

# Sustainable Development: Geospatial Technology as Panacea for Food Security in Nigeria

AJIROTUTU JACOB OLAYINKA

Surveying and Geo-informatics Department, Rufus Giwa Polytechnic, Owo, Ondo State Nigeria

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**Abstract:** Food Security has been an issue of global concern in the recent time. The present Federal Government of Nigeria places much emphasis on agricultural development. However, no meaningful Agricultural development can be achieved without a search for proactive strategies for food security. This paper looks at geospatial technology as strategy that will greatly meet the problems of food security in this country. The paper defines food security; it reviews the food security situation in Nigeria with the problems of food security. Consequent upon these problems, the paper discusses the application and benefits of this technology as tool for food security in Nigeria. The paper concludes that if the current democratic process will indeed yield dividends to the citizenry, the agricultural sector must be technologically revitalized and see as the most relevant of all.

**Keywords:** Food Security, Geospatial Technology, Remote Sensing, Geographic Information System (GIS).

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## 1. INTRODUCTION

Food Security means that all people at all times have physical and economic access to adequate amounts of nutritious, safe, and culturally appropriate foods, which are produced in an environmentally sustainable and socially just manner, and that people are able to make informed decisions about their food choices [1]. It also means that the people who produce our food are able to earn a decent, living wage from growing, catching, producing, processing, transporting, retailing, and serving food. It also means the state of having reliable access to a sufficient quantity of affordable, nutritious food [3].

In Nigeria, we have neglected our export crops which used to be our foreign exchange earners before the discovery of petroleum. In the 60s, Nigeria had over 60% of global palm oil exports, 30% of global groundnut export, 15% of global cocoa export but now the country controls less than 5% of global output of this crop. Presently, the country now import palm oil from Malaysia which in the 60s got oil palm seeds from the Nigerian Institute for Oil Palm Research (NIFOR) in Benin to start its now vibrant and flourishing oil palm plantations. This is a shame for a country like our own with one of the best soil for agricultural production in the world [2].

The neglect of our agricultural sector, because of the easy money from petroleum, has led us to use substantial part of our foreign exchange earnings to import agricultural products, which Nigeria could easily produce, from less agricultural endowed countries. According to the communiqué issued by the Nigerian Institute of Advanced Legal Studies Lagos[2], the amount used in importing food to the country now put at a staggering USD 4.2 billion annually. This is a huge amount of money which could have been used for development of the decaying educational sector and infrastructure.

Since the attainment of independence, successive governments in the federation, whether military or civilian, give the impression that agriculture has the pride of place in their various policies of governance. These were carefully projected through major agricultural programmes designed to boost agricultural productivity since independence include: the farm settlement schemes in the former Western and Eastern Regions in the 50s, the Agricultural Development Project 1973, the Procurement and Distribution of Fertilizer Project, Green Revolution 1983, Creation of River Basis Authorities 1987, the

Agricultural Insurance Scheme 1987, Creation of National Directorate for Food, Roads and Rural Infrastructure 1986, Peoples Bank 1989, the National Agriculture Land Development Agency 1991 and the National Fadama Development Project [10].

## 2. FOOD SITUATION IN NIGERIA

There is no gainsaying that Nigeria is seriously challenged in the area of food production. The greatest threat to national stability today is food security. The family menu is fast disappearing. Juju music icon, Chief Commander Ebenezer Obey, in one of his classic albums released in the late 1980s said Nigerians were using formula to eat. He sang about various eating formula such as 0-0-1, 0-1-0, 1-0-0, 1-0-1 and many others. The 1 in those numerals represents the meals families eat per day out of the three they are supposed to eat. Truly today in Nigeria, in many homes, particularly, among the majority poor Nigerians, hardly will one see those who are having 1-1-1 which represents three square meals per day. Food is a serious matter. It is said that the way to a man's heart is through his stomach. Hunger and starvation had precipitated revolution in many countries.

The recent high cost of food is a sign of food insecurity in Nigeria. Workers are not being paid as and when due, both in the public and private sectors. High inflation, (now at 18.72 per cent) [4], downsizing and rightsizing of workforce are now rife, so also is non-absorption of teeming unemployed youths in any meaningful and gainful employment. Upon all, food prices have hit the rooftop. Expectedly, there is an exponential increase in crime rates. These are all threats to national security.

