ENSURING FOOD SECURITY THROUGH PRODUCTIVE AND SUSTAINABLE USE OF LAND AND WATER IN NIGERIA

ASSURER LA SECURITE ALIMENTAIRE PAR L'UTILISATION PRODUCTIVE ET DURABLE DE L'EAU ET DE LA TERRE AU NIGERIA

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ABSTRACT

Human population is increasing faster than the available food and freshwater resources in many regions of the world. The world population is expected to grow to some 8 billion in 2025 and 9 billion in 2050. In many regions, especially in Sub-Saharan Africa, water management systems have only been developed to a limited extent, or function significantly below their potential. There is an urgent need to scale up the agricultural production in order to meet the food needs, especially in least developed countries and poverty stricken regions such as Sub-Saharan Africa (Molden et al., 2007). Soy bean is nutritious, which is a major reason for its cultivation by the small scale farmers in Nigeria. In this respect, a study was carried out at the Teaching and Reseach farms of Obafemi Awolowo University, Ile-Ife, Nigeria. At this place, the monthly maximum temperature ranges from 28.3°C to 31.5°C while the monthly minimum temperature ranges from 22°C to 28.8°C. The Soil organic matter ranges from 2.46 % at the soil surface to 0.6% at 50 cm depth. Phosphorus content ranges from 10.27 ppm at the soil surface to 9.54 ppm at 50cm depth. The average pH is 5.8. Based on the soil analysis and weather condition at the site, the cultivation of Soy beans should be encouraged in order to ensure food sustainability in Nigeria.

Key words: *Soybean, Water management, Food security, Sub-Saharan Africa, Water shortage.*

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RESUME

La population humaine augmente plus rapidement que l'alimentation et les ressources disponibles en eau douce dans de nombreuses régions du monde. La population mondiale devrait atteindre quelque 8 milliards en 2025 et 9 milliards en 2050. Dans de nombreuses régions, en particulier en Afrique sous-saharienne, les systèmes de gestion d'eau ont été développés seulement à un potentiel limité; ils fonctionnent à un niveau inférieur de son potentiel. Il est nécessaire d'augmenter la production agricole pour satisfaire les besoins alimentaires, en particulier dans les pays les moins développés et les régions affrontées par la pauvreté tels que l'Afrique sous-saharienne (Molden et al., 2007). Le soja est un grain nutritif, ce qui est l'une des raisons principales de sa cultivation à petite échelle par les fermiers au Nigeria. À cet égard, une étude a été faite dans les fermes d'Enseignement et de Recherche de l'Université Obafemi Awolowo, Ile-Ife, Nigéria. La température mensuelle maximale variait de 28,3 ^{0}C à 31,5 ^{0}C alors que la température mensuelle minimale variait de 22 ^{0}C à 28.8 ^{0}C. La matière organique du sol au niveau de la surface variait de 2,46% à 0,6% à la profondeur de 50 cm. La Teneur en phosphore au niveau de la surface variait de 10,27 à 9,54 ppm à même profondeur. Le pH moyen était de 5,8. Compte tenu de l'analyse du sol et des conditions météorologique, il faut encourager la cultivation du soja pour assurer la durabilité alimentaire au Nigeria.

Mots clés: *Soja, gestion d'eau, sécurité alimentaire, Afrique soussaharienne, pénurie d'eau.*

