Population growth and agricultural land use in two agro-ecological zones of Ghana, 1960-2010.

Samuel Nii Ardey Codjoe

Regional Institute for Population Studies, University of Ghana, P. O. Box LG 96, Legon, Accra, Ghana. Tel: 233-21-500274 or 233-244-365916, E-mail: scodjoe@ug.edu.gh.

Abstract

Multiplicative and mediating variables are combined with a demographic variable, in non-linear multiple regression models to assess the effect of population growth on agricultural land use in two agro-ecological zones of Ghana. The paper uses data from a retrospective household survey (conducted among 1,568 farmers in 504 households in 24 communities), population census reports of Ghana, for 1960, 1970, 1984 and 2000, agricultural census data for 1992 and 2000 and a land suitability map. Predictions of cropped area required to meet anticipated population growth are computed for 2010, based on multiple regression models and projected populations. Required cropped area is matched with actual arable area that would be available, based on a land suitability analysis. Predictions show that three and two districts in the dry and derived savannah zones, would, respectively, experience agricultural land shortfall. The rest of the districts in the two agro-ecological zones would have agricultural land available to support future population growth.

Keywords: Population, Agricultural Land Use, Agro-ecological zones, Ghana, Africa

INTRODUCTION

Agriculture is the main economic activity of the population living in Ghana. It contributes over 40% of Gross Domestic Product and employs about half of Ghana's labour force [1]. Out of Ghana's total land area of 23,853,900 hectares, 13,628,179 hectares (57.1%) is suitable for agriculture. But the total area under cultivation in 2000 was 5,808,600 hectares (42.6%) of the agricultural area [2]. This cultivated area also includes fallow agriculture (a system whereby land is left unploughed and unseeded to allow for fertility regeneration). In the past, for every 5 to 6 hectares of cropped land, about one hectare was left fallow. Nowadays, fallow agriculture and/or fallow periods are on the decline, throughout Ghana, and the use of more intensive (e.g., application of fertilizer, phosphate rock, intercropping with legumes, green manure, exchanges with Fulani herders for manure, etc.) systems of farming is widespread [3].

Rapid population growth and low economic standards of living have had consequences for agricultural land resources in Ghana [4]. Fallow lands have been reduced or eliminated. There has been massive migration of mainly the youth to the urbanised, mining and forest areas in southern Ghana. The Greater Accra Region, where the capital city Accra is located, has been the main migrant receiving area. Thus, it has consistently recorded the highest population growth rate (2.9%, 3.3% and 4.4% between 1960-1970, 1970-1984 and 1984-2000, respectively) in the country [5 and 1]. It has also seen the springing up of many satellite urban settlements (in Ghana, settlements with 5,000 population or more are classified as urban). For example, 26% of the urban settlements recorded in the 2000 Population and Housing Census, were non-existent in 1984, when the previous census was held. The majority of these migrants are engaged in occupations in the informal sector and are mainly found hawking on the streets of Accra. The situation is not peculiar to Ghana and there is the likelihood of the development of a coastal mega city between Lagos and Abidjan.

This paper examines the relationship between multiplicative, mediating and demographic variables on one hand and agricultural land use on the other hand in two agro-ecological zones of Ghana, i.e., the dry and the derived (an area with substantial amounts of forest cover previously, which has gradually become savannah vegetation) savannah zones. Specific objectives are to determine the impact of population growth on agricultural land use and make short-term projections on land availability status in the zones.

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). In the 1970s, Ghana was virtually self-sufficient in the production of maize, cocoyam, cassava, and plantain. In 1981-1983, the demand for all these crops except cassava exceeded production. From 1969 to 1983, annual total agricultural production declined by almost 1% while per capita production declined by almost 4% and food supply per person dropped by almost 30% [6]. Maize is the staple crop in Ghana, and its production has had substantial impact on forest cover. Due to declining cocoa production, in the final quarter of the 20th century of -71.1%, farmers turned to maize [7]. 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 [8]. 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% [9]. Furthermore, about 67% of the farmers used maize as a cash crop in addition to feeding the household.