More directly, our agricultural sector, which is primarily responsible for putting food on our table, has been in the doldrums since the discovery of black gold which is crude oil in Oloibiri in the present day Bayelsa State in 1956. All the initiatives such as Operation Feed the Nation (OFN) by the Olusegun Obasanjo military regime; the Green Revolution initiative (GR) of President Shehu Shagari, and similar ones by successive administrations have been more of lip service. As things stand, our choices are very limited as the crude oil which has been our mainstay since the 60s is no longer a money spinner as it used to be. This is because of the low price the commodity now commands in the international market. Despite that, the sabotage on oil and gas pipelines by vandals and militants in the Niger Delta has ensured that our 2.2mbpd OPEC quota upon which the 2016 national budget is based can no longer be met. This has gone a long way to threaten the full implementation of the 2016 Appropriation Act [3].

The fiendish activities of the pipeline vandals apart from being an economic sabotage are also a menace to food security. This is because of the environmental degradation such acts engendered. The eco-system is destroyed as the water gets polluted by the toxic crude oil spill. Concomitantly, the fishes, crabs, prawns and other aquatic lives get destroyed. Even the farmlands affected by oil spills become degraded and sterile for any agricultural cultivation. That is why I have been appealing to militant groups such as the Niger Delta Avengers to stop cutting their nose in order to spite their faces. While it is true that by blowing up oil and gas pipelines, government will lose revenue, however, they are further impoverishing their kith and kins who are engaged in agric- business as they will also suffer collateral damage of losing their means of livelihood. They should imagine how long it took the Federal Government to kick-start the clean-up of the devastated Ogoniland [3], [17].

Another potent threat to food security is the desertification being experienced in Northern Nigeria. Hundreds of kilometres of landmass have been lost to desert encroachment, largely as a result of draught and other human factor such as indiscriminate felling of trees. This phenomenon largely precipitated the exodus of cattle herders from the core north to the Middle Belt and Southern Nigeria where they could get grass and water for their cattle. That migration has been a major source of conflict between farmers and cattle herders. There have been accusations and counter-accusations that cattle herders have been shepherding their cattle to graze on farmlands, a move the farmers have stoutly resisted. Disagreement over this issue has led to hundreds of deaths and destruction of property worth Billions of Naira in places like Benue and Enugu states. The point being made here is that the face-off between these two groups of people constitutes a big threat to food security in Nigeria. Both farmers and cattle herders are food producers and a fight between the two groups does not augur well for the country [11].

Flooding is another threat to food security. In 2012, Nigeria witnessed flooding despite the early warning by the Nigerian Meteorological Agency. Available records show that 2012 flooding directly affected 30 states, killed 363 citizens, injured 5,851 and displaced 3,871,053 persons. The total value of destroyed physical and durable assets caused by the floods in

the most affected states was estimated to have reached N1.48tn. This year, NIMET had through its Seasonal Rainfall Prediction said about 16 states faced the danger of flooding in 2016. This still happened through our accustomed negligence and nonchalant attitude, this still pose threat to food security as many farmlands were washed off and farmers who are displaced will not be able to nurture their plants [12].

The activities of terrorist Boko Haram in the North-East have since 2009 posed a major threat to food production and security in Nigeria. As the group embarked on their destructive missions, many farmers have been killed and those who manage to escape have had to abandon their farmlands to live as Internally Displaced Persons in camps and host communities [17].

At this point, the gory picture painted about the food security situation in Nigeria however, is not a hopeless case. The Nigeria Minister of Agriculture (Chief Audu Ogbeh), at different fora and he sounds very convincing about how to deal with the daunting challenges being a practising farmer himself. Just on July 20, 2016, the Federal Executive Council met and approved the Agriculture Promotion Policy (2016-2019). According to Ogbeh, the policy outlined all that needed to be done to achieve self-sufficiency in agriculture. He said: "The document is entitled, 'The Green Alternative' and it outlines virtually everything we need to do, every policy we need to undertake to achieve self-sufficiency in agriculture and also to become a major exporter of agricultural products." [3]

It is imperative to know that all Nigerians are stakeholders in tackling the issue of food security. We can be smallholder farmers planting vegetables and fruits in our backyards. We can engage in small scale animal husbandry and poultry in our homes. We can also provide an enabling environment so that those who want to engage in agriculture can practise without fear of molestation. Food security is the best security because, as the saying goes, an hungry man is an angry man.

