often. As for children not having balanced meals, 42.3% experienced this sometimes, 50% never did, and 7.1% did so often. Children did not consume enough food often (5.7%), sometimes (45%), and never (49.3%). The frequency of skipping meals was reported as often (5.1%), sometimes (27.1%), and never skipped (67.1%).

Agricultural land parameters to evaluate in the study areas

Table 3 showed the parameter to evaluate on land for food security and agrifood value chain management. These are the physical, chemical and biological parameters to look out for in evaluating land for farming. These include soil type and texture (96.4%), which includes clay, loam, humus, coarse, sandy among others, soil fertility/nutrients (92.1%), soil depth (92.8%), topography of soil (86.4%), surface water (98.6%) and vegetation cover (88.6%). The fertility of soil affects yield of crops, and the nutrients available. Rich soil alluvial soils with nutrients affect productivity, these support household food security. Marginal lands/soil, rocky and stony are not for agriculture. The depth of soil also support plant life and development, loading to bumper harvest. The slope of land or and availability of water play crucial roles in food security as they guarantee nutrient retention or not. Vegetable cover protects the land from direct heat of soil, it add nutrients to the soil as decayed leaves provide rich manure for crop productions.

Table 3. Agricultural land parameters to evaluate in the study areas

Land/Soil parameters	*Frequency	Percentage
Soil type/Texture	135	96.4
Soil fertility/Nutrients	129	92.1
Soil depth and drainage capacity	130	92.8
Topography of soil	121	86.4
Surface water availability	138	98.6
Vegetation cover	124	88.6
Erosion susceptibility	132	94.3
Potential hazards	126	90.0
Land use pattern	118	84.3
Land tenure/Legal issues	137	97.8
Availability of infrastructure	133	95.0

*Multiple Responses

Other parameters include erosion susceptibility (94.3%), potential hazards (90%), land use pattern (84.3%), land tenure/legal issues (97.8%) and availability of infrastructure (95%).

Erosion is not good for agricultural land use as it washes away vital nutrients and degrades land depending type. Land evaluation determines the manner and or possibility of erosion happening on a land and gives prior warning. Potential hazards can also after agrifood value chain management as floods, earthquake, heavy gully degrade land and after food security of households and the nation at large. Both land use pattern available in an area affect food distribution and management. The tenure pattern and legal issues determines extent of investing in agricultural land. The presence of infrastructures like good roads, electricity, water sources, schools, markets among others affect food security and the agrifood value chain management.

Obi and Ogunkunle (2022), observed that both land use planning, land evaluation and soil surveys play a crucial role by providing essential information for effective land management and production choices. Among the results of a soil survey are soil and land evaluation maps along with related reports. A farmer, or other land users, can maximize their net returns by utilizing each soil type for the crop and management strategy that yields the best returns, which is contingent on the resource inventory outlined in the soil survey report. The soil map, an outcome of the soil resource inventory, delineates the boundaries between soils that need different management practices for optimal returns and a sustainable environment. A soil survey represents an inventory of various soil properties, such as texture, internal drainage, parent material, groundwater depth, topography, level of erosion, stoniness, pH, and salinity, as well as their spatial arrangement across a landscape. Soils are categorized into similar types, with their boundaries depicted on a map. Each soil type possesses a distinct collection of physical, chemical, and mineral characteristics and behaves similarly to different uses and management practices.

The information gathered from a soil survey can be utilized to forecast or assess the potentials and limitations of the soils under various uses. Consequently, soil surveys can guide decisions on land opening or evaluate the conversion of land to alternative uses. They also offer insights into the appropriate type and intensity of land management. The capacity of soils, along with relevant environmental factors, can be categorized as highly, moderately, marginally, or not suitable.

Thus, the initial step in sustainable soil management is to confirm that the soil is appropriate for the intended land use activity.

The suitability of soils can be classified from highly suitable (optimal) to unsuitable. For this reason, agricultural development should proceed only in areas where the soil resources can sustain agricultural activities. The only means to achieve this is by understanding the available soil resources. Information from soil surveys is essential for grasping the details about the soil resource. A soil survey, or soil resource inventory, is the thorough examination of soils in the field and their organization into well-defined mapping units, such as soil series and phases, to determine their optimal use and show their locations on a map. Conducting a soil survey is a comprehensive task, and some of its components may be highlighted to emphasize the potential benefits that can be obtained. These components consist of the delineation and mapping of soils into homogeneous units (mapping units), characterization of these units, classification of the units, and land evaluation for alternative uses and guidance on various land applications. The results of soil survey efforts yield a catalog of crucial information that can aid in sustainable land management decision-making processes.

