Title: Population and other determinants of food crop production in the dry and derived savannah zones of Ghana.

ABSTRACT

After Malthus, theories accounting for food production have centred on two key conditions, viz., demographic pressure (Boserup) and market price incentives (Schultz). This paper examines determinants of food crop production in Ghana, placing these two theories and other mediating conditions (environmental, techno-managerial, political economic and institutional) at the heart of the discussions. Information from a household survey undertaken in 2001 among 1,568 farmers in 504 households in 24 rural localities in the dry and derived savannah zones is used. Results show that population is playing a significant role in determining food crop production in the derived and not the dry savannah, due to migration. This is expected because most of the arable land is already being used for production and bushfires have also taken their toll on arable lands in the dry savannah. This piece of research should be extended to the forest zone of Ghana, and consideration should be made to the temporal role of population in food crop production to complement the spatial role documented in this paper.

Keywords: Population; food crop; Ghana; sub-Saharan Africa**.**

INTRODUCTION

Prior to the early 1960s, Ghana was self sufficient in food crop production. The first Ghanaian government led by Dr. Kwame Nkrumah used agricultural wealth as a springboard for the country's overall economic development. However, as a result of a drop in commodity prices in the late 1960s, farmers were faced with fewer incentives to produce as well as with a general deterioration of necessary infrastructure and services. Farmers also had to deal with increasingly expensive inputs, such as fertilizer, because of overvaluation of the cedi. Food production therefore fell, with a decline in the food self-sufficiency ratio from 83% in 1961-66 to 71% in 1978-80, coupled with a four-fold increase in food imports in the decade prior to 1982. By 1983, when drought hit the country, food shortages were widespread, and export crop production reached an all-time low. The 1990s and 2000s saw Ghana making modest gains in food crop production.

On the other hand, Ghana's population of 6.7 million in 1960 grew to 18.9 million in 2000 (Ghana Statistical Service, 2002), registering almost a three-fold increase and is estimated to have reached 22.6 million by 2006 (PRB, 2006). The high rate of population growth has been mainly due to a moderately declining fertility and declining mortality since 1970. Thus, rapid population growth has had consequences for food crop production in Ghana (Benneh and Agyepong, 1990).

This paper examines the spatial role played by population and other determinants in food crop production in two distinct (in terms of vegetation, soils, rainfall, topography, socio-economic conditions, etc.) agro-ecological (dry and derived savannahs) zones of Ghana, using the demographic pressure (Boserup, 1965) and market price incentives (Schultz, 1964) theories, as well as other mediating conditions, namely, environmental (Brookfield, 1972; Brush and Turner, 1987), techno-managerial (Grigg, 1992), political economic (Bassett, 1998; Blaikie and Brookfield, 1987) and institutional (Sheridan, 1988; Zimmerer, 1996; Boyce, 1987).

The justification for this paper is that although studies linking population to agricultural systems in general and food crop production in particular abound in the developing world (see Turner, Hanham, and Portararo, 1977; Vassey, 1979; Metzner, 1982; Higgins et al., 1982; Ali, 1984; Ahmad, 1985; Bilsborrow, 1987 and 1992; Shaw, 1989; Netting, 1993; Jolly and Torrey, 1993; Ali, 1995; Turner and Ali, 1996; Zimmere, 1996; Entwisle et al., 1997 and 1998; Laney, 2002; Ali, 2007), similar studies on Africa, have been few and far in between (Lele and Stone, 1987; Dadson, 1988; Mwalyosi, 1992: Turner et al., 1993; Codjoe, 2004; Codjoe, 2006a). This paper is expected to add to the scanty literature on population-food crop production nexus in Africa.

Agriculture in Ghana

Agriculture in Ghana is predominantly on a smallholder basis, although there are some large farms and plantations, particularly for cocoa (1,200,000 ha), oil palm (285,000 ha), seed cotton (62,000 ha), tobacco (1,600 ha) and coconut, banana, kola, etc. (1,502,500 ha). Main system of farming is traditional with the use of hoe and cutlass. While there is little mechanised farming, bullock farming is increasingly practised, especially in northern Ghana.

The first Ghanaian government used agricultural wealth as a springboard for the country's overall economic development in the early 1960s. However, due to a drop in commodity prices at the end of the 1960s, farmers were faced with a myriad of problems; prominent among them are high fertilizer prices and deterioration of necessary infrastructure and services.

Thus, by the early 1980s food production has fallen and the situation was exacerbated by the drought in 1983. In 1984, the government of the day initiated the first phase of the Economic Recovery Programme (ERP), popularly referred to as Structural Adjustment Programme (SAP). SAP implementation in Ghana focused mainly on agriculture owing to the widely held belief that agriculture was an important tradable sector that holds the key to the future growth of the country. According to the World Bank (1981) and FAO (1989), agricultural reform measures under SAP included: (i) increasing government regulated producer prices towards the farm gate trade parity prices; (ii) removal of subsidies on agricultural inputs such as fertilisers, seeds and chemicals; (iii) adjustment of agricultural price incentives away from domestic food-production and towards exportable cash crops; (iv) reduction of taxes on agricultural exports; and (v) reduction and rationalisation of the activities of public sector organisations, which were involved in the agricultural sector.

As a result of SAP the government invested significant amounts of money in the rehabilitation of agriculture. This was done primarily through the use of loans and grants. Furthermore, the government directed capital toward repairing and improving the transportation and distribution infrastructure serving export crops. In addition, specific projects aimed at increasing cocoa yields and at developing the timber industry were initiated. Except for specific development programs, however, the government allowed the free market to promote higher producer prices and to increase efficiency.

Although the government was criticized for focusing on exports rather than on food crops under SAP, by the early 1990s the government had begun to address the need to increase local production of food. In early 1991, the government announced that one goal of the Medium Term Agricultural Development Programme (MTADP)

1991-2000 was to attain food self-sufficiency and security by the year 2000. As a result, the government improved extension services for farmers and crop-disease research. Despite the policy mentioned in the MTADP, the plan was still heavily oriented toward market production, improvement of Ghana's balance-of-payments position, and provision of materials for local industrial production.

Furthermore, following World Bank guidelines, the government planned to rely more heavily on the private sector for needed services and to reduce the role of the public sector, a clear disadvantage for subsistence producers. In particular, industrial tree crops such as cocoa, coffee, and oil palm seedlings were singled out for assistance. Clearly, agricultural sectors that could not produce foreign exchange earnings were assigned a lower priority under SAP.