### 3. AGRICULTURAL DATA COLLECTION IN NIGERIA

Various agencies are one way or the other involved in the collection of agricultural data in the country. Some of such agencies include the Projects Coordinating Units (PCUs) of Agricultural Development Programmes (ADP), Federal Office of Statistics (FOS), Nigeria Institute of Social and Economic Research (NISER), and the Central Bank of Nigeria (CBN). Presently, agricultural data collection and processing in Nigeria is done largely by manual techniques. For instance, in collecting crop data, the ADP adopts various manual systems such as the Cropped Area and Yield Survey (CAYS), objective measurement techniques, Rapid Rural Appraisal (RRA), Participatory Rural Appraisal (PRA) visits, guesstimates and farmers' memory recall methods. In the so-called objective measurement technique, field enumerators usually embark on manual measurements of certain measurable parameters using survey equipment like prismatic compass, measuring tapes, ranging poles, pegs, measured ropes and weighing scales [7].

Some of the agricultural data collection problems in the country occasioned by the largely manual methods adopted have been identified by Ingawa [7], especially with respect to ADP collected food production data. The analogue system used coupled with the reliance on proxy estimations and farmers memory recall, greatly affects the quality of data collected. Certain shortcomings inherent in the data collectors often reflect on the data quality in form of under- or over-estimations. Generally, the quality of the data generated is often weak in terms of integrity, precision, accuracy, completeness, reliability and timelessness. By and large, making and implementing decisions based on Geographic Information Systems (GIS) can save agricultural field enumerators from burdensome task of manual measurements that often produce low quality data. Moreover, GIS can be used to obtain timely, accurate, comprehensive, and useful geo-referenced agricultural data for sound decision making and effective project planning and implementation [8].

### 4. ROLE OF GEOSPATIAL TECHNOLOGY IN FOOD SECURITY

In maximizing agricultural productivity, there is need for the application of modern technologies in agricultural processes. Information technology is becoming increasingly all-pervasive and farming is no different. Modern, innovative technologies offer great potential to help farmers reduce costs and increase yields. Geospatial is one such technology.

**4.1 Geospatial technology:** This refers to equipment used in visualization, measurement, and analysis of earth's features, typically involving such systems as Global Positioning Systems (GPS), Geographical Information Systems (GIS), and Remote Sensing (RS) [9].

Geospatial technology (also known as Geomatic) is the discipline of gathering, storing, processing, and delivering geographic information, or spatially referenced information. It includes the tools and techniques used in land surveying, remote sensing, cartography, geographic information system (GIS), global navigation satellite system (GLONASS), Galileo, and compass.

One reason why this technology has a significant role to play is because of the spatial nature of agriculture itself. Agriculture and natural resources are essentially understood by a geographic location. Historically, farming has a straightforward concern of understating agronomic possibilities for a field, determining demand for a local area, allocating input resources to maximize outputs and delivering the fruits of that labour to market. While fundamentally this hasn't changed, what has changed is that arable land is decreasing, consumer demands and expectations are growing, costs of farming are skyrocketing and risk and volatility dictate the tempo of business. Spatial technology is a very important lever in responding to these market forces, GIS, GPS and remote sensing are all finding a place. [5]

Geospatial technology (GT) has drastically transformed the way we acquire, manage, communicate and use geographic information. GT are eminently suited for the systematic collection, integration, storage, analysis and communication of large volumes of geo-referenced data from various sources, for decision making and problem solving [8]. Geographic information can be described as any information linked to a specific location under, on or above the surface of the earth using a standard cartographic referencing system such as graticules (latitudes and longitudes, or UTM coordinates system), street addresses, postcodes, and so on. Basically, geo-information technologies include Remote Sensing (RS), Global Positioning System (GPS), Automated Mapping (also known variously as Automated Cartography, Digital Mapping or Digital Cartography) and Geographic Information System (GIS). Earth observation remote sensing spacecraft and aircraft systems are used to observe and acquire imagery containing environmental information about various portions of the earth's surface. The data obtained by imaging remote sensing systems could have a number of agricultural applications. For instance, images of different parts of Nigeria from the NigeriaSat-2 have the following potential agricultural applications: [6]

- For mapping land use planning and management,
- Crop inventory and yield forecast;
- Vegetation inventory, planning and management including sustainable forest logging and grazing and planning afforestation programmes,
- Mapping, investigating and monitoring pest infestation including desert locust and quella birds risks;
- Mapping, investigating or monitoring distressed crop areas and;
- Crop performance monitoring.

## 5. APPLICATION AND BENEFITS OF GEOSPATIAL TECHNOLOGY

Geospatial information lends itself to many opportunities that can result in better decisions, higher productivity and enhanced efficiencies in agriculture. Here is a look at how various geospatial technologies can be applied to agricultural processes.