1. INTRODUCTION

Water ensures continuity of an ecosystem and biodiversity. Historically, land and water have notable contributions to social economic development of all regions of the world. Irrigated agriculture along River Nile in Egypt (Ray et al., 1988) and hydroelectric power generation at Kainji Dam in Nigeria are examples (Marks, 2003). In the West African Sub-region, the Senegal and Niger rivers play prominent roles in supporting agricultural activities. In Europe for instance, Rhine valley, which is recognized as a locus of both co-operation and conflict was a primary center of economic growth (Sadoff and Wittington, 2002). The provision of clean portable water in Nigeria has gone a long way in reducing water-borne diseases and in improving the general sanitation of towns and cities. However, despite the relative abundance of water, the complaints everywhere are the same, "shortage of supply in quantity and quality". In many of the African countries and in other places, the demand for water has been on the increase (Sharma et al., 1996), due mainly to increase in human population. The demand for water and productive land will be on the increase in the future (Neil, 1995). Due to water scarcity, poverty and stressed ecosystems, about 850 million people currently live under in food insecurity conditions (FAO, 2009). In Nigeria, only 60% of the population has access to improved drinking water out of which 49% are rural. Similarly, an expected additional 1-2 billion people will need to be fed by 2025 (UN, 2009). This places a great challenge on water resources management. Global water resources are limited and only through a more sustainable approach to water management and use, we can hope to achieve the international development targets for poverty reduction set for the year 2015 (Caroline, 2002). The world contains an estimated 1,400 million km^3 of water but only 45, 000 km^3 (0.003 %) is fresh water that is, the water that can be used for drinking, hygiene, agriculture and industry, while the remaining is saline water. About 9,000-14,000 km^3 are economically available for human

use, thereby making fresh water a very valuable and scarce resource (FAO AQUASTAT, 2010). About 75% of the earth's fresh water is contained in ice caps and glaciers while another 14% is locked up in very deep and inaccessible aquifers (CSD, 2002). From the total volume of the available fresh water resources, about 20% is used by industries, 10% by household and 70% by agriculture and agro-industries (CSD, 2002; Cai and Rosegrant, 2003). The objectives of this study are to determine the suitability of soils for the cultivation of Soybeans under both the dry and rainy seasons in order to ensure sustainable use of land and water in Nigeria.

Pressure on water resources

Demographic processes inpose a lot of pressure on water resources. In the recent times, there has been a rapid increase in human poulation and and living standards (Shultz, 2001; ICID, 2003; Liu et al., 2007). It has been estimated that the world's population is growing by about 80 million people in a year and the implication is that there will be an increasing demand of about 64 BCM (billion cubic metres) a year (UN-WWAP, 2006). In developed countries, people are richer and consequently demand more commodities. Economic water scarcity is being experienced in most parts of West, East and South African countries. Overexploitation and poor management of the existing water resources are threatening the resource base on which water depends (Adekalu, 2004; Pereira, 2005; Perry, 2007; Anderson et al., 2008; Steffen, 2008). The situation is aggravated by other problems such as poor or unsustainable land use practices, desertification and deforestation, activities caused by economic pressure especially in the least developed countries such Sudan and Ethiopia. It has been observed that climate will not only change in average conditions but also in variability and frequency and that all climatic processes are likely to intensify (IPCC, 2008).

Current challenges in water resources development and management

Appropriate actions need to be taken to improve water management and also to increase water use efficiency (Alcamo et al., 1997; Seckler et al., 1998; Shiklomanov, 2000; Rosegrant et al., 2002, 2005; Bruinsma, 2003; Falkenmark and Rockstrom, 2004; Vorosmarty et al., 2004; Rosegrant et al., 2005). In Africa, land degradation and extensive desertification are direct effects of intensive land cultivation and inappropriate land use systems (Mohammed et al., 1996). Also changes in global climate are imminent challenges to crop production and the environment. Various social and economic activities upset the natural hydrologic balance in the least developed countries where the natural resources have not been fully developed and utilized. Deforestation and lumbering activities expose land surfaces to the battering action of tropical rainfall thereby initiating soil erosion and sediment accumulation. This is one of the major causes of frequent flood disasters in Nigerian coastal cities such as Lagos and Porthacourt. Diminished water allocation to agriculture is no longer a future challenge but is a current reality. Dependency on rainfall for future crop production has become a major constraint for sustainable food production in the emerging countries including Nigeria and China (Karam et al., 2007). With an increasing human population and less water availability for food production, food security for the future generation is at stake (Zwart and Bastiaanseen, 2004). Sustainable food and fibre production which are expected to cater for the teeming population will depend largely on judicious and conjunctive use of surface and groundwater in order to attain the Millennium Development Goals (MDG) of equitable water distribution and usage for all by 2015 (Smith, 2000; Howel 2001; Molden, 2003; UNWWAP, 2006).