In addition, the government attempted to reduce its role in marketing and assistance to farmers in several ways. In particular, the Cocoa Marketing Board steadily relinquished its powers over pricing and marketing. The government, furthermore, established a new farmers' organization, viz, the Ghana National Association of Farmers and Fishermen, in early 1991 to replace the Ghana Federation of Agricultural Cooperatives. The farmers themselves funded the new organization which operated as a cooperative venture at the district, regional, and national levels. Although the government argued that it did not want to be accused of manipulating farmers, the lack of government financial support again put subsistence producers at a disadvantage.

Over the years, the Government of Ghana has implemented policies that add value to Ghana’s raw agricultural products (e.g. cocoa, cotton, oil palm, etc), but this has been on a very small scale. In recent times, intensive efforts have been made by government to process some of these products; e.g., volume of cocoa beans processed locally rose from the current rate of 20% to 40% of national output (Government of Ghana, 2005). In addition, there has been the establishment of a special initiative by the President of the Republic of Ghana for oil palm, cassava starch, and soon there will be one for cotton. The purpose is to expand and add value to non-traditional exports and to diversify the economy, create employment and improve local livelihoods.

Trends in food crop production

The leading food crop produced in Ghana from the 1960s to 2000s was cassava, followed by yam, plantain, maize, sorghum, millet and rice in that order (Codjoe, 2007). Cassava, plantain and maize productions increased in all five decades by annual rates of 13.6%, 4.9% and 7.8%, respectively. Yam production decreased between the 1960s and 1970s. However, yam production increased in the 1980s through the 2000s by a rate of 13.2% per annum. Between the 1960s and 2000s, yam production increased at a rate of 5.3% per annum. Sorghum production also increased by an annual rate of 5.7% between the 1960s and 1970s. However, sorghum production declined by a rate of 0.4% per annum in the following decade. Sorghum production then increased at an annual rate of 9.9% between the 1980s and 1990s, and decreased again by 0.3% per annum between the 1990s and 2000s.

Furthermore, millet production increased by 10.8% per annum in the first three decades, i.e., from the 1960s to 1990s. However, it declined slightly by 0.1% per annum between the 1990s and 2000s. Finally, rice production increased by 7.6% per annum between the 1960s and 1970s. It however, declined by 0.6% per annum in the period between the 1970s and 1980s. Rice production picked up again from the 1980s until the 2000s, increasing by an annual rate of 23%.

Constraints to Food Production in Ghana

Poor performance in food production can be attributed in part to external economic conditions, physical conditions (for instance the drought and bushfires of 1982-1983), deficient agricultural policies, low priority given to food production in the past, inadequate support for the agricultural sector and an emphasis on capital-intensive agriculture and industry to the neglect of the larger traditional farming sector. Other reasons for poor performance include, the failure to appreciate the roles and needs of women in agriculture, the persistence of low agricultural technology, a lack of pricing and marketing incentives for farmers in the past, and, until recently, insufficient research and financial support for the small farmer.

Furthermore, agricultural subsidies mainly from the West have been a disincentive for the majority of small-scale farmers in Africa. In regard to cotton production, the cotton subsidy program has undermined the Heavily Indebted Poor Countries (HIPC) Initiative, costing countries such as Benin, Burkina Faso, Chad and Mali more than they have received in debt relief (Oxfam, 2002). For instance, the cost of lower cotton prices to Mali amounted to $US -43 million in 2001, exactly the amount of debt relief from the World Bank and the IMF in the same year under the HIPC Initiative. In 2001 lower cotton prices in Benin resulted in a 4% rise in poverty in 2001(Kousari, 2004).

One major concern is that lower prices force desperate small farmers, in already over-populated areas such as Burkina Faso, to increase and/or maintain income levels by expanding production of cotton on marginal land, resulting in habitat degradation, and/or through the over-use of fertilizers and pesticides in attempting to increase production, resulting in soil and environmental degradation (Oxfam, 2002). The result is that farmers in poor countries earn far less for what they produce. This is very important because more than 10 million people in West Africa alone depend on cotton for cash to buy food and medicines, and to send their children to school. Lower prices mean more poverty in already desperately poor communities. Africa as a whole loses $300m a year as a direct result of US cotton subsidies (Palmer and Kline, 2003).

In addition, quite a substantial proportion of Ghana's productive land is already exploited. Most of the unexploited land is either too steep, too wet, or too dry for agriculture. There are therefore difficulties in finding new land that could be exploited for agricultural production. Expansion of cropland is occurring at the expense of forest and rangeland, much of which is very essential in its present uses.

The issue of quality and degradation has also constrained food production in Ghana. The loss of productive soil has occurred as long as crops have been cultivated. Land degradation is gradually becoming a major threat to the sustainability of food supply in Ghana. These losses are mainly from soil erosion, salinization, water-logging and urbanisation with its associated highway and road construction. Nutrient depletion, over-cultivation, overgrazing, acidification, and soil compaction have all played roles in constraining the food supply situation in Ghana. Many of these processes are caused or are aggravated by poor agricultural management practices. These factors when considered together or in various combinations decrease the productivity of the soil and substantially reduce annual crop yields.

The supply and use of water has also been one of the major constraints to agricultural production in Ghana. Crops require and transpire a lot of water. For example, according to Leyton (1983), a corn crop that produces about 7000 kg/ha of grain will take up and transpire about 4.2 million litre/ha of water during its growing season. To supply this much water to the crop, assuming there is no practice of irrigation, not only must 10 million litres (1000 mm) of rain fall per ha, but it must be reasonably evenly distributed during the year and especially during the growing season.

Poor rainfall distribution and its erratic nature make the achievement of all-year cropping difficult. Furthermore, irrigation in the dry months between October and April allows all-year round cropping and increases productivity. Supplementary irrigation is therefore used to reduce the risks of crop failure. It has been estimated that Ghana has a potential area of 500 000 ha for irrigation, however, only 2% cent of this potential (10,000 ha) has been developed so far. Although the major dam in Ghana, viz, Akosombo, is mainly used for hydroelectric power generation, prominent irrigation projects for food crop production in Ghana are Tono (2,400 ha), Kpong (1,400 ha), Vea (1,000 ha), Afife (880 ha), Bontanga (450 ha) and Weija (220 ha). These irrigation schemes mainly used gravity and pumping methods and have been used mainly for the production of rice, Soya bean and vegetables (Ghana Irrigation Development Authority, 2000).