**5.1 Geographic Information System (GIS):** This can store layers of information, such as yields, soil survey maps, crop scouting reports and soil nutrient levels. GIS can display geographically referenced data, adding a visual perspective for interpretation. In addition to data storage and display, GIS can be used to evaluate present and alternative management by combining and manipulating data layers to produce an analysis of management scenarios [13][14].

GIS has a wide range of possible applications at the national and local level. Geographical data can assist agricultural planners in deciding on factors like the best zones for a cash crop, combining data on soils, topography, and rain-fall to determine the size and location of biologically suit-able areas. It can also provide information on related aspects like land ownership, transport, infrastructure, labour availability, and distance to market centres.

GIS in agriculture is about allocative efficiency, profitability, and record keeping. Spatial thinking enables producers to minimize inputs and maximize out-puts. GIS provides mechanisms to better understand environmental, policy, and

market forces from local to global scales. In an increasingly regulatory environment, GIS offers a means to develop real time records of applications of fertilizers, herbicides, etc. and quantify bio-mass, increasing profitability.

Matthew [5] opines that productivity, by definition, is primarily concerned with outputs. In that context, the GIS helps enhance agricultural productivity on the farm by analyzing field and crop conditions, monitoring environmental patterns such as weather, and developing input recommendations for the right place, at the right time, in the most efficient manner. Desktop, mobile, server and online components of GIS systems are now completely integrated for agriculture, this means that the same platform can be used by producers and crop consultants for field based management and analysis; agribusiness for customer and market development; and governments and associations for regional to global analysis and monitoring.

Another aspect of agricultural planning benefiting from GIS is agrometeorology, or agricultural meteorology. Agricultural weather and climate data systems are needed to expedite generation of products, analyses and forecasts that affect agri-cultural cropping and management decisions, irrigation scheduling, commodity trading and markets, fire weather management and other preparedness for calamities, and ecosystem conservation and management.

**5.2 Remote Sensing:** Accurate and timely information on agriculture is essential for practicing sustainable agriculture. This information can be categorized into three groups: information on current situation of state variables (e.g. current cropping pattern, crop condition, soil degradation, present land use etc.) information on changes that have occurred in agriculture and their rate (i.e. monitoring the changes that have occurred in the state variables) and information on the long-term (future) effects of the changes that have occurred in the state variables and the agricultural practices. Remote sensing is an effective source of such information [15].

Remote sensing data can be used for facilitating sustainable agriculture in three different ways:

- i. **Mapping/monitoring:** These include mapping of the current extent of crops, soil degradation, irrigated area, etc. and monitoring changes over a period of time therein.
- ii. **Parameter retrieval:** Since remote sensing data provide quantitative values of spectral reflectance or emittance from the target (e.g. crop or soil), these can be used to retrieve various biophysical parameters of plants. These parameters include various Vegetation Indices (VI's), Leaf Area Index (LAI), fraction Absorbed PAR (fAPAR), Evapotranspiration (ET), Crop Water Stress Index (CWSI), etc. These parameters are used in crop growth models to predict crop yield, crop soil condition, soil water balancing etc.
- iii. **Management/decision support:** Using the information received from the above two activities and with the help of decision support models (such as cropping systems simulation model, land utilization model, irrigation scheduling model), remote sensing helps the user to arrive at the right decisions for sustainable management of agriculture. In this activity, apart from remote sensing data, other collateral information such as soil, weather, irrigation network, socio-economic data, etc. are also used to arrive at decisions. GIS helps integrate all this information.

Elaborating on the application of these two technologies, the role of remote sensing and GIS in agricultural applications can be broadly categorized into two groups - inventorying/ mapping and management. While remote sensing data alone is mostly used for inventorying purposes (crop acreage estimation, crop condition assessment, crop yield forecasting, soil mapping, etc), management (irrigation management, cropping system analysis, etc.) needs other spatial physical / environmental information to be integrated with RS data, where the functionality of GIS are used [15].

Some satellite imagery providers have a wide range of offerings for agriculture. For example, Digital Globe's Red Edge band and Yellow bands on WorldView-2 satellite were primarily designed for vegetation applications. With the 0.5 meter resolution of satellites and associated high positional accuracies, the imagery offered by the accuracy is used to digitize accurate farm/field boundaries, can also map crop types with greater accuracy and variations in crop health/vigour using the 8 bands.

