



STRATEGY FOR AGRICULTURAL INTENSIFICATION IN NIGERIA: EMPHASIS ON AGRICULTURAL AVIATION

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ABSTRACT:

This paper reveals strategy for agricultural intensification with emphasis on agricultural aviation. As the population densities of Nigeria have been high for a long period, land degradation, involution, and perhaps even stagnation have set in. It was backed up by the theories of Thomas Malthus, and Bose upon agricultural intensification and population growth. Nigeria is the most populous country in Africa with 188.7 million people (2017 estimate) which is known to have good soil that enhances agriculture. Furthermore, agricultural practice in Brazil was examined because they have similar characteristics with Nigeria in the area of soil fertility, and they are technologically developed most especially in agriculture with the practice of agricultural aviation. Nigeria still struggles with low agricultural productivity with old technological involvement. The beauty of this study is the suitability of sound policies that emanates towards achieving agricultural intensification. This is a major means to banish hunger and reduce poverty.

KEYWORDS:

AGRICULTURAL INTENSIFICATION; AGRICULTURAL AVIATION; BRAZIL; NIGERIA

1 INTRODUCTION

Before the advent of oil boom in the 1970s, Nigeria was strongly an agrarian nation, also the form of agriculture practiced and the crops planted were determined by the nature of soil and the terrain of the region (Adeniran and Akanbi, 2019). Shifting cultivation and crop rotation characterized agricultural practices in that era resulting primarily to land tenure practice and lack of knowledge of highly mechanized farming (Ehimore, 2009). Usually, farmers depend on farm implements such as digging stick, hoe, cutlass and sickles which reduces the level of agricultural output. The common crops produced based on territorial specialization included, yam, okra, vegetables, maize, cocoyam, cassava, plantains, bananas, kolanuts, cocoa, oil palm and forestry products (Fasinmirin and Braga, 2009).

There is need to be conscious of the fact that the population growth in Nigeria is increasing, the participation of able-bodied in agriculture is decreasing, and the increased development for agriculture and industry continue to be reasons for massive agricultural turnover. Population pressure, uncontrolled land ownership, housing and estates construction has led to fragmentation of many farms into small sizes which make it difficult for aggressive planting of crops in the agricultural enabled states. Some owners of small size farms vacated their farms because of high rate of insecurity in the country.

Recently, agriculture in Brazil was a result of state

intervention and protection policies as well as private sector participation (Ogen, 2007). Agriculture continued to play a significant role in the Brazilian economy through fiscal incentives, special credit facilities, and most especially the introduction of agricultural aviation which strongly promoted greater efficiency and huge productivity. Agricultural aviation is an aspect of general aviation (Adeniran and Akanbi, 2019).

General aviation is the largest segment of aviation based on number of aircraft, number of pilots, and number of airports and communities served. It is a \$40 billion industry that generates over \$100 billion annually in economic activity. There is need for the Nigerian government to look into this area because of its significant effect in alleviating the suffering of many Nigerians in the area of hunger, poverty, and unemployment. This study is an improvement on the earlier research carried out by Adeniran and Akanbi (2019). It is believed that more plausible recommendations will be coined out.

2. CONCEPTUAL CLARIFICATION

2.1 Agricultural Intensification and Population Growth

According to Tiffen, Mortimore, and Gichuki (1994), agricultural intensification is the increase in average inputs of labour or capital on a smallholding of cultivated and grazing land, for the purpose of increasing the value of output per hectare. Some authors define agricultural intensification based on the outputs rather than the inputs.

For example, Brookfield describes it in relation to constant land, the substitution of labour, capital or technology for land, in any combination, so as to obtain higher long-term production from the same area (Brookfield, 1993). In spite of whether agricultural intensification is defined based on agricultural input increases or an increase in agricultural outputs there must be a demand for output before intensification will occur. An increase in the demand for agriculture may come from an increase in population, market demand for high value crops, or even an increase in migration to an area (Carswell, 1997).

Many theories examine agricultural intensification and its causes in the last decades; they provide insights and different perspectives on the issue. The following starts with broader theoretical ideas concerning agricultural intensification based on the population-environment debate (Turner, Hyden and Kates, 1993). The theories of Thomas Malthus, and Boserup regarding agricultural change and population growth were examined in this study.

2.1.1 Relevance of Thomas Malthus Theory

One of the first theories of the effects of population growth on agriculture change is that of Thomas Malthus (1798; 1960). In the model, birth and death rates vary according to changes in the standard of living, and the return to labour ultimately decreases because the amount of land available for agriculture is fixed. Malthus (1960) further states that as the population grows the rate of food production does not grow proportionally, thus real wages decrease, and subsequently the birth rate declines and the death rate increases. Hence, food production establishes the limits to population growth.