In the 1990s, the Kawakawa/Global 2000 project introduced maize as part of a "*Green Revolution*" package using hybrid seeds, fertilizer, herbicides, no-till and intercropping with legumes. There were concerns about the fact that relying completely on hybrids would result in the loss of local varieties of maize and associated genetic germ plasma. The 'green revolution' requires placing fields under permanent cultivation, and using expensive inputs that must be subsidized by governments. The loss of farm subsidies under the World Bank Structural Adjustment program in the 1980s gave farmers no option but to continue clearing new lands in order to maintain enough fertility to produce the high yields of these hybrid varieties. Further, the high yielding hybrid maize, unlike traditional maize, requires sunlight and complete elimination of forest cover – both primary and secondary. Thus, with growing urban populations and the demand for food in the 21st century, the spread of this kind of maize farming may bring about dire consequences for both the forest fallow cultivation system and the forest canopy, a system which is suitable for cocoa cultivation [8]. This will probably reduce agricultural production and have serious impact on biodiversity in the long-term, especially in savannah eco-systems.

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 [10]. 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.

Problems of Agricultural Production

The agricultural sector in Africa has suffered many setbacks. Poor performance in food production can be attributed in part to external economic conditions, physical conditions (e.g., 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. External influence on the agricultural sector in Africa was mainly felt in the 1980s, during the implementation of the Structural Adjustment Programme (SAP) by the International Monetary Fund (IMF) and World Bank. SAP implementation in Africa focused mainly on agriculture. This reflected the belief that agriculture is an important tradable sector that holds the key to the future growth of the region.

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 [11]. In a nutshell, all these policies harmed the production capacity of the majority of subsistence farmers in the country.

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 [12]. 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[13].

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 [12]. 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 [14]. The results for the agricultural sector have been very limited growth; in capital formation, employment, productivity, and incomes.

STUDY AREA

As shown in Figure 1, the dry savannah zone is located in Northern Ghana, and constitutes the Upper East and Upper West regions. The derived savannah zone located in the middle belt of Ghana is found mainly in the Brong-Ahafo and Ashanti regions of Ghana. Table 1 summarises certain climatic conditions, as well as vegetation and soil characteristics in the two agro-ecological zones. The differences in the rainfall seasons and their levels, temperature, humidity, soils and the vegetation types all have implications for agricultural production in the two zones. 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.

[Figure 1: About here]

[Table 1: About here]

METHODOLOGY

Population data

The main sources of data for determining the population sizes of the zones and their subsequent projection are the Population Census Reports of Ghana, for 1960, 1970, 1984 and 2000. The Census reports present information on population at the national, regional and district levels. District level information is used in this paper. Population projections were carried out for 2010, using the annual inter-censal growth rate between 1984 and 2000. The inter-censal growth rate (r) between 1984 and 2000 was calculated as;

$$r = ln\ (P_2/P_1)\ ^1/t\ .\ k \quad (1)$$

where P_1 is the population in the year 1984, P_2 the population in the year 2000, *t* the time interval and *k* a constant (100). Population estimates for 2010 were then derived using

$P_{2010} = P_{1984} \,.\, e^{tr}$ (2)

Agricultural land use data and land suitability analysis

Agricultural land use was measured by the total cropped area (hectares) of the major crops in the two zones, namely maize *(Zea mays)*, rice *(Oryza sativa),* cassava *(Manihot esculenta)*, yam (*Dioscorea spp.)*, cocoyam *(Xanthosoma sagittifolium)*, plantain *(Musa x paradisiaca)*, sorghum *(Sorghum bicolar)*, millet *(Panicum colonum)*, and groundnut *(Arachis hypogaea)*. The data, which are available for every district, were derived from the Ghana Ministry of Food and Agricultural (MOFA) Census of 2000. At the household level, agricultural land use was measured by total hectares cropped by the household for all crops grown.

An existing soil suitability map for crops grown in the two zones was remapped into a binary layer of *suitable* and *not suitable* for agriculture. Prior to implementing the land suitability assessment, crop specific agro-climatic and agro-edaphic suitability classifications were ascertained. Comparison of the prevailing climatic, soil and terrain conditions with crop requirements formed the basis of the climatic, soil and terrain suitability classifications. When the requirements of a particular crop were well met, it was concluded that the land is physically well suited to its production. If the requirements are not met, e.g., insufficient moisture or inadequate soil depth, the land was classified as not fully suited to the production of that particular crop [15]. A district map was made to overlie the resulting land suitability map, to determine the proportion of land area suitable for agriculture within each district, using a weighted average index. Figure 2 shows the land suitability map.