THE STUDY AREA

The two study areas used in this paper are two distinct savannah zones in Ghana, and they were chosen to find out how their distinctive characters (discussed below) influence the population/other determinants-food crop production nexus. As shown in Figure 1, the dry savannah is located in Northern Ghana, and the derived savannah is found in the Middle belt. Migrants from the dry savannah over the years have moved to the derived savannah and forest zones mainly to farm (Manshard, 1961). Migrants who are in three categories are made up of Mole-Dagbani, Gurma, Grusi and Mande-Busanga ethnic groups (Codjoe, 2006b).

The dry savannah falls within the savannah high plains with the most widespread rocks being granite. Due to the fact that much of the erosion is caused by sheet flooding, the topography is more gently rolling (Dickson and Benneh, 1995). The average altitude is between 180 and 300 metres above sea level. The derived savannah on the other hand, lies in the Voltaian sandstone basin. The area is generally characterised by gently dipping or flat-bedded sandstones, shales, and mudstones, which, generally speaking, are easily eroded. This has resulted in an almost flat and extensive plain, which is between 60 and 300 metres above sea level, which is conducive for growing most of the major crops in Ghana.

With regard to rainfall, the dry savannah lies within the geographical area of Ghana with a single maximum rainfall regime. Areas within this rainfall regime, experience only one rainy season from about May to August, followed by a long dry season. The dry savannah experiences a mean annual rainfall of 115 centimetres. The derived savannah, however, experiences a double maxima rainfall regime, where there are two rainy or wet seasons. The two wet periods occur from May to August and from September to October, with a mean annual rainfall of 143 centimetres. The two rainfall regimes allow for two crop-growing seasons in the derived savannah and a single one in the dry savannah.

[Figure 1: About here]

On vegetation, the dry savannah vegetation type in Ghana is characterised by few and scattered trees such as the baobab *(Adansonia digitata)*, locust bean tree *(Parkia biglobosa)*, acacias *(Acacia spp.)* and the sheanut tree *(Butyrospermum parkii)*, which have adapted to the environment. Regular burning, the grazing of livestock and cultivation have left only few trees still standing and rendered the vegetation to be open and dominated by short grasses. The vegetation in the derived savannah is composed of short branching trees, many less than 15 meters high, which do not usually form a closed canopy and are often widely scattered. The ground flora consists of apparently continuous layers of grass, some species of which reach a height of about 4 meters. Vegetation and other conditions in the dry savannah is favourable for the growing of groundnut *(Arachis hypogaea)*, sorghum *(Sorghum bicolar)*, millet *(Panicum colonum)* and cowpea *(Vigna unguiculata)*, while that of the derived savannah favours the growing of maize *(Zea mays)*, vegetables, cassava *(Manihot esculenta)* and yam *(Dioscorea spp.)*.

On soils, Lixisols are found in both the dry and derived savannahs. In the derived savannah, the normal profile consists of about 30 cm of dark brown to brown, fine sandy loam overlying, from 30-152 cm, reddish brown to reddish yellow, fine sandy loam to fine sandy clay loam. They are moderately well supplied with organic matter and nutrients. Moisture holding capacity is moderately good and the soils are easily tilled by machines and by hand. They are mainly utilized for the production of yams *(Dioscorea divaricata)*, maize (*Zea mays)*, cassava *(Manihot esculenta)*, groundnut *(Arachis hypogaea)*, cowpea *(Vigna unguiculata)*, tobacco *(Nicotiana andicola)*, cotton *(Geossypium herbaceum)* and vegetables but are, however, subject to moderate erosion (Adu and Mensah-Ansah, 1995).

The derived savannah also has patches of Plinthosols. It has poor humus fine sandy loam topsoil approximately 12 cm or less in thickness, over brown to light yellowish brown fine sandy loam containing abundant ironstone concretions and large boulders or iron pan. The soils are poorly drained and medium to light textured and subject to seasonal water logging or flooding for varying periods, but generally become thoroughly dry during dry seasons. The dry savannah also has patches of Leptosols, which consist of about 10 cm of brown slightly humus sandy loam topsoil overlying hard massive rock. Frequently, ferruginized rock brash and fragments of stones are incorporated in the topsoil. It has little agricultural value. The differences in the rainfall seasons and their levels, topography, soils and the vegetation types all have implications for agricultural production in the two savannah zones.

THEORIES AND CONCEPTS

After Sir Thomas Malthus (1960), other theories accounting for food crop production have centred on two key conditions, viz., demographic pressure (Boserup, 1965, 1976, 1981) and market price incentives (Schultz, 1964) often referred to as the driving forces. Writing after the agricultural and industrial revolutions, Boserup suggests that increasing population pressure mostly leads to an increase in land use intensity. Thus, every population through technological innovations adapts itself to the best fitting land use system according to population density.

In her view, so long as an area has low population density there would be room for long fallow periods, and required outputs for agriculture can be obtained without the investment of additional capital. However, in highly populated areas, there would be the need to sustain a large growing population, and this will culminate in the adoption of more intensive farming methods, which would require additional labour inputs per unit area. On the whole, even though, this scenario will bring about a diminishing return on the labour and capital that has been invested, on the other side of the coin, it will bring about an increase in the total agricultural output (see also Chayanov, 1966; Turner et al., 1993). Schultz (1964) on the other hand argues that higher market price of food crops, causes farmers to intensify the cultivation of those crops and increase the farm holdings used to cultivate those crops (see also Mellor 1969 and Wharton 1969).

Boserup has however been criticised as a result of the following. First, she assumes, at least implicitly, that farmers' objective is to maximise leisure (by maximising labour productivity) under the constraint that they meet their subsistence needs ("the law of least effort"). This is not always true, as many farmers in developing countries have exhibited profit-maximising behaviours.

Secondly, the scope of agricultural intensification in some systems can be very limited owing to intrinsic ecological constraints (Mortimore, 1993). This is the case for fragile soils of West Africa and Ghana for that matter, that is, Oxisols and Ultisols that are highly oxidised and intensely leached. When there is no known feasible technology that the population can adopt, the carrying capacity of the ecosystem is outstripped and a Malthusian limit is reached. Apart from this, inefficient markets characteristic of the West African region and lagged responses to population growth have exacerbated land degradation in the region. For instance, artificially low producer prices for agricultural products and lack of property rights in many countries in Africa have been identified as a disincentive for land resources conservation (Lele, 1989).