Following the recent downward trend in freshwater allocation to agriculture, it is clear that the sector is under heavy pressure to produce more food from less water. This will amount to increasing Crop Water Productivity (CWP) under both rainfed and irrigated agriculture. In technical terms, CWP is the ratio of economic crop yield to the amount or depth of water used in producing it (Kirda et al.,1999, Molden et al., 2003). In order to meet these new challenges, a more precise technique needs to be incorporated into the irrigation sector in order to justify the investment being made in this sector. These include new and efficient design of irrigation systems, innovations and management of existing facilities for ensuring sustainability and adaptability.

Food security in Nigeria and irrigated agriculture

Irrigated agriculture is vital in meeting the food and fibre needs of the rapidly increasing human population in Nigeria. Agriculture is the largest consumer of freshwater (Fig. 1) with an estimated 1,300 m^3/year required to produce an adequate diet (Falkenmark and Rockstrom, 2004). There is an urgent need to scale up its food production with less water for the increasing world population in order to reduce poverty and hunger (Howell, 2001; FAO, 2009). The total cultivable land area in Nigeria was estimated at 61,0000 km^2, which is about 66 % of the total area of the country. The cultivated area was 3.3 million km^2 in 2002, of which arable land covered 3.02 million km^2 and permanent crops 28,000 km^2. About two-third of the cropped area is in the far North with the rest about equally shared between the Middle belt and the South. As on 2004, the total land area equipped for irrigation was 2,931.17 km^2 but the total area actually irrigated was 2,188.40 km^2 with about 30 % of the population economically active in agricultural activities.

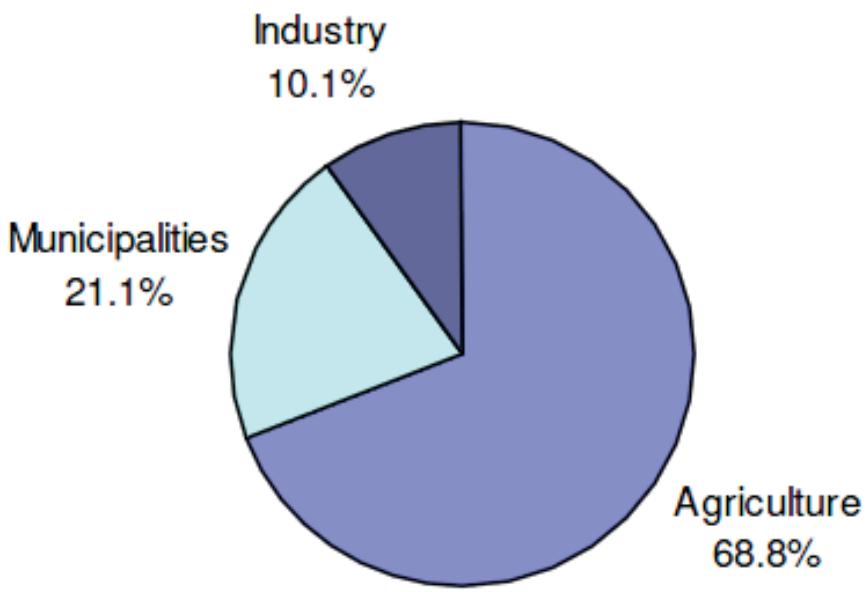

Fig. 1. Water withdrawal in Nigeria (Food and Agriculture organisation of the United Nations, (FAO, 2005)

The output in terms of annual agricultural productivity such as crop yield from the various agrarian communities cannot justify the land and water resources for which the Ogun-Osun River basin and other areas in Nigeria is endowed with. This can be directly attributed to inadequate planning and management of the water resources especially for food production (Adekalu et al., 2002; Adeboye and Alatise, 2008). Different arms of government are involved in irrigation and the structure of involvement (Fig. 2). Private small scale schemes account for the land area being used in Nigeria for crop production and this is followed by the River basin Authourities located in different parts of the country.