[Figure 2: About here]

Field Survey

The paper used information from a retrospective 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 and Ejura-Sekyedumase districts). A structured and open-ended questionnaire was employed by the study and was administered by direct interview with the respondents. This technique was employed because the majority of the respondents had no formal education. Six extension workers of the Ghana Ministry of Food and Agriculture (MOFA) mainly administered the questionnaire over a period of 30 days. Even though the questionnaire was in English, the interviewers translated the questions into the local languages, i.e., "*twi*"(language spoken by the Akan, mainly found in the Ashanti and Eastern Regions of Ghana) and "kassin" (language spoken by the Kassena people of the Upper East Region of Ghana) for the respondents, and the responses were recorded in English on the questionnaire. The entire survey had a response rate of 95%.

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 had very small populations. For example, about 97% and 82% of all communities in the Ejura-Sekyedumase and Kassena-Nankana districts, respectively, had populations of under 800 in 2000 [1].

A criterion (communities with population more than 800) was used to select the study areas. Twelve communities in the Ejura-Sekyedumase 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 Kassena-Nankana district, 40 communities qualified. Twelve communities were randomly selected to conform to that of Ejura-Sekyedumase. 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 households were randomly selected from each of the communities. Every farmer in a selected household was interviewed. Association between cropland and population for 2000 was determined from non-linear multiple regression models shown below and was used to predict the effect of population growth on agricultural land use in the dry and derived savannah zones in 2010:

$$\ln(Ca) = 0.033_{P} + 0.007_{AL} + 0.001_{AC} \ldots - 0.013_{ED} + 0.756 \text{ Dry}$$

$$\ln(Ca) = 0.058_{P} + 0.003_{AL} + 0.001_{AC} \ldots + 0.129_{ED} + 0.276 \text{ Derived}$$

The projected population for each district for 2010 was substituted for *p* in the regression models. Together with the constant and the other independent variables, *Ca*, which is the required cropped area in 2010 was determined. The description of variables and how they were measured is presented in Table 2.

[Table 2: About here]

Concepts and Variables

The paper incorporates concepts from the multiplicative and mediating perspective of the population-environment nexus. The former states that population interacts in multiplicative ways with other factors, such as levels of consumption and technology, to have an impact on the environment [16-20]. Multiplicative variables considered in this paper include, affluence (measured by household ownership of livestock, namely cattle, sheep and goat, ownership of household consumer goods including car, motorcycle, bicycle, television, and radio, off- and on-farm income) and technology (use of tractor, and inorganic fertiliser, the practice of the land fallow farming system, as well as cultivation of new land. Although there is some local cattle rearing in Ghana, the activities of Fulani herders from the Sahel who began permanently moving southward in the middle of the 20th century, invading northern Ghana to use boreholes, increased human populations. The Fulani caused loss of dry season grazing land on floodplains, and degraded habitat became worse through the drought of the 1970s/80s. The ability of the migrant Fulani herdsmen to establish reciprocal relations with the host population largely explains their migration and settlement in Northern Ghana [21].

Affluence was used as a proxy because affluent households may be in the position to invest more in their farms and may increase the size of their farm holdings. Besides, the type of farming system used, whether slash-and-burn (vegetation is slashed and burned and ash from burned vegetation helps fertilize the soil), crop rotation (different crops are planted in a regular sequence so that a crop that leaches the soil of one kind of nutrient is followed during the next growing season by a crop that returns that nutrient to the soil), land fallow, etc, and the inputs, whether they are tractors and/or inorganic fertilizers, may all affect agricultural land use. 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 [22]. 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.

Finally, the availability of additional arable land for the households can encourage the cultivation of new land since households would turn to such land to increase productivity during times of soil fertility decline in cultivated areas. This may result in the elimination of secondary and primary forests.

The mediating perspective emphasizes that social, cultural and institutional factors play a mediating role in determining population-environment relationships. [23-24]. Mediating perspectives considered include educational background of household members, proportion of major farmers in household, land tenure arrangement and distance travelled to farm. Educational level was considered due to the fact that the quality of a population is very important and can influence agricultural land use.