One of the most significant benefits of this technology is that it touches agricultural processes, at various stages and offers potential to meet requirements of various stakeholders at different levels, thereby addressing the entire life cycle of agriculture. Agribusinesses are providing services to these producers for farm field management while going so far as to implement latest technologies in asset management solutions, vehicle routing/logistics, and custom applications for weather, imagery, and agronomic recommendations. At the regional to global scale, organizations are using spatial

technologies to monitor production supply and demand patterns, transportation and infrastructure, and economic indicators for commerce and trade. In the multifarious role of geospatial technology, governments want to know the location of agricultural areas, their size and the crop type for mapping, planning and taxation purposes; agricultural companies want to monitor and manage their crops; financial companies are interested in the health and potential yield of crops and risk managers in governments and NGOs want to better understand crop health and food security. And geospatial technology offers solutions to all these requirements [16].

## 6. CONCLUSION

Geospatial technology is an indispensable tool in agriculture for food security and management as traditional methods of farming are slow, costly and time consuming. New technologies like GIS and remote sensing should be adopted to enable the country produce more food to meet her developmental needs.

## REFERENCES

- [1] FAO, (1996): Socio-Political and Economic Environment for Food Security Food and Agriculture Organization of the United Nations, World Food Summit Vol. 1 Sect 1.4
- [2] Olabode Lucas: Problems of food Security in Nigeria. A Communiqué Issued by Nigerian Institute of Advance Legal Studies, Lagos, August 2011.
- [3] Treats to Food Security in Nigeria; Punch, Monday October, 2016; [www.punchng.com/treats-food-security-nigeria/](http://www.punchng.com/treats-food-security-nigeria/)
- [4] Nigeria Inflation rate: Trading Economics [www.tradingeconomics.com/nigeria/inflation-cpi](http://www.tradingeconomics.com/nigeria/inflation-cpi) Accessed 15 February, 2017.
- [5] Mathew Bechdol: Agriculture Gets a Makeover; Geospatial Industry Magazine, August, 2011 Vol. 2. [www.geospatialworld.net](http://www.geospatialworld.net)
- [6] Nigeria sat-2-eoportal <https://directory.eoportal.org/web/eoportal/satellite-missions/n/nigeriasat-2>
- [7] Ingawa, S.A. (2004): The Role of Data in Food Security in Nigeria. Paper presented at the 1<sup>st</sup> Seminar on Satellite, Remote Sensing and Geographic Information Systems in Sustainable National Development, held at Merida Hotel Abuja.
- [8] Uluocha, N.O. (2004): Geoinformation: Manure for Sustainable Agricultural Development and Management, in Ekpenyong, R.E. and Uluocha, N (ed.) Cartography, GIS and Agricultural Development. Special Publication of The Nigerian Cartographic Association, pp119-134.
- [9] Geospatial Technology as a Core Tool; [www.usnews.com](http://www.usnews.com)
- [10] Daneji, M.I. - Agricultural Development Intervention Programmes in Nigeria (1960-2011). A Review; Savannah Journal of Agriculture Volume 6(1), June 2011
- [11] Compass Newspaper: Effect of Desertification and Desert Encroachment to Agricultural Development in Nigeria. [www.compassnewspaper.com.ng/2014/10/effect-desertification](http://www.compassnewspaper.com.ng/2014/10/effect-desertification) Accessed 25 February, 2017.
- [12] Flood List 2016. [www.floodlist.com/tag/ng](http://www.floodlist.com/tag/ng) Accessed 15 February, 2017
- [13] Kenneth E. Foote and Margaret Lynch: The Geographer's Craft Project, Department of Geography. The University of Colorado at Boulder. "Geographic Information Systems as an Integrating Technology: Context, Concepts, and Definitions" Accessed 25 February, 2017.
- [14] Clarke, K. C., 1986: Advances in Geographic Information systems, Computers, Environment and Urban Systems, Vol. 10, pp. 175–184.
- [15] Shibendu S. Ray: Agriculture Gets a Makeover; Geospatial Industry Magazine, August, 2011 Vol. 2. [www.geospatialworld.net](http://www.geospatialworld.net)
- [16] Aaron: Agriculture Gets a Makeover; Geospatial Industry Magazine, August, 2011 Vol. 2. [www.geospatialworld.net](http://www.geospatialworld.net)
- [17] Vanguard News Paper: President Buhari's 2016 Independence Anniversary speech. <http://www.vanguardngr.com/2016/10/nigeriaat56-read-president-buharis-independence-anniversary-speech/>