The Petroleum Find: Its Possible Impact on the Agricultural Sector in Ghana: The Role of Soil Science

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Abstract

The opportunities the petroleum industry present comes with challenges that Ghana needs not to overlook. It is globally accepted that petroleum find is usually associated with the economic situation dubbed "Dutch disease", whereby, the over-expectation of rewards from oil revenues diminish the attention paid to other sectors of the economy. The paper examines the potential impacts of the petroleum discovery in Ghana on its agricultural sector and the role of soil science in minimizing adverse effects. The agricultural sector is likely to lose its recognition as the backbone of the economy due to the discovery of petroleum in commercial quantities and having recently been overtaken by the service sector. An impact of the oil find could be the high risk of the agricultural sector losing its potential labour force to the petroleum industry. There is also the fear of neglect of the agricultural sector in future similar to what happened in some countries that experienced petroleum boom. Oil spillage could pollute farmlands, and gas flaring without temperature or emission control could pollute the air and release unacceptably high levels of carbon dioxide and carbon monoxide into the atmosphere. There could be resettlement of farming communities and farmlands because of the fear of spillage and destruction of lands by oil and gas operations. The petroleum find could also present the opportunities for the agricultural sector in that there would be improvement of infrastructure in the farming communities. Variety of items including fertilizers and insecticides which play important roles in agricultural production can be manufactured from petroleum by-products. Soil science is the engine of agricultural land use and management. For best benefit, the education of farmers on the oil industry and management of oil contaminated soils is very paramount. Soil science units in the country need be involved in research on the dynamics of oil degradation, the isolation and identification of the most effective microorganisms for future bioremediation as well as in the identification of soil conditioners from petroleum and its by-products for the improvement of soil properties.

Introduction

In the mid-1800s petroleum began to replace whale oil in lamps. The first oil well, specifically constructed to extract petroleum oil was drilled in 1859 when the American oil pioneer E. L. Drake drilled a producing well on Oil Creek in Pennsylvania at a place which later became Titusville. In Ghana, the initial oil exploration begun between 1896 and 1967 with focus on onshore. The second phase was shallow-water exploration which occurred between 1968 and 1980. The third phase saw the emergence of the Ghana National Petroleum Commission (GNPC), which established the National Oil Company in 1983, and given legal backing by two main statutes (PNDC Laws 64 and 84). The fourth phase involved offshore activities leading to "Mahogany" discovery in which the following fields were found; Jubilee in 2007, Tweneboa-Enyernra-Ntomme (TEN) between 2009 and 2012. Mahogany-Teak-Akasa-Banda (MTAB) discovered between 2009 and 2011 and the most recent discovery being the Sankofa-Gye-Nyame field, for which exploration and appraisal work is on-

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going. In the closing days of 2010, the country joined the league of oil producing countries when the Jubilee Oil Field officially came on stream with the pumping of oil in commercial quantities in the Western Region. This Region is noted historically for the cultivation and production of rubber, cocoa, forestry and minerals of various kinds.

Though considered of great economic value, some 'unpleasant' consequences have also been observed to be associated with oil finds the world over. In the 1960s, a crisis occurred in the Netherlands resulting from the discoveries of vast natural gas deposits in the North Sea. The new found wealth caused the Dutch Guilder to rise, making exports of all non-oil products less competitive on the world market. In 1970s, a similar economic condition occurred in Great Britain when the price of oil quadrupled and it became economically viable to drill for oil in the North Sea off the coast of Scotland. By the late 1970s, Britain had become a net exporter of oil and no more a net importer. The British Pound soared in value, but the country fell into crisis when British workers demanded higher wages. This crisis was then termed the "Dutch Disease" which is accepted globally as the negative consequences arising from large increases in a country's income primarily associated with a natural resource discovery. It can also result from any large increase in foreign currency in flow and, or earning, including direct investment, foreign aid or a substantial increase in natural resource prices.

A continuous fall in the prices of some major commodities excluding oil and gold has been observed in Ghana suggesting that the country is on the verge of experiencing the Dutch Disease. In the third quarter of 2011, when the country earned a total of 337.3 million US dollars from the first three liftings of 2,980,720 barrels of oil from the Jubilee Fields there were also high demands on the government to increase salaries of public workers under the "Single Spine" salary scheme.