The dominant type of land tenure in any community can greatly affect the total agricultural land cropped. This assertion is being made as a result of the fact that in communities where there are flexible land tenure systems, i.e., *"abunu"* (splitting into two; farm proceeds shared in ratio of 1:2 between farmer and landowner) or *"abusa"* (splitting into three; farm proceeds shared in ratios of 1:3), members may put more land under cultivation. But, in areas with very stringent land tenure systems or in situations where land may be hired, land accessibility may be difficult. The study considered two kinds of land tenure systems, namely, tenancy and individual ownership (customary and family). In Ghana, sharecroppers have put enormous pressure on soil fertility to secure high yields in order to pay land rents [25-26]. Farmers in such situations discount the future at very high rates, thereby reducing the incentive for long-term investments in improved soil fertility. This could be another reason for intensification, especially in derived savannah areas full of tenants with no incentive to reinvest in long-term soil productivity. Besides, the distance travelled to a farm may be related to land accessibility and availability. Finally, a demographic variable, viz. population of the locality, has been included in the analysis to assess the role of population in agricultural land use.

RESULTS AND DISCUSSIONS

Trends in Population and Agricultural Land Use

As shown in Table 3, the dry savannah zone, which covers a total of 22,727 square kilometres, had a population of 355,851 in 1960, which by 2000 had risen to 1,153,822 and was projected to be 1,376,096 in 2010. The derived savannah zone on the other hand covers a total of 25,070 square kilometres and had a population of 167,277 in 1960, which also grew to 776,941 in 2000 and was projected to be 1,081,991 in 2010. This may indicate that factors such as declining fallow and soil productivity, and thus production, as well as lack of land availability for the youth are key issues contributing to migration of the youth from the savannah zone.

[Table 3: About here]

With regard to agricultural land use, derived savannah households had larger farm holdings compared to the dry savannah in both 1984 (4.5 hectares compared to 2.3 hectares) and 2000 (6.0 hectares compared to 2.1 hectares). 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.

Multiplicative variables

Household Affluence

As shown in Table 4, derived savannah households earned on average almost twenty times more from the sale of farm produce in 2000 than dry savannah households. But, dry savannah households earned more than derived savannah households with regard to monthly off-farm income, although the difference is minimal.

[Table 4:About here]

Although, incomes measured in this study did not include remittances, it is a fact that in many of the savannah areas of Sub-Saharan Africa where land is at a premium and soil productivity is declining, many rural households are highly dependent upon remittances from family relations working in town or even overseas. A study has shown that about 37.6% and 19.9% of households, in the dry and derived savannahs, respectively, received remittances from household members living away from home in 2001 [27]. Furthermore, when all categories of consumer goods used to measure household affluence are considered, people in the derived savannah owned more than their counterparts in the dry savannah in both 1984 and 2000. The only exceptions were bicycle and motorcycle ownership. This may be attributed to the fact that bicycle and motorcycles are the major mode of transportation in the dry savannah.

The scenario is almost the same with regard to livestock ownership. But, in 1984, dry savannah households had more cattle compared to derived savannah households. While ownership of sheep and goats decreased for both groups within 1984 and 2000, it increased for cattle in the derived savannah. The explanation may be the increasing importance of cattle in the community. Cattle are used as dowry for marriages, perceived as objects of prestige and wealth, and are used for security in periods of economic crisis. Fulani herders have been used by local people for caring and building up local herds. Nevertheless, trypanosomiasis continues to pose a threat to cattle rearing especially in the derived savannah zone.

Technology

The use of both farm inputs, viz. tractor, and inorganic fertiliser, was higher for both 1984 and 2000 in the derived savannah compared to the dry savannah. Among each group, the use of both inputs was higher in 2000 compared to 1984, indicating that the use of mechanised farm inputs increased with time (Table 5). The mean fallow years per household decreased from 2.5 years in 1984 to 2.3 years in 2000 in the dry savannah, and from 3.4 years in 1984 to 2.7 years in 2000, in the derived savannah. This was possibly dictated by pressure on land.

[Table 5: About here]

The analysis further shows that farmers in the derived savannah, farmed on new agricultural lands, which were generally seven times as large as that of dry savannah farmers. This indicates that more new lands are cultivated in the derived compared to the dry savannah. This scenario could also be attributed to the fact already mentioned, that most farmers started using maize as a cash crop in addition to feeding the household in the face of declining cocoa production in the final quarter of the 20th century, mainly in derived savannah areas.

Mediating variables

As shown in Table 6, the proportion of people with no formal education is lower in the derived (34.6%) compared to the dry savannah (44.2%) in 2000. It is therefore envisaged that more people in the dry savannah would be engaged in farming compared to the derived savannah. An analysis based on the ten administrative regions of Ghana shows a strong positive correlation of 0.75 between illiteracy and farming. Further, the majority of the population i.e., 71.9% and 72.7% in the dry savannah, and 69.9% and 72.1% in the derived savannah, respectively, had farming as their major occupation for 1984 and 2000, indicating that farming is the major occupation in both zones.