While the information is not specific, it generally encompasses a compilation of available natural resources within the study area. This data is tailored to meet specific needs and interpreted by professional planners from various disciplines. Predictions derived from such soil surveys form the basis for making judgments regarding land use and management for areas ranging from small plots to vast regions spanning millions of acres, largely influenced by the resources allocated to the effort. However, these predictions must be assessed in conjunction with economic, social, and environmental factors before they can be utilized to make sound recommendations for land use and management.

Role of farmland surveying and planning in promoting food security

Table 4 illustrated how farmland surveying/planning contributes to enhancing food security. Farmland survey/planning enables farmers to comprehend land characteristics (72%). Through this understanding, farmers can identify soil types, terrain, water availability, and the physical and chemical properties of the soil, allowing them to decide on the most suitable crops for a specific area, thereby optimizing crop selection and maximizing yields, which secure food supply. Farmland survey/planning assists farmers in designating appropriate land for crop irrigation to maintain fertility and boost food production, ensuring food security. Additionally, farmland surveying/planning aids in selecting and determining farm building locations (93.6%), mapping and distinguishing fertile lands (85%), establishing soil conservation and water management practices (89.2%), minimizing food waste (77.8%), securing access to land and other productive resources (87.8%), and promoting rural development (89.2%). Moreover, farmland survey encourages the preservation of biodiversity (84.2%), enhances crop resilience variety (82.2%), fosters soil health (81.4%), helps prevent land degradation (87.8%), aids in climate change adaptation (93.6%), identifies potential risks (90.7%), and assists farmers in understanding land capabilities (88.6%).

Table 4. Role of farmland surveying and planning in food security

Roles of farmland surveying and planning	*Frequency	Percentage
Understands land characteristics	101	72.1
Allocates suitable land for crop irrigation	120	85.7
Determines sites for farm buildings	131	93.6
Separation/mapping of fertile lands	119	85.0
Marking/mapping of marginal areas	136	97.1
Determines soil and water conservation practices	125	89.2
Reduced food waste	109	77.8
Improved access to land and other productive resources	123	87.8
Fosters rural development	125	89.2
For biodiversity preservation	118	84.2
Promotion of variety by crops for resilience	116	82.8
Promotion of soil health	114	81.4
Prevention of land degradation	123	81.4
Helps mitigate climate changes	131	93.6
Identification of farm potential risks	127	90.7
Helps farmers understand land capability	124	88.6

*Multiple responses

Numerous factors can influence the increase in food production and productivity. One such factor pertains to land management and secure land tenure rights. These roles are typically associated with land surveyors, as outlined in the earlier referenced FIG definition. Furthermore, we contend that the supply of geo-information will enhance decision-making processes. The challenge is evident: to accommodate the agricultural intensification on currently cultivated areas and bring an additional 120 million hectares into cultivation to nourish the projected global population of 9.5 billion by 2050 (FIG, 1991; FIG, 2004). Acknowledging that numerous technical and institutional aspects are involved, we assert that without addressing this 'land issue,' challenges surrounding land and water rights will significantly hinder advancements in food security. The first aspect, land management, presents an opportunity for land surveyors to explore potential areas for land expansion. This initially necessitates the ability to identify and adjudicate land rights from both formal legal frameworks and especially from informal systems.

Additionally, it is essential to master the latest geospatial technologies and collaborate within multidisciplinary teams. The rapid advancement of geospatial technologies justifies their extensive use (Doytscher, 2013). Collaborating with diverse disciplines requires understanding other areas of expertise and empathy. Land managers must support both smallholder and commercial farms, while being aware of the value that each holds. Particularly, food security depends heavily on smallholder agriculture, so land surveyors should strive to find a middle ground between the two groups. Preventing the eviction of smallholders and vulnerable individuals for the benefit of large investors is crucial by offering allocation proposals that cater to both parties' interests. Land managers should especially prioritize women's land rights and address the issue of landlessness.