For the past five decades agriculture had been the backbone of Ghana's economy because it was the leading contributing sector to the country's GDP and provided more than 50% employment to the labour force. The agriculture sector has recently lost its leading position to the service sector. With this trend of event, coupled with the discovery and production of petroleum oil in large quantities, there is the fear of the agricultural sector being further relegated.

Over 2 billion tons of petroleum is produced annually worldwide and the National Academy of Sciences (2002) reported that over 1,300,000 tons of petroleum are introduced into the natural environment worldwide. One of the major environmental problems of today is petroleum product(s) contamination resulting from the petrochemical industry, accidental and deliberate activities. According to Nilanjana & Chandran (2011) accidental release of petroleum products is of particular concern in the soil environment. The soil is an essential natural body that determines agricultural productivity and it is, therefore, of great concern when petroleum and its products find their way into the soil environment.

It is against this background that the paper examines the possible impact of oil discovery on the agricultural sector, and the role of soil science in sustaining the sector in Ghana, in spite of the oil find.

Fig.1. A map indicating Ghana's offshore oil fields (Source: EPA, Ghana)

Impacts of oil on agriculture

Contribution of agriculture to GDP

According to Wikipedia (2009), countries which experienced oil boom and rise in their gross domestic products (GDP) shifted their attention from the total agricultural output to the booming oil industries. For example, since 1970, there was a steep drop in agricultural production in contrast to the rise in federal revenue from petroleum extraction in Nigeria (Wikipedia, 2009). Although Nigeria had been the world's leading exporter of cocoa the production of this cash crop dropped by 43%, with the production of other important income generators like rubber and cotton also plummeting between 1972 and 1983 (Wikipedia, 2009). This decline in agricultural production amid the oil boom was unfortunately not limited to cash crops but the national output of foodstuff also fell. This situation is in contrast to Nigeria in 1960 just after independence when the nation was more or less sufficient in terms of food supply whilst crops made up 97% of all revenues from export. Ghana likewise stands a similar risk with the boom in the oil sector if the nation fails to strike a balance between the oil and the agricultural sectors.

According to the CIA World Factbook (2012), the GDP growth rate of Ghana between 1999 and 2010 was in the range of 3.0–7.3% but in 2011 the growth rate increased to 13.6% and ranked fourth after Turmenistan, Mongolia and Qatar. This rapid increase could be attributed to the petroleum find because in the closing days of 2010 the country joined the league of oil producing countries and oil was pumped in commercial

quantities. The GDP composition in 2011 stood at agriculture 28.3%, industry 21% and services 50.7%. The agricultural sector has lost its position as the top contributor to GDP to the services sector. With the discovery and production of oil and gas in the country in commercial quantities and including the oil and gas as a sector in the GDP composition, the percentage composition of agriculture could further decline drastically with regard to GDP growth rate. Although the manufacturing and agricultural sectors among many others of the economy have been declining in the last few years before the oil discovery, the situation has persisted and it is becoming even more alarming. Besides, the Budget Statement and the Government's Economy Policy for the 2012 financial year, the agricultural sector expanded only by 2.8% as against a targeted growth of 5.3%, a shortfall of 2.5%. For the agricultural sector to maintain or increase its relative contribution there is the need to drastically increase production to meet targeted growth.

Job opportunities

The discovery of oil and gas in commercial quantities in Ghana has resulted in a burgeoning and promising oil and gas industry. This has inspired people because the petroleum industry offers attractive salaries and compensation packages to its workforce while there also appears to be a high demand for opportunities in the emerging industry. This could lead to the migration of workforce, usually the youth, from agricultural sector or rural areas in search of elusive jobs. Therefore, the country's agriculture is at a high risk of losing its potential labour force to the urban areas and the oil sector. According to a research by the World Bank (2009) on economy-wide impact of oil discovery, Ghana's agriculture could particularly be exposed to the "Dutch disease" consequence during the oil boom period. As one of the major treadable sectors, Ghanaian agriculture could particularly be exposed to the risk of losing external competitiveness through the real exchange rate appreciation which could result in large mobility of labour force. A higher requirement of labour for the oil industry would exert upward pressure on agricultural wages and reduce external competiveness of both import and export oriented agricultural sector. This could likely increase prices of food and create shortage in food supply as the work force in agriculture is being drifted away.