Malthus also proposed that the impact of population growth would be detrimental to the environment by outstripping all natural resources. This would result in severe environmental deterioration and famine, as well as the involution of agricultural intensification and irreversible land degradation. This was supported in the works of Martin (1987), and Lele and Stone (1989), and they have found that where population densities have been high for a long period, land degradation, involution, and perhaps even stagnation have set in. This is quite true with the case of Nigeria. However, in some countries like Rwanda, Lewis, Clay and Dejaegher (1988) found that farmers were managing their resources wisely and have been able to maintain yields over time. In Kenya, Tiffen and Mortimore's (1994) found that population growth combined with market development and access to capital resulted in new technologies, which brought about increased agricultural productivity and improved land and water conservation. From the foregoing, the economic recession that Nigeria recently experienced was an eye-opener to the fact that agriculture seems to have been abandoned, and that there is a limited investment in agriculture. This is resulting to farmer's consciousness in managing their resources wisely so as to maintain yields over time and be able to meet the demand of increased

population and export.

2.1.2 Relevance of Boserup's Theory

Boserup's is another well-known theory concerning agricultural change and population growth (1965) which predicts that agriculture will intensify as a response to increased population pressure. In view of this, the pressure on resources resulting from population growth can stimulate change and agricultural innovation. Boserup hypothesized that an increase in population density (or land scarcity) is an independent variable that can initiate agricultural intensification. This is because increased labour is used for agriculture, and the intensification of agriculture usually occurs after the expansion of agriculture.

The process of agricultural intensification starts with a reduction of the fallow period, followed by the adoption of new technologies, increased use of labour, and eventually by the addition of organic and/or inorganic inputs. Farmers do not intensify agriculture until the demand for food production forces them to since intensification requires increased work (Boserup 1965). However, the theory ignored other factors such as markets. Pingali, Bigot and Binswanger (1987) state that changes in the landscape are a response to local demands, which includes market demands. Also, Turner and Brush (1987) suggest that agricultural change and intensification are influenced by consumption and commodity demands. Changes in agriculture are a result of constraints and demands placed on farmers by local and national economic conditions (Turner and Brush 1987). The beauty of Boserup's theory is that farmers' participation in markets can be an advantage for farmers as they may intensify production for purely monetary reasons such as for producing surplus yields, which they can sell for cash (Goldman 1993).

In order to enhance high surplus yields, there is need to cultivating more acres of land. In a situation where land is scarce or expensive, farmers will attempt to increase the yield per acre, often by increasing the amount of labour used or by adding available organic or inorganic fertilizers. On the other hand, in a situation of abundant land and scarce labour, mechanical and biological technology such as tractors and herbicides may be used. Intensification in agriculture does not always come under the conditions of population pressure or market forces. A major obstacle to intensification is the environment. Lele and Stone (1989) are of the view that soil conditions and rainfall are constraints to agricultural improvement in Africa. Although the environment, including soil conditions, may not limit intensification, it influences how intensification is pursued (Goldman 1993). In Nigeria, farmers have been able to overcome most of environmental conditions by maintaining crop diversity, using crop residues, and other resourceful farming techniques that maximize crop output. Another technique that can be introduced to enhance maximum output is agricultural aviation.

2.2 General Aviation

According to Adeniran and Akanbi (2019), there is no legal definition of general aviation. It is defined with respect to the application of aviation, for instance in agriculture, photography, security and monitoring, traffic monitoring, and others. General aviation is the aerial application plane that treats one out of every five tillable acres of land, which facilitates greater food production and keeps the cost of food low. It is the land developer making survey flights and the police officer observing traffic. It is the family on a vacation trip and the air ambulance flying a mercy mission. It is the relaxation flight. It is the air taxi bringing passengers to the airline or picking them up at the terminal to whisk them to a distant off-airline point. It is the spare part flown in to keep an assembly line running. It is the pilot ferrying people, mail, and supplies from towns to wilderness areas.

According to Quantick (1985), agricultural aviation is a branch of commercial aviation, which performs the essential task in production, and protection of the world's food and fiber crops. Aerial application is also used in areas such as insect control, fighting forest fires, and protection of biological resources. For this study, the definition of general aviation as the aerial application plane that treats one out of every five tillable acres of land, which facilitates greater food production and keeps the cost of food low, will be adopted. It is important to note that in the industrialized countries, 80% of spraying is performed from air, and there are approximately 30,000 agricultural aircrafts in the world.

2.3 Aircraft Usage on Aerial Application

Any use of an aircraft for work purposes related to the production of foods and fibers or to health control measures, in which the aircraft is replacing farm implements or ground vehicles for the particular task accomplished is referred to as aerial application of aircraft. This includes fire-fighting operations and the distribution of chemicals or seeds in agriculture, reforestation, and insect control. Approximately 4,000 aircraft are used for aerial application in the Japan, China, and Russia. The majority are single-engine piston aircraft.