The second aspect, land administration, is integral to the profession. Nevertheless, land surveyors frequently focus excessively on statutory property rights and traditional land recording. In various ways, many land surveyors seem hesitant to venture beyond formal law, resulting in a situation where globally only 1–2% of land is registered under formal tenure (Alden Wily, 2012). In Central and Eastern Europe, the World Bank expresses frustration towards land surveyors due to their excessively slow procedures and unreasonably high precision demands (Adlington *et al.,* 2009). If the profession fails to address these criticisms, other professions will take over adjudication and registration tasks, as is already occurring in Bangladesh, where – under the BRAC property rights initiative – the government certifies non-professionals to deliver these land services (McLaren, 2014). There is even more motivation for innovation considering the extensive documentation of the traditional land administration system's misuse by elites (Augustinus, 2015) and the rampant corruption in the land sector (TI, 2011). The Voluntary Guidelines (FAO, 2012a) and the Land Governance Assessment Framework (Deininger *et al.,* 2012) also specifically call for the inclusion of all types of land rights, in whatever forms they may take. From this, we understand that besides land rights, water rights are equally significant, and may even hold greater importance. This area is relatively unfamiliar to land surveyors, but it certainly deserves attention. Fortunately, a growing number of technical tools today assist with this work (Lemmen *et al.,* 2015).

Geoinformatics role in ensuring food security

Table 5 showed the roles of geoinformatics in food security. With a discriminator mean index of (M) of 2.0, the following roles were identified: proper management of inputs through precision farming (M= 2.54), assessment of soil quality for farming (M= 2.45), analyze nutrient status of fixed for farming (M= 2.34), monitoring crop health and growth (M=2.41), pests and diseases control (M=2.51), irrigation water management (M= 2.38), assessment of damages during hazards/risks (M= 2.31), analysis of land use trends/distribution (M= 2.47), used for supply management (M =2.51), climate change and hunger awareness (M=2.35) and tracking movement of farm animals (M= 2.49). According to Earl *et al.,* (1996) precision agriculture seeks to enhance the management of inputs such as seeds, fertilizers, pesticides, herbicides, and water by applying the right quantities at the optimal times and locations. Geographic Information Systems (GIS) play a crucial role in precision farming by assisting farmers in decision-making through the management of spatial data. This ensures the precise application of water, fertilizer, and pesticides, targeting areas that require them most (Earl *et al.,* 1996). It can also highlight specific regions of fields that necessitate special care and support farmers in making decisions that will enhance future yields, such as modifying irrigation practices or amending soil nutrients.

Table 5. Geoinformatics role in food security

Geoinformatics roles	Mean	SD
Proper management of inputs through precision farming	2.54	0.48
Assessment of soil quality for farming	2.45	0.59
Analyze nutrient status of food to farm on	2.34	0.68
Monitoring crop health and growth	2.41	0.61
Pest and disease control	2.51	0.82
Innovation water management	2.38	0.61
Assessment of damages during hazards/risks	2.31	0.72
Analysis of land use trends/distribution	2.47	0.54
Used for supply chain management	2.51	0.57
Used for climate change/hunger awareness	2.38	0.64
Tracking movements of animals	2.49	0.48

Accepted mean = 2.0

Conventional soil mapping tends to concentrate on an average soil characteristic from a single focus point, which limits its ability to capture the diversity of soil properties in the resulting maps. Additionally, the procedures involved in gathering, analyzing, interpreting, and mapping soil samples can be laborious, costly, and time-intensive. Therefore, integrating GIS, GPS, and Variable Rate Technology (VRT) provides farmers with unprecedented capabilities to analyze field maps and apply inputs precisely when and where they are needed to ensure optimal crop production (Sishodia, 2020). Evaluating soil quality aids in effective soil management, optimally utilizing its functions, and preventing degradation for future use. It also reveals soil patterns and their interactions that can enhance soil fertility. Satellite remote sensing data and GIS are utilized for assessing soil quality by storing, retrieving, and manipulating data to calculate and represent soil parameters (Rahman *et al.,* 2017). Furthermore, it identifies soil patterns and their relationships that can promote soil fertility. By employing GIS to evaluate the nutrient levels of the field and detect nutrient deficiencies, agricultural producers can distribute external nutrients more accurately (Ghosh, 2022). Based on the nutrient assessment, fertilizer recommendations can be provided, potentially boosting crop yields, reducing excess fertilizer expenses, and ensuring balanced nutrition for the crops (Kumar *et al.,* 2021).