Fear of neglect of agricultural sector

There is fear of neglect of the agricultural sector in the future in the wake of oil and gas production. International experience shows that competitiveness of agriculture is often undermined by natural resource discovery. Some countries that experience oil and gas boom often ignore agriculture, leading to decimation of an otherwise vibrant agricultural export sector leading to increase food import and increase in poverty.

During the oil boom era in Nigeria, there was intensive exploration and export of petroleum and its products. The oil boom in Nigeria led to neglect of its strong agriculture and light manufacturing bases in favour of an unhealthy dependency on oil for more than 97% of export earnings and 80% federal revenue. According to Sekumade (2009) due to over dependency on oil, Nigeria is no longer a major exporter of cocoa, groundnut, rubber and palm products. Cocoa production mostly from obsolete varieties and over-aged

trees is stagnant at around 150,000 tonnes annually, as opposed to 25 years ago when production was 300,000 tonnes per annum (Sekumade, 2009). There has been a similar decline in groundnut, palm oil and the major export crops. The share of agricultural products in total exports of Nigeria has plummeted from over 70% in 1960 to less than 2% (Sekumade, 2009). The decline was largely due to the phenomenal rise in oil shipments, but also reflected the fall in the output of products like cocoa, palm oil, rubber and groundnuts of which Nigeria was once a leading world producer (Sekumade, 2009).

Another serious form of neglect that Ghana's agriculture has to reckon with is the drift of potential investors from the agricultural sector to the oil sector, as the oil sector seems to be more promising with quick investment than the agriculture sector. The problem could even be compounded if the agricultural sector fails to put in measures that increase attractiveness and adopt pragmatic measures to reduce production cost and increase farm output. Potential investors would prefer to invest their money in more lucrative ventures which the oil industry gives hope for. Large scale agriculture and plantation farming which is at its infancy could collapse. The agricultural sector in the near future faces the threat of losing investors, and Ghana may have to continue depending on peasant farmers to sustain the agricultural economy which is not conducive for Ghana, a country trying to attain a middle income status.

As a result of increasing price and fear of exhaustion of oil, a new attention would expect agriculture to play a role in supporting growth in energy demand through the production of biofuels, such as ethanol and biodiesel. This shift to support the energy sector has stimulated new demand for particular crops, such as grains. In Ghana, sometime ago the cultivation of the plant jatropha (*Jatropha curcas*) for the production of biodiesel and increase in oil palm plantation received appreciable attention. However, with the discovery of petroleum in the country, there is the likelihood of shifting from the production of biofuels from plants to the production of fossil oil.

With the discovery of oil in the country there is proliferation and introduction of courses in oil and gas into the educational curriculum. Graduates of these new courses are highly needed in the oil sector at various stages of oil exploration and production. This shift in knowledge dissemination could lead to neglect of courses in agriculture educational institutions. Stakeholders are calling on government to assist educational institutions, especially universities, to offer professional training to students in oil and gas programmes. The government's commitment to assist educational institutions with the needed resources to competently educate and train students in oil and gas courses is crucial if Ghanaians are to take advantage of opportunities that abound in the oil and gas markets. The training would help Ghanaians with the required expertise to meet the challenges of the industry and effectively manage the sector. There is the need for the oil and gas industry to become more proactive in recruiting and training new engineers, geologists, technicians and managers to address the personnel challenges of the industry. The government's commitment to assist in training through provision of the needed resources could shift

attention from the agricultural sector, which had been the backbone of the country's economy before the discovery of petroleum.