2.3 Agricultural Aircraft

Agricultural aircraft is an aircraft that has been built or converted for agricultural use usually aerial application of pesticides, fertilizer, and planting of specialized crops (hydro-seeding). Before mid-1920s, a number of individuals began to experiment with uses of flight technology that would later become important parts of general aviation. For example, the first uses of airplanes for crop treatment, aerial surveying, and corporate flying all dated before the mid-1920s. Alfred Zimmermann, a German forester in Detershagen, was the first to identify the 'Agricultural aviation' as a means of combating crop pests (Quantick, 1985).

2.4 Historical Overview of Agricultural Aircraft

Alfred Zimmermann described the use of aircraft in the application of pesticide (in this case lime-water) in the

control of the nun moth (black arc moth) in the European forests in his patent letter, dated 29 March 1911. Although his approach was visionary, suitable aircraft and trained pilots who were able to perform this task were only available after the World War I. In many countries, experiments were conducted in the 1920s, and practical results were recorded by Neillie and Houser (August 1921) in the U.S.A., and Professor V. F. Boldyrev (July 1922) in the U.S.S.R (Quantick, 1985).

In the 1940s, more effective insecticides and fungicides were developed, and aerial application of fertilizers was developed by government research in New Zealand and Australia. There have been some significant changes in Agricultural Aviation Industry in the last 20 years. Aircrafts are getting bigger, while turbine power is becoming available for fixed wing aircraft. Ag-1 was the first specially designed aircraft to distribute agricultural chemicals developed in 1949-50 at the Texas A.&M. Aircraft Research Centre. The project was initiated by the National Flying Farmers Association, and was carried out under the sponsorship of the Civil Aeronautics Administration, the U.S. Department of Agriculture and the Texas A.&M. College System. Ag-2 and Ag-3 are other experimental aircrafts followed Ag-1. These aircrafts incorporated pilot safety characteristics with regard to field of view and structural arrangements for protection of the pilot in crashes (Quantick, 1985).

In 1960s, the DH82 Tiger Moths were replaced by such aircraft as CA28 Ceres and Transavia PL12 Airtruck, Cessna 188, Piper PA 25 Pawnee, DHC-2 Beaver, G-164 Ag Cat, and the Snow Commander S-2D, to name the most numerous (Aerial Agricultural Association of Australia, 2005). By the mid 1970s, the Cessna 188 Ag Wagon (230hp), Ag Truck (300hp) or Ag Husky (310hp), became the leading models followed by the Piper PA 25 Pawnee (235hp) and PA 36 Pawnee Brave (285 & 300hp). The DHC-2 Beaver (450hp) and PAC Fletcher FU 24 dominated the fertiliser spreading business (Aerial Agricultural Association of Australia, 2005; Antuniassi, 2015). The hopper size varied from 750L on the Ag Wagon to 1000L on the Ag Husky and from 550L on the PA-25 to 850L on the PA36. In the design of these aircrafts greater attention is paid to pilot safety. The FU24 has a dry solids capacity of just over 1000 kg (Aerial Agricultural Association of Australia, 2005; Antuniassi, 2015).

The US manufactured Air Tractor and Ayres Thrush models were introduced next. The Air Tractor AT301/2, 401/2, 501/s and 802 model numbering system followed the hopper size in US gallons. The first turbine-engined model was the 400, powered by a Pratt and Whitney Canada PT6A-15 Ag engine with a reversible pitch propeller. A P&WC PT 6A-35 Ag turboprop engine of 750hp powers the AT-502 introduced in the late 1980s. The Ayres Thrush models are descended from the Rockwell Thrush Commander and consist of the Thrush S2R-600 (1340) powered by a P & WR-1340 radial engine; the Bull Thrush S2R-1820 and the Turbo Thrush S2R with options of a P&WC PT 6A-15, -34 and -65 turboprop

engines or Garrett TPE 331-10 . There are also several models of helicopters, used for spraying, spreading and stock mustering including the Bell 47 and 206, Hiller 12 E, Hughes 269 and Robinson R-22 (Aerial Agricultural Association of Australia, 2005; Antuniassi, 2015).