Furthermore, other factors that can impede Boserup's responses (land intensification process) in the face of increased population density include macroeconomic policies that discriminate against agriculture and distort market prices, land tenure systems which concentrate land ownership/access in certain groups, poor credit markets and lack of appropriate technology suited for tropical agriculture (Jolly and Torrey, 1993).

In addition, the Boserupian theory has been criticised for the negativities (rapid urbanization, farmland conversion to residential land, deforestation, land degradation, soil erosion, etc.) that growth in population brings (Holmberg, 1991; Lonergan, 1993; Scherr, 2000). Finally, the fact that the market forces in Schultz's thesis puts pressure on farmers to frequently cultivate their lands and clear forests, which could in turn lead to soil erosion and loss of water and soil nutrients has also been criticised (Zhao et al., 1991).

Despite the merits and demerits of the two theories discussed above, farmers in the developing world and for that matter Sub-Saharan Africa produce food crop for direct consumption as well as for the market, thus are not merely pure subsistence or pure market farmers. These production behaviours are influenced by environmental, techno-managerial, political economic and institutional factors within the settings in which they produced.

Environmental constraints may come in the form of poor soils, flooded soils, drought, etc., and may limit the frequency of cultivation as well as yields of particular food crops (Brookfield, 1972; Brush and Turner, 1987). Technology has also been argued to play a very significant role in food crop production (Grigg, 1992). Technology can be used to circumvent constraints imposed by the environment and increase the frequency of cultivation and thus, increase food crop yield. Nevertheless, there could be negative consequences of technology as a result of excessive use of inorganic fertiliser and tractor which can increase the acidic contents of soils, cause salinity in soils and general soil degradation (Ali, 2004; Douglas, 1994).

Political economic determinants are in the form of socio-economic arrangements in the household that influences whether the farmer has power and therefore access to land (Bassett, 1998; Blaikie and Brookfield, 1987). Farm size has mainly been used as the variable to measure the political economic determinant. This is due to the fact that it is the main factor that determines land use decisions made by the farmer. Studies have shown that intensity in food crop production is inversely related to farm size (Boyce, 1987; Griffin et al., 2002). This is because in order to achieve food security and produce for the market, small and large landholders, respectively, allocate more land to consumption and commodity crops. Finally, institutional determinants also play a role in food crop production by making available capital resources in the form of price subsidies on farm inputs, credits, soft loans, etc. to farmers (Sheridan, 1988; Zimmerer, 1996; Boyce, 1987).

METHODOLOGY

Field Survey

The paper utilised information from a household survey undertaken in November 2001 to February 2002 among 1,568 farmers in 504 households in 24 localities (12 localities each in the Kassena-Nankana district (representing the dry savannah and Ejura-Sekyedumase district representing the derived savannah). A structured and open-ended questionnaire was employed by the study and the administration of the questionnaires was by direct interview with the respondents. This technique was employed because the majority of the respondents had no formal education. Extension workers of the Ghana Ministry of Food and Agriculture (MOFA) mainly administered the questionnaire.

With regard to the sampling procedure used, the 2000 Ghana Population and Housing Census Report on communities was the basis for the selected communities used in the study. Most of the communities in both districts were very small in size as far as their populations were concerned. For example, about 97% and 82% of all communities in the dry and derived savannah zones, respectively, had populations less than 800 in 2000 (GSS, 2002).

A criterion (communities with population more than 800) was used to select the study areas. Twelve communities in the derived savannah district qualified and were selected for the study. The communities include, Ejura, Sekyedumase, Anyinasu, Dromankuma, Frante, Kasei, Hiawoanwu, Aframso, Drobon, Nkwanta, Ashakoko and Bonyon. In the dry savannah district, 40 communities qualified. Twelve communities were randomly selected to conform to that of the derived savannah. They include Telania, Navrongo, Bonia, Kanania, Atibabisi, Yuwa Afarigabisi, Nabango, Paga, Mirigu, Badania, Manyoro and Janania.

The random sample procedure was used to select the houses where the interviews were undertaken after a complete listing of all the houses in the communities. Twenty-one households were randomly selected from each of the communities. Every farmer in a selected household was interviewed. A multiple regression (OLS estimates) model is used in the paper to assess the role of population and market price incentive as well as other mediating factors in food crop production. The enter method is used, the regression equation is specified below. The description of variables and how they are measured is presented in Table 1.

$$FCROP = \alpha + ß_1 HSIZE + ß_2 LABOR \ldots ß_n SOILS + \varepsilon$$

[Table 1: About here]

VARIABLES

As shown in Table 1, the dependent variable in the model is the total food crop (FCROP) produced (measured in kilograms) by the household in the year 2000, for the following crops; maize *(Zea mays)*, millet (*Panicum colonum*) cowpea (*Vigna unguiculata*.) and groundnut *(Arachis hypogaea)*. The number of household members i.e., household size (HSIZE) and market price (MPRIC) i.e., total amount received from sale of farm produce in the year 2000, were, respectively, used to measure population and market price incentive.

Chayanov (1966), has argued that the use of absolute numbers in agrarian households is inadequate and considerations should be made to the number of workers/labour actually available for farm work since labour available for farm work is not necessarily synonymous with absolute household size. Thus, a variable, i.e., labour (LABOR) available has been included in the model to actually capture the total number of people used on the farm. It must be noted that LABOR includes household members as well as hired workers.

Furthermore, land tenure (LTENU) was used as another determinant of food crop production. The paper considers four kinds of land tenure systems, namely, tenancy (1); customary/communal ownership (2); family ownership (3); and individual ownership (4). Land tenure laws operating in the derived savannah are the same as the one for the Akan (major ethnic group) of Ghana. An individual (male) establishes his right over the use of land by being the first to bring that piece of land under cultivation. As long as he continues to use the land or he is able to show evidence of his previous occupation, no one including the chief can take away that tract of land from him (Benneh 1970). Once an individual establishes his right over a piece of land, no person can farm on that piece of land without his permission. He is only obliged not to sell that piece of land to another person although land could be pledged during financial difficulties, or for share-cropping basis.