Impacts on agricultural soils and environment

The demand for petroleum as a source of energy and as a primary raw material for chemical industries in recent years has resulted in an increase in world production. This dramatic increase in production, refining and distribution of crude oil has brought with it an ever increasing problem of global environmental pollution (Atlas & Barther, 1992; Plohl *et al*., 2002). The whole world, especially the petroleum oil producing countries, are vulnerable to oil spills due to the large volume of petroleum oil and its products transported from the producing end to the consumer end. For example, in the Niger Delta of Nigeria alone, there have been over 550 reported cases of crude oil spillage since 1976, releasing about 2.8 million barrels of crude oil into the environment. Petroleum products contamination has been further compounded by sabotage and vandalization of pipelines in restive communities, particularly in the Niger Delta region of Nigeria. In 2010, the oil leak by the British oil giant, British Petroleum (BP), in the Gulf of Mexico in the United States has been described by the environmental experts as the worst in history.

Several properties of agricultural soils are adversely affected by oil spills. These include the loss of soil organic matter, leaching of nutrients, loss of the nutrient-laden top soil, changes in soil *p*H, reduction in cation exchange capacity, salinization, water logging, and other forms of soil degradation are major problems associated with agricultural productivity in oil processing areas(Aina & Adedipe, 1991). Frequent crude oil spillage on agricultural soil and the consequent fouling effect on all forms of life render the soil (especially the biological active surface layer) unproductive. The oil reduces the soil fertility such that most of the essential nutrients are no longer available for crop and plant utilization (Abi & Nwosu, 2009). Beyond 3% concentration, oil has been reported to be increasingly deleterious to soil biota and crop growth (Baker,1976; Amadi *et al*.,1993; Osuji *et al*., 2005).

On December 26, 2009, Ghana experienced its first spillage of about 584 barrels of low-based mud drilling fluid and the second mud spill of seven barrels occurred on March 23, 2010 (Daily Graphic, 2010). This frequency of spillage in the drilling field is of great concern. Offshore oil spillage is usually associated with the oil and gas industry. Spillage affects aquatic life such as sea birds, fishes, planktons, and this may affect the whole food chain through a process called bioaccumulation. For example, the Exxon Valdez spill killed as many as 300 harbour seals, 900 bald eagles, 2,800 sea oysters and 250,000 sea birds. Fishermen may not be able to fish when there is an oil spill, and this would affect their income levels.

Gas flaring without temperature or emission control pollutes the air and releases unacceptably high levels of carbon monoxide and carbon dioxide into the atmosphere (Hurtig & Sebastian, 2002). High levels of carbon dioxide are also emitted from seismic vessels and drilling rigs. These gases are greenhouse gases that contribute to global warming and environmental acidification. The potential future effects on global climate change include shift of plant and animal ranges, trees and plants flowering sooner to

produce low quality fruits, more frequent wildfires, longer periods of drought in some regions, increase in number, duration and intensity of tropical storms resulting in flooding and destruction to structures. According to NASA (2012), between 75 and 250 million people in Africa are projected to be exposed to increased water stress, yields from rain-fed agriculture could be reduced up to 50% in some regions by 2020, and agricultural production including access to food may be severely compromised.

Potential terrestrial impacts may result from poor design and construction of facilities. Impacts such as soil erosion and vegetation removal could lead to low soil productivity. Currently, large areas of farmlands in the Western Region have been acquired for the construction of facilities meant for gas storage and processing. In time, technical faults resulting in release of gas into the environment could result in fire outbreaks and destruction of vegetation, and risk to life and property would be of paramount concern.

Resettlement of farming communities and farmlands

The discoveries of petroleum in areas where farming communities and farmlands are located are usually associated with resettlement because of fear of spillage and destruction to oil and gas operations. For instance, in Sudan thousands of people were forcefully evicted to make way for a low-sulphur crude oil venture in south-central Sudan. Through this forced eviction, the people of this community lost venerated ancestral homes, died from contamination, with livelihoods being jeopardized. Agriculture is the mainstay of a substantial number of African families. It has been documented in the work of Baanante *et al.* (1999) that agricultural systems in Africa depend as much on the efforts of women as they do on the efforts of men. However, men are more likely to be cash crop farmers, with food crop farmers usually being the poorest in our societies (Darkwah, 2005). Forced resettlements which jeopardize the livelihoods of women and food crop farmers, put undue strain on them and their families as they struggle to develop alternative livelihood practices to fend for their already cash-strapped families. A similar situation could hit Ghanaian farmers around the entire oil basin along the coast of Ghana.