The techniques of aerial applications are becoming refined (Antuniassi, 2015). In Japan, due to the departure of younger generation from the farming communities, around 10 years ago, Yamaha company started to develop the unmanned helicopters to compensate for the shortage of land workers. These helicopters are intended to be more flexible and precise during spraying. Today, Yamaha helicopters have extended its applications area to include the insect pest control of rice paddies, soybeans, and wheat. Yamaha unmanned industrial helicopters is anticipated as a solution for various problems facing the farming communities in Japan and as a contributor to raising the level of food self-sufficiency (Wong, 2001)

3. AGRICULTURAL AVIATION IN BRAZIL

In Brazil agriculture generates about one-third of its export earnings as it is the world's largest exporter of soybeans and the largest producer of sugarcane, coffee, cotton, maize, various beans, rice, and manioc, or cassava. According to Antuniassi (2015), Brazil has experienced an enormous investment and expansion in agriculture over the last 5 years with the opening up of large farms in various regions of the country. As an example, according to Deral (2013), the total production of soybeans in Brazil increased by 27.5% from 2009 to 2013, while the average growth in total production for this crop worldwide was only 8.9%. Just from 2012–2013, soybean crops increased by 5.1%, compared with a global increase of 2.7%. This process has led to a demand for timely delivery of crop protection products against key pests and diseases, for which there has been a remarkable tendency of farmers to choose aerial application as a tool to treat their crops.

In order to meet the demand in agriculture, the Brazilian agricultural aviation industry has grown steadily. There are 231 companies offering aerial application according to data published by the "Agronautas" web page. This number increased by 2.7% in the first half of 2014, when six new companies were launched into the market. On average, this sector has been growing by 6% per year. At the end of 2013, 1925 aircraft were registered, of which 61.7% were Brazilian-made aircraft manufactured by Embraer, the main model being the Ipanema EMB-202A. The other 738 aircraft manufactured mainly by Air Tractor (USA). Over the last five years on average, 95 new aircraft have been added each year (Antuniassi, 2015).

Furthermore, most aerial sprays are applied at volume rates from 10 to 30 L/ha, applying very fine to medium quality sprays. Also, rotating sprayers are very popular in Brazil as they enable the spray volume to be lowered to less than 20 L/ha, while applications with volume rates above 20 L/ha are done mainly with hollow cone nozzles. In 2014, around 50% of the 100 aircraft were sold

to private owners. Farmers are now heavily investing in aerial application as a means to treat their crops. This is a change from supply companies that provide a contract service to farmers, although rural entrepreneurs have also realized that aerial application is an indispensable tool. More than 30% of the Brazilian agricultural aircraft are registered by private operators, showing that, indeed, agribusiness entrepreneurs are purchasing their own aircraft (Antuniassi, 2015).

According to the National Union of Agricultural Aviation, the Brazilian agricultural aviation accounts for 23.8% of the total area of crops on which pesticides are applied, corresponding to more than 70 million hectares treated per year in the country. This average considers all the main crops using aerial applications. The highest share percentage is in cotton, with 35.7% of the applications made by air. Another important share is for rice, where one third of the applications (33.3%) are made by aircraft. On soybean 41 million hectares are treated per year by air, representing 56.8% of the area applied annually by Brazilian agricultural aviation. Most of the aerial applications on crops like soybean, cotton and corn are primarily with insecticides and fungicides. For the sugarcane market, growth regulators also have an important market share of the aerial applications. The size of fields that favour aerial application is variable across the country. In the South of Brazil, mainly on the State of Rio Grande do Sul, rice fields sprayed by aircraft are usually small (up to 50 ha), while on the central and northern regions of the country fields might be very large, frequently of more than 500 ha each (Antuniassi, 2015).

4. CONCLUSION AND RECOMMENDATIONS

In conclusion, it is important to note that population densities of Nigeria have been high for a long period, land degradation, involution, and perhaps even stagnation have set in. The theories of Thomas Malthus, and Boserup on agricultural intensification and population growth cannot be overemphasized. It is evident that the increasing demand for agricultural produce requires modernization of farming, hence the need for agricultural aviation as an operation tool. Agricultural aviation is a good approach for agricultural intensification which enhances food surplus, and poverty and hunger eradication. It is crucial to note more than 70 million hectares of land were tilled by the application of agricultural aviation which enhances the planning of cotton, rice, corn, soybean, and sugarcane in Brazil. It also helps in the application of insecticides and fungicides on the farm. The size of fields that favour aerial application is variable across the country, hence the need to review the land use act so that large areas can be set aside for cultivation in Nigeria. There is need to implement new strategies for the chemical treatment of the crops, seeking to combine the best agricultural practices for the environment and the agriculture sustainability for operational capacity and field efficiency provided by the agricultural aviation. Other recommendations are;

1. Agricultural aviation piloting should be added to

the courses offered in Nigerian aviation institutes.

2. Agricultural aviation as a course should be added into the curriculum of Nigerian tertiary institutions offering transport related courses, and researches supported by public and private foundations.
3. Nigerian Air Force (NAF), Nigerian airlines and private agricultural companies should collaborate to ensure the achievement of agricultural aviation.
4. Nigerian airports that are underutilized should be equipped and be used for training technicians and engineers on how to service and design aircrafts that will be used for agricultural aviation.

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