Before the derived savannah became an important tobacco and yam producing area in the 1950s, it was relatively easy for the numerous migrant farmers in the area to acquire land for cultivation. The chief of a village or the head of a landowning group made a free grant of land. The migrant would normally have stayed with a family in a village for about a year and throughout the period have been of good character. The migrant continued to use his tract of land as long as his conduct was satisfactory to the chiefs and elders. With the development of cash-crop farming, land acquired economic value and it was no longer given free to migrant farmers. Migrant farmers in contemporary times pay a consideration fee "*aseda*", and an annual tribute to the chief and a rent to the local tax collector. In the dry savannah, land is mainly family owned and since inheritance is by a patrilineal lineage, males have dominance over land.

Length of fallow (FLNGT) i.e., mean number of years allowed for land fallow in the household was used as another determinant of food crop production. The practice of leaving land to fallow in an agricultural system can be said to be interrelated to the availability of land in the system. Boserup suggests that increasing population pressure mostly leads to an increase in land use (Boserup, 1965). On the other hand, the adoption of intensive farming methods also requires enormous financial inflow for the purchasing and transportation of farm inputs. This venture is too expensive for the majority of subsistence farmer in Ghana, especially where there is no government subsidy. Furthermore, because of the fragile environments, and the recent changing cycles of the rainfall regime, the risk of crop failure is eminent. These circumstances could make the farmer unable to pay for the costs of inputs; and thus the whole process of intensification becomes a risk not worth taking even in the face of rapid population growth.

A further dimension to this issue, is the perception that development of fallow in Africa and for that matter Ghana, may already be the best management of the soils and that the cost of inputs versus the increase in yields may not be economically viable. Thus, agriculture and conservation must be part of a larger plan to take pressures off the land, as there may not be an agriculturally cost-effective remedy for some areas in the savannah.

The mean amount of inorganic fertilizer (IFERT) used by the household per hectare of farmland, was used as the techno-managerial determinant. Although the study gathered information on the use of tractor and improved seed variety, the two variables were omitted from the analysis to avoid multicollinearity problems. In addition, IFERT turned out to be the best predictor of food crop production as far as the other techno-managerial variables are concerned.

Government assistance (GASST), which was measured by the proportion of farmers ever visited by an agricultural extension agent, is used as the institutional determinant in the model. This is due to the fact that government assistance is channelled through agricultural extension agents. They organise training programmes in farm management, integrated pest management, agro-forestry, farm measurement and combating fire. Other training programmes are designed to introduce farmers to new seed varieties, new technologies, offer assistance in fertilizer application, financial support and supervision.

One of the major problems facing agriculture extension services in Sub-Saharan Africa and for that matter Ghana, is the low level of staff education as compared with the education of their research counterparts. This lack of proper education and training hampers research-extension linkages and results in a slow or ineffective diffusion of technology to farmers (Opio-Odongo, 2000).

Also, the inadequacy of farm inputs often leads to frustration for extension staff. Promises they make to farmers about the availability of fertilizers, seeds, hand-tools, implements or agricultural chemicals is often not fulfilled, and the staff are tempted to keep away from those farmers they have disappointed (Bortei-Doku, 1984). Another problem of extension agents is the large inaccessible sub-districts and unwieldy ratios of extension staff to farmers. Ghana has an area of about 24 million hectares and a population of about 22 million. The average extension officer does not know how many farmers or farm families he or she had to work with in a sub-district. Some are not able to tour their entire districts to know all their villages and to plan how they could function within their areas. The lack of mobility makes the situation of the large extension-to-farmer ration worse. Although a few of the officers have motorcycles, some have to travel by public transport.

Furthermore, the total household farm size (FSIZE) for the various food crops, measured in hectares was used as the political economic variable in the model. Finally, the study determined the water absorption capacity of the soils (SOILS) in two stages; viz, using local knowledge of the farmers and then confirming with a scientific experiment. At the first stage, all the farmers interviewed were asked to mention the local name of the soil on which they grow their crops. Three main categories were identified; in the dry savannah – *bolo (clayey), bolinga (loamy)* and *wura (sandy)* and in the derived savannah – *natiefufuo (clayey), natietuntum (loamy)* and *natiekokoo (sandy).* Using a disc infiltrometre to penetrate the top soil, and following Bonsu (1992) and Agyare (2004), the water absorption capacity of the soils were classified (values in parentheses) for the dry and derived savannahs, respectively, into slow (<2 cm/h and <5 cm/h), moderately rapid (2-5 cm/h and 5-10 cm/h); or rapid (>5 cm/h and >10 cm/h).

RESULTS AND DISCUSSIONS

Food crop production

As shown in Table 2, maize (*Zea mays*) is the most important crop grown in the derived savannah, while groundnut (*Arachis hypogaea*) is grown by majority of the farmers in the dry savannah. A few of the farmers grow fruits, and tree crops such as cotton (*Gossypium herbaceum*), cocoa (*Theobroma cacao*), oil palm (*Elaeis guineensis*), cashew (*Anacardium occidentale*), shea nut (*Butyrospermum parkii*), etc., in both areas.

Furthermore, while cassava (*Manihot esculenta*) and yam (*Dioscorea divaricata*), which are root crops, are widespread in the derived savannah, they are not grown at all in the dry savannah. In addition, while sorghum (*Sorghum bicolar*) and millet (*Panicum colonum*) are widely grown in the dry savannah, they are scarcely grown in the derived savannah. Due to the fact that the derived savannah has two rainfall regimes, maize, yam and cassava are planted during the major rainy season, and cowpea (*Vigna unguiculata*) and the vegetables are planted during the minor rainy season.

[Table 2: About here]

The mean annual household production of cowpea (340 kgs to 40 kgs) and groundnut (550 kgs to 440 kgs) was higher in the derived savannah compared to the dry savannah (Table 3). The mean annual household maize and millet production was

2280 kgs and 140 kgs in the derived and dry savannah zones, respectively. The production figures of maize in the dry savannah and millet in the derived savannah were so minimal and were therefore excluded from the analysis.

[Table 3: About here]

Population and other determinants of food crop production

The mean household size was larger in the derived (8.1) compared to the dry (6.8) savannah (see Table 4). As already mentioned earlier on in this paper, the derived savannah serves as a migrant-receiving area for migrants from the dry savannah. Thus, declining fallow and soil productivity, and thus production, as well as lack of land availability for the youth may be key issues contributing to migration of the youth from the dry to the derived savannah. In addition, derived savannah households have larger household sizes because household members are used as part of the labour force on farms. As a result, the mean household labour input is also larger in the derived savannah (4.8) compared to the dry savannah (4.2).