Positive impacts on agriculture

Despite the many negative effects of oil find on agriculture, there are several indirect benefits. According to ANWR (2012), a variety of items can be manufactured from petroleum by-products. Among these items, the manufacture of fertilizers and insecticides play an important role in farming. Most tropical soils have poor soil fertility and the availability of fertilizers at affordable prices and utilization would increase agricultural production. The infestation of farms by insects is one of the factors responsible for low agricultural productivity in the tropics. The use of insecticides at affordable prices to control insects would also increase agricultural production. Other products include tractor tyres, farm gears, soil conditioners and food preservatives.

Ghana's oil economy presents an unparalleled opportunity for the agricultural sector and for improvement of infrastructure. The concern to the agriculture sector is the extension of electricity to the various farming communities in the remote areas. Most of the farming communities in Ghana are

without electricity. It is believed that the revenue generated from the oil industry could be used to extend power supply to these farming communities. This could also help to reduce the rural urban migration which reduces the agriculture labour force.

Most Ghanaian farming communities lack good and accessible roads to transport their farm produce from the farms to the market places and urban areas. This often results in great losses to the farmers as they cannot transport perishable goods such as tomatoes to the consumers on time. Revenue generated from the oil industry could be used to establish agro-based processing plants and storage facilities to add value to the primary goods so that they can sell better. Absence of such facilities means that farmers always have to sell the raw produce without adding value to them. The revenue generated could also be used to construct schools and hospitals, improve water supply and sanitation in the farming communities because these social amenities are very important for livelihood of farmers.

The role of soil science

The environmental concerns as a consequence of industrialization was a major focus of the Department of Soil Science of the University of Ghana, Legon, in the early 2000s. Following several discussions, a new post-graduate programme, namely "Environmental Soil Science" was introduced into the Soil Science curriculum in 2003. The spectrum of the programme includes domestic sewage treatment, soil pollution and remediation, issues related to greenhouse gas emissions, climate change, among others. The impact of oil spills on soil quality has received major attention.

As mentioned earlier, since soil science is the engine of agricultural land use and management it would be appropriate to educate farmers on the discovery of oil and their perception of farmland contamination through oil spillage and other issues related to the oil industry. The perception of farmers on contamination is important when it comes to education and introduction of technologies for remediating contaminated soils. It is in this vein that a field survey was conducted by the Department of Soil Science of the University of Ghana to collate information on farmers' perception on petroleum product(s) contamination of farmlands using structured questionnaires in Greater Accra, Volta and Central regions (Lawson *et al*., unpublished). Results indicated that 85% of farmers were aware of the discovery of petroleum in the country and about 38% of the farmers were not aware that petroleum product(s) could contaminate their farmlands.

There is the need, therefore, to educate the public, more especially the farmers, on the impact of oil and gas on agriculture and the environment. Lack of information on the oil and gas industry could lead to farmers and other human resources from the farming communities drifting into the oil sector. Education could start from the basic schools to the tertiary level, and organization of workshops for farmers and farmer-based organizations in order to create awareness on this new industry and the management of oil contaminated soils. This is where soil science education would play a major role in the dissemination of information to schools and farmers in the various farming communities.

With respect to oil spills, Soil Science Department of the University of Ghana has started research on petroleum and its

product(s) in the soil environment. In the first research work, Lawson *et al.* (2012) reported that Ghanaian soils sampled from the forest, northern savanna and coastal savanna ecological zones showed signs of containing hydrocarbon utilizing microbes and had the potential to degrade diesel oil (Fig. 2). The forest soils degraded more diesel oil than the savanna soils. The main factors responsible for differences in degrading abilities of these soils were hydrocarbon utilizing bacteria population, availability of organic carbon, nitrogen and phosphorus. Apart from these nutrients, the added advantage that the forest soils had over the savanna soils was the high number of hydrocarbon utilizing bacteria.