[Table 6: About here]

There was an almost universal ownership of farm holdings in the dry compared to the derived savannah where migrants mainly hire farmlands for both 1984 (90%) and 2000 (89%). It must, however, be pointed out that tenant farmers put enormous pressure on soil fertility to secure high yields in order to pay land rents. Thus, they are insensitive to the long-term investment in improved soil fertility. Finally, more farmers in the derived savannah (9.2%) travelled a distance of 10 kilometres or more to their farthest farms compared to their counterparts in the dry savannah (6.0%).

Factors affecting agricultural land use

A variable used to measure household affluence (livestock) predicted agricultural land use in the dry and derived savannah zones in 1984. The variable is positively correlated with cropped area in both models. This indicates that the more affluent a household is, the more cropped area it had. Fallow years allowed, was another variable that predicted agricultural land use in both zones in 1984. As anticipated, land fallow is negatively correlated with cropped area in the models, which implies that the more land people left to fallow, the less land area they had cropped. Farmers in both zones who allowed an additional year of fallow in 1984 had about 0.002 (0.004 acres) less hectares of farmland than their counterparts. This certainly has positive implications for long-term soil fertility. Furthermore, *'major farmer in household'* was a statistically significant predictor of agricultural land use in the dry savannah zone in 1984 (Table 7).

[Table 7: About here]

Finally, none of the agricultural technological indicators (use of tractor, and inorganic fertilizer) predicted agricultural land use in both zones in 1984. This strongly indicates that innovations in mechanized forms of farming had not significantly spread to the two agro-ecological zone of Ghana in 1984, and simple subsistence forms of farming were still being practised, as was the case in other agro-ecological zones of Ghana. In 2000, household affluence (livestock), proportion of major farmers in household, and distance to farthest farm predicted agricultural land use among both dry and derived savannah households. But, while inorganic fertilizer use, and fallow years allowed, predicted agricultural land use in the dry savannah zone, on-farm income, tractor use, and cultivation of new land predicted agricultural land use in the derived savannah zone.

Income from on-farm activities plays a significant role in agricultural land use among the derived savannah households. This is mainly due to the enormous disparities that exist between the income patterns from this source between the two groups. As expected, the results show that income gained from the sale of farm produce is channelled into farming among derived savannah farmers. The fact that the use of inorganic fertilizer and tractors for farming were statistically significant predictors of agricultural land use among dry and derived savannah households, respectively, in 2000 amply demonstrates that the use of technologically advanced forms of farming is gradually becoming prominent in both zones. The intensification being talked about in these farming systems entails an increase in seed densities, application of small amounts of inorganic fertiliser, and the limited use of improved seed varieties. This is a process which could best be described as mining the soils for short-term gains. This cannot be described as agricultural intensification. Rather, the salient facts are the cost of inputs versus yields and risks, transportation on a poor road network, and the cost of bringing these soils back with modern methods, which is too expensive for most subsistence farmers. Besides all this, there is limited and in some instances no government subsidy.

Distance to farthest farm had positive correlations with agricultural land use, in both zones, which was an unexpected outcome. This means that the farther people travelled to their farms, the more land they cropped. This result may indicate that longer distances travelled to farms by farmers do not necessarily result in smaller cropped areas. This situation is clearly related to land inheritance and tenure. Finally, new land cultivated was a predictor of agricultural land use in the derived savannah. This could be interpreted to mean that there is more new land cultivation in the derived savannah zone compared to the dry savannah, because of the use of mechanized farming systems and implements.

The variable used to assess the role of population on agricultural land utilization, i.e., population of the locality, was a statistically significant predictor of agricultural land use in 2000 in the derived savannah, but not the dry savannah. Each additional person added to a derived savannah community resulted in a slight increase in agricultural land use in 2000. This situation suggests that out-migration is occurring, particularly, in 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.

Population and agricultural land availability – 2010

According to the classification used, the results of the agricultural land availability status in Table 8, shows that three and two districts, namely, Bolgatanga, Bawku East and Kassena-Nankana in the dry savannah and Atebubu and Techiman in the derived savannah, would experience agricultural land shortfall in the year 2010 as a result of population growth.