[Table 4: About here]

With regard to land tenure arrangements, there was almost a universal ownership (customary/communal, family and individual) of farmlands in the dry savannah (89%) compared to the derived savannah (78%) where migrants mainly hire farmlands. Further breakdown of the land ownership category for the dry and derived savannah zones, respectively, is as follows; customary/communal (20% and 16%), family (69% and 34%) and individual (2% and 31%). It is important to note that tenant farmers put enormous pressure on soil fertility to secure high yields in order to pay land rents. As a result of this, they are insensitive to the long-term investment in improved soil fertility.

Furthermore, derived savannah households had on average almost twenty times more (4,683,000 to 243,000 Ghanaian Cedis) in market price (annual sale of all categories of farm produce) than dry savannah households. The mean fallow years per household was higher in the derived savannah (2.7 years) compared to the dry savannah (2.3 years) and this was possibly dictated by pressure on land. The use of inorganic fertiliser was also higher in the derived savannah (243 kg/ha) than in the dry savannah (88 kg/ha) confirming an assertion made in an earlier paper that the use of technological inputs such as tractor, inorganic fertiliser and improved seed variety is widespread in the derived savannah (Codjoe, Ehlers and Vlek, 2005). Also, 57% and 23% of the households in the derived and dry savannah, respectively, received assistance from Government. This could be attributed to the fact that most agricultural extension agents, through whom government assistance is offered, do not accept posting to the dry savannah as compared to the derived savannah. Agents tend to resign from their positions rather than take up duties in the dry savannah.

Derived savannah households had larger farm holdings compared to the dry savannah. The mean household total farm size was 6.0 ha and 2.1 ha in the derived and dry savannah zones, respectively. This could be caused by the fact that farmers in the derived savannah are mainly commercial while their counterparts in the dry savannah are generally subsistence farmers. It could also be possible that given lower productivity and reduced fallow, there is no more land available for the increase in human population. Finally, 32.3% and 12.2% of dry and derived savannah farms, respectively, had soils that had slow water absorption capacity and therefore prone to flooding.

Multivariate Analysis

In both dry and derived savannah households, fallow length predicted and is inversely related to cowpea production in the models. This implies that the more land farmers left to fallow, the less cowpea they produced. Farming households in the dry and derived savannahs who allowed an additional year of fallow produced about 0.5 and 1.5 kilogram less of cowpea than their counterparts. The fact that this scenario occurred in both savannahs indicates that fallow lengths are shortening possibly because of population pressure as predicted by Boserup (1965). (Tables 5 and 6).

[Table 5: About here]

[Table 6: About here]

Market price predicted groundnut production in the dry savannah, and maize and groundnut production in the derived savannah. In all instances, the relationship was positive, indicating that the more income earned from sale of farm produce from the market, the more food crop is produced. This is justifiable, because maize production in the derived savannah is more capital-intensive compared to the other crops. Maize is more capital-intensive because it is the major crop and therefore, the other crops, i.e., cowpea and groundnut are normally mixed with maize. Expenditures on farm inputs are therefore mainly for maize production.

Since this paper, does not engage in temporal analysis, it is unable to demonstrate whether Schultz's (1964) assertion that higher market price of food crops, causes farmers to intensify the cultivation of those crops and increase the farm holdings used to cultivate those crops (see also Mellor 1969 and Wharton 1969). However, the fact that market price predicted maize (the most important and widely grown crop in the derived savannah) may amply demonstrate that Schultz's observation is true. Infact, other studies have shown that between 1975 and 1991, maize production increased from 319,700 ha to 610,400 ha; a 125% increase in area and a 230% increase in yield (1 to 1.5 tons/ha) in Africa (McCann, 1999). In the case of Ghana, maize production increased from an average of 262,300 metric tons in the 1960s to 1,117,000 metric tons in the 2000s, an increase of 326% (FAO, 2004).

Land tenure arrangements predicted cowpea and groundnut productions in the dry savannah and groundnut production in the derived savannah. Households that farmed on their own lands, on the average produced 0.8 and 1.3 kilograms more of cowpea and groundnut, respectively, in the dry savannah and 2.9 kilograms more of groundnut in the derived savannah than their counterparts who rented land for farming. As already mentioned, land tenure laws operating in the derived savannah are the same as the one for the Akan of Ghana, where a male establishes his right over the use of land by being the first to bring that piece of land under cultivation. This land tenure arrangement may have resulted in many more people owning lands and thus, the production of more food crops in the derived savannah.

Government assistance (GASST) predicted groundnut production in the dry savannah. According to the analysis, households that received government assistance on the whole produced 1.6 kgs more groundnut than their counterparts who did not receive assistance from government. This finding buttresses the claim made by Sheridan (1988), Zimmerer (1996) and Boyce (1987) that institutional factors significantly influences food crop production by making available capital resources in the form of price subsidies on farm inputs, credits, soft loans, etc. to farmers.

Furthermore, farm size predicted groundnut production in the dry savannah and maize and cowpea productions in the derived savannah. In all the instances the relationships were positive, indicating that the bigger the farm size, the more crop is produced. An increase of a hectare in farm size resulted in 0.3 kg more of groundnut produced in the dry savannah and a 0.7 kg and 0.3 kg of maize and cowpea produced in the derived savannah, respectively. This is due to the fact already raised earlier that in order to achieve food security small landholders allocate more land to consumption crops (see Boyce, 1987; Griffin et al., 2002).

Also, the soil predicted both cereals (millet and maize) of the dry and derived savannahs used in the models. While soils that had rapid water absorption capacity, and were therefore less prone to flooding increased millet production in households by 0.5 kgs, soils with the same characteristics in the derived savannah increased maize production by 2 kgs. This supports an assertion that environmental constraints could be in the form of flooded soils and may decrease the yields of particular food crops (Brookfield, 1972; Brush and Turner, 1987).

Finally, it is ironic to note that the technological variable used, namely, INFERT, did not predict any of the food crops in any of the agro-ecological zones, contrary to findings by Grigg (1992). It must however, be pointed out that the same variable had positive relationships with all the food crops in the two agro-ecological zones, implying that the use of inorganic fertiliser increases food crop production.