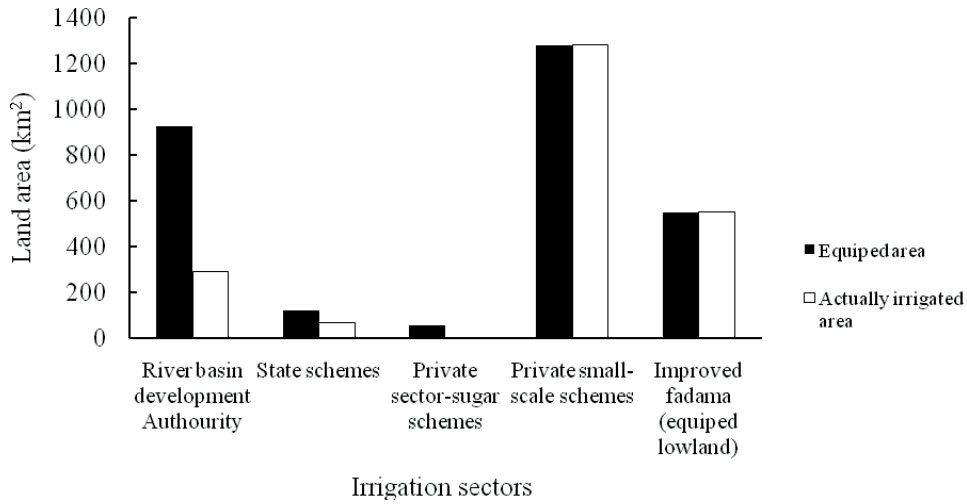

Fig. 2. Structure of the irrigation sub-sector in Nigeria in 2004

2. MATERIALS AND METHODS

Site description. Ile-Ife is located in the sub-humid tropical area of the South Western Nigeria at Longitude 4° 33'' and latitude 7° 33'' and elevation above the mean sea level is 298 m. Ile-Ife is located within Ogun-osun River basin, one of the river basins in Nigeria established for the management of water resources. The soil in the River basin differs spatially. In the study, the plot under cultivation had been left fallow for a long period of time.

Climate and Soil Data Analysis. The climatic data of Ile-Ife where the field experiment is being carried out were obtained from the meteorological station located at Obafemi Awolowo University, Ile-Ife under the auspices of Nigeria Meteorological Experiment (NIMEX) (Table 1). At Obafemi Awolowo Teaching and Research Farms, soil samples were obtained at depths of 0 -10; 10 - 20; 20 - 30; 30 - 40 and 40 - 50 cm and analysed for textural class, cations compositions and acidity in order to know the suitability of the soil for cultivation of Soy beans.

Table1. Meteorologic data at Obafemi Awolowo University, Ile-Ife in the year 2010

	Air Temperature		Air Humidity			Wind Speed	Radiation	Rainfall (mm)
	Maximum Temperature (°C)	Minimum Temperature (°C)	Maximum Relative Humidity (%)	Minimum Relative Humidity (%)	Mean Actual Vapour Pressure (KPa)	Average Wind Speed (m/s)	Net Solar radiation (Wm^{-2})	
January	33.91	22.35	92.83	34.71	2.4210	2.9960	49.49	14.44
February	35.45	23.77	90.85	35.19	2.5056	3.9004	72.21	27.96
March	34.29	23.98	90.77	38.95	2.5556	3.3692	81.14	104.73
April	33.85	23.35	92.65	49.14	2.7483	3.8516	125.23	149.99
May	31.47	23.32	94.82	60.17	2.7333	2.8820	108.32	206.33
June	30.55	22.77	81.63	67.55	2.7328	3.3276	87.34	205.10
July	28.69	22.01	95.10	65.99	2.6017	3.4836	82.13	208.50
August	28.23	22.17	94.82	67.82	2.5929	3.3900	79.24	216.26
September	28.98	22.01	95.24	70.99	2.6178	3.6000	82.17	284.03
October	30.20	28.78	93.82	60.85	2.6263	3.0528	107.31	234.32
November	31.34	22.14	94.55	56.74	2.6427	2.9192	93.58	72.08
December	33.60	22.09	92.61	37.09	2.3408	2.8716	58.66	10.04

3. RESULTS AND DISCUSSION

Table 1 contains the meorological data of Ile-Ife. Minimum temperature of 22.01°C was obtained in July at the peak of the raining season while maximum temperature was recorded in February during dry season. Maximum relative humidities of 95.10 and 95.24% were reccorded in July and September respectively. The lowest actual vapour pressure of 2.3408 KPa was recorded in December while the maximum average wind speed at a height of 2m was 3.90 ms^{-1}. Highest net solar radiation of 125 Wm^{-2} was recorded in April of the year. High rainfall depths are normally experienced from May till October of the year provided there is no sudden break in rainfall as a result of cimate change. Average annual rainfall was 144.48 mm.