Assessing crop health and growth along with making accurate yield forecasts are critical for evaluating food production and economic returns, which play a significant role in managing food security. Several studies have highlighted the traditional techniques for estimating agricultural yields can lead to inaccurate evaluations and ineffective area assessments of crops. Additionally, these conventional methods require the collection of expensive, labor-intensive, and time-consuming data related to crops and yields (Soomro, 2015). This necessity is addressed by technologies such as GPS, GIS, and remote sensing (RS), which are extremely useful for analyzing the spatial and temporal variations in crop dynamics and yield. These technologies enable the monitoring of crop health, growth patterns, and yield predictions through the use of drone and satellite imagery. They detect regions that require intervention, like nutrient deficiencies and disease outbreaks, thereby optimizing land use and boosting crop yields. Using historical and current agricultural satellite data, EOS Data Analytics (EOSDA) has developed a reliable technique for forecasting crop production with over 90% accuracy (Hanh *et al.,* 2017). Geographic Information Systems (GIS) provide valuable tools for monitoring, predicting, managing, and controlling the spread of agricultural pests and diseases. These tools create opportunities for effective and cost-efficient targeting of interventions and controls. GIS facilitates monitoring by correlating diseases with additional spatial data, identifying spatial patterns of diseases, and evaluating their geographic spread (Bouwmeester *et al.,* 2010).

Furthermore, GIS can analyze the shifting thresholds of pests and diseases due to climate change, project the expected spatial distribution of diseases, and supply data for risk assessment models in pest management. A system utilizing advanced image recognition technology detects potential pest and disease threats before they escalate into significant issues. This capability allows for the reduction of crop losses, the application of targeted treatments, a decrease in pesticide usage, and the protection of beneficial insects. GIS not only provides information on rainfall and soil moisture levels in various areas, but it also indicates how quickly water drains in those regions, enabling engineers to take appropriate measures to rectify any imbalances. Water stress is commonly detected through the use of the Normalised Difference Water Index (NDWI) or the Normalised Difference Moisture Index (NDMI). NDMI can early identify water stress before it becomes severe. Furthermore, monitoring irrigation with NDMI significantly enhances crop growth, especially in areas where natural water supply is insufficient for crops (Keria *et al.,* 2024). The NDMI index, which ranges from -1 to 1 and is automatically included in EOSDA Crop Monitoring, provides a clear summary of the collected data. Values near 1 may indicate waterlogging, while those close to -1 suggest water deficits (Hanh *et al.,* 2017).

GIS serves as a valuable resource for planning strategies to mitigate risks and assessing the extent and impact of damage inflicted by tornadoes, severe winds, floods, fires, and other similar events. By employing spatial analysis within GIS, it is possible to evaluate the spatial autocorrelation associated with natural hazards; when paired with regions vulnerable to multiple environmental threats, this approach can forecast potential risks and the intensity of future damages (Ghorbani *et al.,* 2023). To enhance land utilization, it is critical to understand the present land cover and uses in a given area. This information facilitates informed decision-making regarding resource management, agricultural practices, urban development, and conservation efforts. Accurate data enables stakeholders to optimize land scenarios for sustainable development. GIS aids planners in studying trends and distribution of land use while forecasting upcoming developments. Furthermore, it allows planners to examine various land-use alternatives and choose the most appropriate plan for agricultural and other purposes (Elmabod *et al.,* 2019). The objective of supply chain management is to treat suppliers, producers, and consumers as an integrated entity, ensuring the competitiveness of the entire chain while minimizing costs. This also involves optimizing routes and storage facilities to enhance food distribution and diminish waste. GIS assists in the management of agricultural supply chains by consolidating information about farm locations, transportation routes, and market demands. This support can lead to improved logistics and distribution efficiency, ultimately lowering spoilage rates (Ghosh, 2022). Geographic Information Systems are playing a significant role in raising awareness about global hunger, which is intricately linked to agricultural resources, in response to the immense food demand currently and in the future.

Insights drawn from geoinformatics data are crucial for forecasting climate conditions, making informed agricultural choices, and developing policies related to food security and farming activities (Chakrawarti *et al.,* 2024). In the realm of animal husbandry, effective tracking of animal movements necessitates the use of agricultural GIS applications. Farmers can identify the locations of livestock on their property and monitor factors such as their growth, nutrition, fertility, and overall health. GIS enables farmers to track their livestock's movements, assess their health, growth, nutrition, and fertility; map disease trends for prompt interventions; identify veterinary resources for targeted response during outbreaks; optimize grazing patterns and enhance productivity; analyze epidemiological data; mitigate soil erosion to promote environmental sustainability; and evaluate animal behavior and pasture usage (Tadesse *et al.,* 2021).