Population and food crop production

Household size is used to assess the role of population on food crop production. Household size only predicted cowpea production in the derived savannah and the variable had a positive relationship with cowpea production. Thus, each additional person added to a household in the derived savannah increased cowpea productions by 0.6 kilograms. This shows that population is playing a role in determining food crop production, confirming Boserup (1965) and others (Chayanov, 1966; Turner et al., 1993). However, this scenario is occurring in the derived savannah and not the dry savannah. This situation also confirms an earlier finding that out-migration is occurring, particularly, in the dry savannah to the derived savannah, due to the fact that most of the arable land is already being used for production and bushfires have also taken their toll on arable lands (Codjoe, 2006a).

Related to this is the labour variable, which also predicted the same variables that household size predicted, namely, groundnut and cowpea productions in the dry and derived savannah zones, respectively. However, while labour had an inverse relationship with groundnut production in the dry savannah, the same variable had a positive relationship with cowpea production in the derived savannah. This may be an indication that the two variables are closely linked.

CONCLUSION

Prior to the 1970s, Ghana was virtually self-sufficient in the production of all categories of major food crops. However, since the 1980s, per capita food production has been declining. Poor performance in food production can be attributed in part to external economic conditions, physical conditions, deficient agricultural policies, rapid population growth, etc. This paper used the driving forces (population and market price incentive) as well as other mediating variables (environmental, techno-managerial, political economic and institutional) to spatially examine the determinants of food crop production in the dry and derived savannah agro-ecological zones of Ghana.

Results show that apart from millet and maize, which are predominant in the dry and derived savannah zones, respectively, more cowpea and groundnut is grown in the derived savannah. In addition, derived savannah farming households had larger household sizes, larger labour inputs on their farms, earned more income from sale of farm produce, had extended fallow periods, used more inorganic fertilisers on their farms, received more government assistance, and had arable lands which were less prone to flooding compared to their dry savannah counterparts.

Furthermore, the analysis indicates that population is playing a significant role in determining food crop production in the derived and not the dry savannah, due to migration from the dry to the derived savannah. This is expected because most of the arable land is already being used for production and bushfires have also taken their toll on arable lands in the dry savannah.

The paper recommends that population rates are high in Ghana and programmes (reposition family planning, raise the age of marriage, do more regarding education particularly of the girl-child in the rural communities, intensify programs to lower infant and child mortality rates, etc.) should be targeted at reducing the rate of population growth in Ghana. Secondly, farmers should be encouraged to increase the length of fallow, since as already argued, the development of fallow in Africa and for that matter Ghana, may already be the best management of the soils.

Thirdly, government should provide more assistance (farm management, integrated pest management, agro-forestry, farm measurement, combating fire, introduce farmers to new seed varieties, new technologies, offer assistance in fertilizer application, financial support and supervision) to farmers through agricultural extension agents. Fourthly, agricultural technologies can improve agricultural land use in Ghana. For instance, there are numerous ways by which cropland productivity can be raised which do not induce injury over the long term. If these technologies (including the use of inorganic fertilizer) are put into common use in agriculture, some of the negative impacts of degradation in the agro-ecosystem could be reduced considerably and the yields of many crops increased. Furthermore, recommendations of a land policy reform research, which the Institute for Social, Statistical and Economic Research (ISSER) at the University of Ghana is currently undertaking should be implemented. This is because the study will provide greater clarity and knowledge about the nature and problems of land tenure and administration in Ghana, in order to assist policy makers and civil society groups in their deliberations about the direction, character and specific areas land tenure reforms in Ghana should take.

Finally, it is recommended that this piece of research should be extended to the forest zone of Ghana, so that the results could be compared to what pertains in the dry and derived savannah zones. Consideration should also be made to the temporal role of population in food crop production to complement the spatial role documented in this paper.

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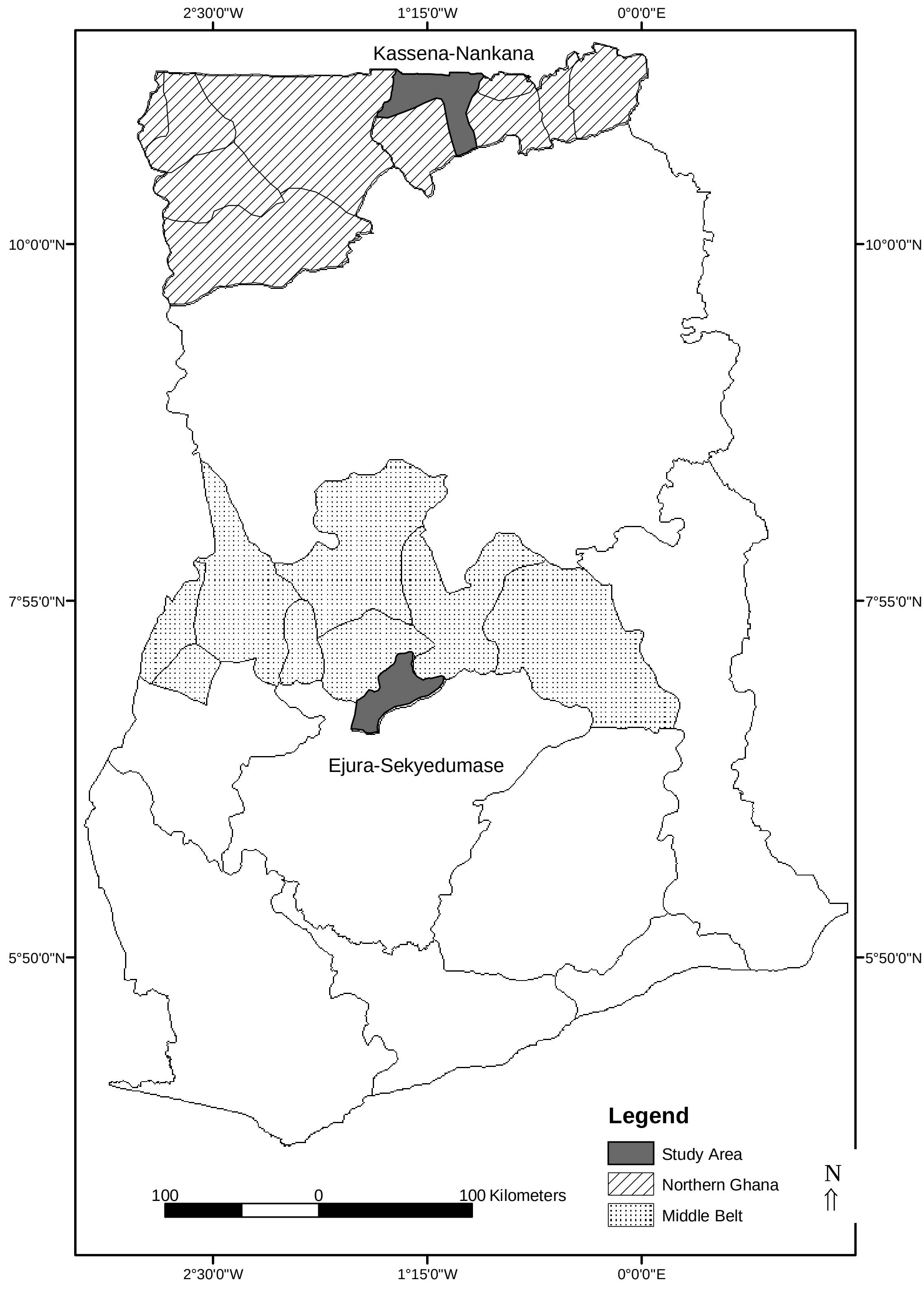