Soil

At 0 - 10 cm depth, there were 73, 22 and 5 per cent of sand, clay and silt, respectively, with bulk density of 1.13 g cm^{-3}. The soil surface contains the highest amount of organic matters of 2.48 % with electrical conductivity of 0.24 dSm^{-1} while the pH is 6.2. The amount of phosphorus was 10.27 ppm while the dissolved cations were 0.14, 0.16, 5.0 and 4.03 meq/100g of soil for Na, K, Ca and Mg, respectively. From 10 - 50 cm, there were almost the same quantities of sand, clay and silts although with slightly varying bulk densities. The organic matter decreased down the soil depth with the minimum value of 0.6 % at 40-50 cm of soil depth. The presence of phosphorus at the depth of 20cm makes it suitable for shallow rooted crop such as soy beans with little application of artificial fertilizers.

Production of Soy bean in Nigeria. Soybean was introduced to Nigeria as early as 1908. In 1937, the Malayan variety was introduced by the British colonial officers in Benue State (Singh et al. 1987) and the variety is the only one being cultivated by the farmers until recently when new varirties have been introduced by the International Institute for Tropical Agriculture (IITA). Over the past twenty years, IITA has made substantial efforts to improve the productivity of the crop by developing high yielding, early maturing varieties capable of nodulating in association with local rhizobia, and possessing other good agronomic traits (IITA 1995). The improved soybean varieties released in Nigeria include TGx 849-313D, TGx 1019-2EN, TGx 1019-2EB, TGx g1447-2E, TGx 536-02D, TGx 306-036C, TGx 1485-1ED, and TGx 1440-1E (IITA 1995). The introduction of these varieties and their high productivity had led to an increase in the production of Soy beans and its use in praparation of local dishes (Osho and Dashiell 1998).

Economic potential of Soy beans production in Nigeria. Areas known for the cultivation of the crop include Benue state and Southern Kaduna in the Northern states where the crop is processed into *daddawa*, a fermented condiment traditionally made from locust bean. Soybean production expanded into non-Tiv areas of Benue State (Knipscheer, 1985). Soybean production increased between 1984 and 1989 in most Tiv villages and half the non-Tiv villages. Other factors which led to increase in the production of the crop included a temporary ban on imports of soybean meal and edible oils, the opening of an oil mill in the state and the introduction of new commercial foods. Similarly, the promotion of home consumption of soybean by hospitals, religious missions and the government also played a part. Although soybean was grown primarily for sale, some villages grew soybean only for home consumption. In Ayepe in the Soth western part of Nigeria the high rate of soybean adoption was attributed to instruction provided in semi-annual workshops on production, cooking methods and the nutritional benefits of soybean. Based on the level of awareness created on the benefits of Soy beans, the demand for it will continue to rise in the subsequent years and there there is a need to ensure round the year production of the crop through the use of simple and affordable irrigation system expecially during the dry seasons. Due to nutritional defiencies in the diets of many Nigerians, the production and consumption of Soybeans will help in solving the problems of malnutrition and improve the nutient status of the soil.

4. CONCLUSSIONS

Soy beans are one of the promissing crops in Nigeria which had not been fully utilized for social economic advantages. The recent researches at IITA have made available many varieties of the crop with varying agronomic properties. Conducting a research on the water use pattern of the crop during the rainning and dry season will furnish information on the amount of water required for the cultivation of the crop under the present climate variability. Similarly, the foreign exchange earning of Nigeria can also be trmendously increased through mechanised and round the year production of the crop both at large and small farm scales. Land degradation which is a major challenge in the agricultural sector of Nigeria can be minimised by cultivation of the crop.

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