This preliminary study, therefore, provides the awareness for the identification of the hydrocarbon utilizing microbes, especially bacteria, associated with the soils used in the study. Lawson *et al.* (2013) isolated six hydrocarbon utilizing bacterial genera, *Bacillus*, *Staphylococcus*, *Enterobacter*, *Yersinia*, *Proteus*, and *Alcaligenes*; the dominant genus was *Bacillus*. The study clearly indicated that Ghanaian soils contain diverse bacterial genera capable of degrading and utilizing diesel oil as carbon source. These microbes can, therefore, be used as inocula for bioremediation. Other ongoing research activities include degradation of oil under different land use management; physiochemical properties and microbial populations in soils at garages and engine depots; using nitrogen and phosphorus to stimulate the microbial degradation of diesel oil contaminated soil; using biochar from agricultural wastes to remediate oil

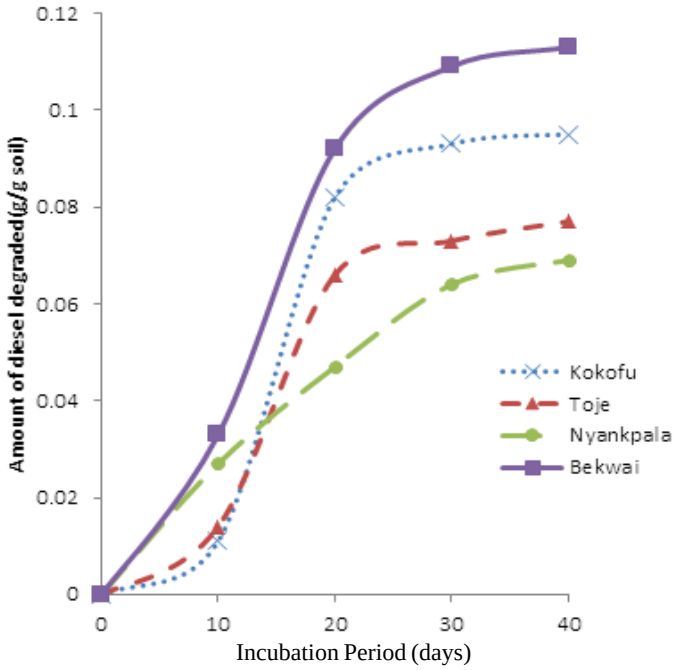

Fig. 2. Amount of diesel oil degraded in four soil series soils (Lawson *et al.*, 2012)

contaminated acid soils. The information from these present and future research activities could be used in bioremediation of oil contaminated soils.

Extensive research could be undertaken by soil scientists to discover the potential of by-products of the oil and gas production. A research area that could be of interest is the manufacture of soil conditioners; these conditioners could be added to oil contaminated soils to improve soil quality, especially in the provision of nutrients, improvement of cation exchange capacity, water retention, and soil structure. Soil conditioners include a wide variety of materials, among which are hydroabsorbant polymers. The soil scientist could take advantage of the polymers found in petroleum to design chemical structures from the by-products for manufacturers to come out with high quality soil conditioners to improve soil quality. The soil scientist could also assist in the testing, both laboratory and in the field, of the newly developed soil conditioners before they are made available commercially on local and international markets. A product discussed earlier that can be obtained from petroleum by-product is fertilizer. The various forms of fertilizer that can be developed could be tested in the different types of soils under the different agro-ecological zones, and then recommend the appropriate application rates and management practices to farmers in the country's agro-ecological zones for increased agricultural production.

Conclusion

The impact of Ghana's petroleum find on the agriculture sector and the role that soil science can play were examined. The influence of the oil find on the agricultural sector includes losing its current position to service and oil sectors as far as contribution to GDP is concerned, the loss of its potential labour force to the oil sector, potential neglect of the sector, pollution of farmlands, resettlement of farming communities and farmlands and infrastructure development in the farming areas. For proper agricultural land use and management, soil science education, research on oil and its spillage in the soil environment, and development of new soil conditioners from by-products of petroleum are very important.

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