Perceive Roles of Agricultural Land use Evaluation in food security

Table 6 showed the perceived roles of agriculture land evaluation in promoting food security and agrifood value chain management. With a discriminating mean value index (M) of 2.0, land evaluation play the following crucial roles in optimizing the agrifood value chain: - identification of suitable land for farming (M= 2.56), identification of suitable crops for an area (M= 2.58), promotion of efficient resources allocation (M= 2.30), specifies the areas suited for farm infrastructure (M= 2.25), helps identify better land management practices (M= 2.59, and minimization of environmental impact (M= 2.65). Land evaluation guarantees good knowledge of suitable area to farm. It identifies the soil, type, fertility, topography, climate action, water availability for crop growth and yield. Having the above knowledge helps determine the type of crops suitable for the area, for growth and productivity. It guarantees equitable and efficient resources allocation and use. Land evaluation reveals areas suitable for high value crop like fruits and vegetables.

Table 6. Perceive roles of agricultural land use evaluation in food security

Perceived role of agricultural land used evaluation	Mean	SD
Identification of suitable land for farming	2.56	0.75
Identification of suitable crops for an area	2.58	0.81
Promotion of efficient resource allocation	2.30	0.68
Specifies areas suitable for farm infrastructure	2.25	0.78
Helps identify better land management practices	2.59	0.64
Minimization of environmental impact	2.65	0.58
Promotion of biodiversity	2.70	0.51
Helps optimize farm logistic/Transportation	2.54	0.34
Determines processing/Marketing facilities	2.35	0.69
Promotes individual farmer decision ability	2.40	0.81
Encourages project appraisal	2.37	0.77
Improvisation of rural livelihood	2.47	0.74
Reduced conflict	2.52	0.65
Provide opportunities for diversification	2.71	0.83

Accepted Mean=2.0

Other roles for promotion of food security and agrifood value chain management includes promotion of biodiversity (M= 2.70), optimize farm logistics (M= 2.54), processing/marketing facilities (M= 2.35), promotes farmers decision-making facilities (M= 2.35), promotes farmer decision making ability (M= 2.40), encourages project appraisal (2.37), improvisation of rural livelihoods (M= 2.47), reduce conflicts (M= 2.52) and provision of opportunities for diversification (M= 2.71).

Supporting the above, Obi and Ogunkunle (2022) said that thessignificance of conducting soil surveys or assessing land resources is crucial for the development of any nation, as all sectors are likely to benefit, either directly or indirectly, from the soil maps created and the subsequent interpretations through land evaluation and planning. This process fundamentally dictates how various resources are allocated within the physical environment. As a result, it is essential to carry out soil surveys during the initial planning phases for distributing all physical infrastructures. This illustrates that soil survey activities should be among the first actions taken in the planning and development for any entity seeking to occupy a physical or virtual space on the earth's surface. A soil map reveals the boundaries among different soils that require distinct management practices to achieve optimal returns. The advantages gained from a soil survey tend to increase with the specificity of the soil units depicted. Thus, it is clear that a country's soil map represents an essential foundational project for agricultural growth and the sustainable management of the primary sector. A farmer, or any land users, maximizes their net returns by managing each soil type in a way that yields the best results. The foundation of food security lies in the soil's fertility, which refers to its capacity to support plant growth and maximize crop yields. The main factors influencing food security are availability, accessibility, stability, and utilization, all of which are fundamentally linked to soil conditions: securing sufficient food supply or availability; ensuring that food supply remains stable; and guaranteeing economic and social access to food. Soil fertility is characterized by the ability to produce abundantly.

Essentially, soil fertility defines how well soil contributes to productivity, indicating a site's potential to generate plentiful yields for ensuring food availability and supply stability, which are crucial for food security. Obstacles to high productivity are often traced back to poor soil fertility arising from low inherent quality, insufficient management, loss of topsoil, and depletion of essential soil nutrients, all of which can lead to reduced per capita food production. The opportunity to attain food security lies in maintaining soil fertility and boosting productivity through proper soil management and preservation (Tittonell, 2015).

CONCLUSION

Surveying farmland resources, utilizing geoinformatics, and planning land use play vital roles in enhancing food security by maximizing agricultural land efficiency and ensuring sustainable food production. This entails evaluating land suitability for various crops, comprehending land degradation processes, and formulating strategies for the sustainable intensification and expansion of agricultural areas. The evaluation of land for the advancement of food security involves analyzing its appropriateness for different applications, such as agriculture, to guarantee sustainable food production and supply. This process takes into account elements like climate, soil, and vegetation to pinpoint the best land use practices that bolster food security.

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