Figure 1: Map of Ghana showing the study areas

Table 1: Description of Variables and Aggregation method used in the Model

Abbreviation	**Variable**	**Description**	**Aggregation method**
FCROP	Food Crop	Food crop (maize, millet, cowpea and groundnut) produced by household (in kilograms) – Dependent Variable	Total
HSIZE	Household size	Number of household members	Total
LABOR	Labour	Number of people used on farm	Total
LTENU	Land tenure	Land tenure system of household	Tenancy = 1; Customary ownership = 2; Family ownership = 3; Individual ownership = 4.
MPRIC	Market price	Amount received from sale of farm produce	Total
FLNGT	Fallow length	Number of years allowed for land to fallow in household	Mean
IFERT	Inorganic fertilizer	Amount of inorganic fertiliser used by household per hectare of farmland	Mean
GASST	Government assistance	Received assistance from government through agricultural extension agents	Yes = 1; No = 2
FSIZE	Farm size	Household farm size for the particular crop (in hectares)	Total
SOILS	Soil	Water absorption capacity of the soil	Slow = 1; Moderately rapid = 2; Rapid = 3

Table 2: Percent of households that grow particular crops by district, 2000

Crops	**Dry savannah**	**Derived savannah**
Maize	14	90
Cowpea	61	46
Groundnut	94	43
Millet	80	1
Tree Crop (Cotton, Cocoa, Tobacco, Oil Palm etc.)	1	9
Sweet Potatoes	7	0.3
Rice	54	8
Vegetables (Tomatoes, Pepper, Onion, Garden eggs)	29	52
Fruits	0.6	0.3
Cassava	-	53
Yam	-	59

Source: Field Survey, 2001 & 2002.

Table 3: Food crop production (00's of kg) by agro-ecological zone, 2000.

Food production/Farm size	**Dry savannah**	**Derived savannah**
Mean household millet production	1.4	-
Mean household maize production	-	22.8
Mean household cowpea production	0.4	3.4
Mean household groundnut production	4.4	5.8

Source: Field Survey, 2001 & 2002.

Table 4: Determinants of food crop production by agro-ecological zone, 2000

Determinant	**Dry savannah**	**Derived savannah**
Mean household size	6.8	8.1
Mean household labour input	4.2	4.8
Land tenure system (percent ownership)	89	78
Mean annual income from sale of farm produce (000s cedis)	243	4683
Mean fallow length per household (years)	2.3	2.7
Mean inorganic fertiliser use per hectare (kg)	88	243
Proportion that received assistance from Government	23	57
Mean household total farm size (in hectares)	2.1	6.0
Soil (percent with long water holding capacity)	32.3	12.2

Source: Field Survey, 2001 & 2002.

Note: 5,500 Ghanaian Cedis = I Euro at the time of interview.

Table 5: Parameters of multiple regression models explaining determinants of food crop production among households in the dry savannah, 2000

Variable	**Millet**	**SE**	**Cowpea**	**SE**	**Groundnut**	**SE**
HSIZE	0.016	0.126	-0.100	0.084	0.473	0.169
LABOR	-0.039	0.199	0.153	0.134	-0.436*	0.261
LTENU	0.471	0.691	0.773**	0.324	1.332*	0.682
MPRICE	0.001	0.001	0.001	0.001	0.001***	0.001
FLNGT	0.117	0.297	-0.495***	0.174	0.410	0.380
IFERT	0.003	0.008	0.001	0.005	0.001	0.010
GASST	0.499	0.649	0.100	0.428	1.631*	0.900
FSIZE	0.057	0.101	-0.100	0.053	0.258***	0.097
SOILS	0.472**	0.179	0.164	0.120	0.255	0.221
Constant	-2.974	2.545	-2.166*	1.266	-3.666	2.721
R^2	0.274		0.278		0.393	
n (Households)	252					

**p<0.10; **p<0.05; ***p<0.01*

SE: Standard Error

Table 6: Parameters of multiple regression models explaining determinants of food crop production among households in the derived savannah, 2000

Variable	**Maize**	**SE**	**Cowpea**	**SE**	**Groundnut**	**SE**
HSIZE	0.459	0.588	0.606**	0.306	-0.335	0.489
LABOR	-1.556	1.015	1.595***	0.522	-0.147	1.011
LTENU	-1.513	1.523	0.597	0.820	2.870*	1.510
MPRICE	0.001***	0.001	-0.010	0.001	0.001***	0.001
FLNGT	-1.255	1.031	-1.488**	0.705	-0.431	0.942
IFERT	0.001	0.043	0.103	0.028	0.100	0.039
GASST	2.000	3.273	1.575	1.786	0.168	2.992
FSIZE	0.667***	0.111	0.341***	0.060	0.122	0.118
SOILS	2.046*	1.128	0.645	0.702	-1.289	1.063
Constant	21.954**	10.891	-6.192	6.537	16.176	10.516
R^2	0.568		0.474		0.130	
n (Households)	252					

**p<0.10; **p<0.05; ***p<0.01*

SE: Standard Error