[Table 8: About here]

The Bolgatanga district centres on Bolgatanga town, which is the administrative capital of the entire Upper East region of Ghana. It has therefore attracted many migrants. The Bawku East district has the Bawku township as its capital, and is a commercial border town between Ghana and Burkina Faso, and thus has attracted migrants to Ghana from Burkina Faso for many years. Moreover, the district has maintained a large population as a result of the discovery of new mining areas in the 1980s. These mines have attracted migrants, who are mainly small-scale miners practising, what is called "*galampsey*" (small-scale illegal gold mining) in the local parlance. The activities of these small-scale gold miners in these already densely populated areas have resulted in much soil degradation, an issue that has been a major concern for the government. Lands, which were hitherto used for agricultural production, have been converted to mining and this is expected to continue [28]. Finally, the Kassena-Nankana district is home to the Tono dam which caused the inundation of large tracts of agricultural land.

It is ironic to note that only Techiman and Atebubu in the derived savannah zone would experience agricultural land shortfall during the projection period. These are migrant receiving areas, and it was envisaged that the influx of migrants from most parts of Ghana, particularly from the dry savannah zone, would eventually culminate in a drain of the agricultural land resources in the zone. But this has not happened. This means agricultural land use in the zone would keep pace with population growth at least for the projection period that is being considered. Finally, the rest of the districts in both zones would have agricultural land available to support any form of population growth. It is in these areas, especially the ones in the derived savannah zone, that the Government of Ghana should encourage seasonal as well as permanent agricultural migrants to settle.

CONCLUSION

The paper has shown that rapid population growth (it is estimated that Ghana's population will double in 26 years) is a problem in some parts of Ghana and there is the need to tackle this problem. There is rapid growth in population mainly as a result of high fertility and the age structure; 41.3% of the population is below 15 years of age. According to the 2003 Demographic and Health Survey (DHS) in Ghana, about 98% of all women *know of* at least a family planning method; but only 47% of all women had *ever used* a method of contraception. According to the same survey, only 39% and 18.3% of all women, respectively, used any modern method of contraception and condoms. These proportions must rise if Ghana intends to make any inroads in its efforts to curb the high population growth rate.

Efforts should also be made to erode the use of traditional and outmoded contraceptives such as the use of charms, amulets and concoctions, since about 26% of all women claimed in the 2003 DHS that they use traditional methods. These methods have no scientific basis and have generally failed to prevent pregnancies. Illiteracy is also a debilitating factor in curbing high fertility. Over half the female population - 54.3% of women - in Ghana are illiterates. Furthermore, infant and under-five mortality rates are also high, i.e., 64 and 111 per 1,000 live births, respectively. Couples tend to replace lost children in areas of high infant and child mortality. Although abortion is illegal in Ghana, it has been estimated that there are about 17 induced abortions per 1000 women [29]. Finally, HIV/AIDS is another significant factor of the population dynamics in Ghana. The first AIDS case was recorded in March 1986 and the prevalence rate in Ghana has slowed down in the last 3 years (3.6%, 3.1% and 2.7% in 2003, 2004 and 2005, respectively). If current trends continue, HIV/AIDS is not expected to affect significantly the population growth rate of Ghana. But, HIV/AIDS may be underreported in Ghana, and many more more people may be HIV-positive and thus become AIDS patients in the future, with a consequent impact on the economic productivity and efficiency of the nation. If so, then AIDS will considerably affect the future population growth rate of Ghana.

All these issues are unfavourable to curtailing the high population growth rate in Ghana. The government is therefore urged to 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, increase contraceptive usage, and educate people on the need for smaller family sizes, as well as make effective propaganda against HIV/AIDS.

With regard to improving the agricultural land use situation in Ghana, the following recommendations are made. 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 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. Some of these technologies are inorganic fertilizer and tractor use, which are related to the practice of agricultural intensification.

REFERENCES

[1]. Ghana Statistical Service., 2002, *2000 Population and housing census. Summary report on final results*. Accra: Medialite Co. Ltd.

[2]. Ministry of Food and Agriculture., 2001, *Agricultural census report, 1992 -2000*. Accra.

[3]. Codjoe, S.N.A., Ehlers, E., and Vlek, P.L.G., 2005, Effects of change in population, household conditions and farming practices on agricultural land use in the Volta River Basin of Ghana, 1984-2000. *Erdkunde* **59**(2): 126-135.

[4]. Benneh, G. and Agyepong, G.T., 1990, *Land degradation in Ghana*. London: Commonwealth Secretariat/University of Ghana. Pall Mall.

[5]. Ghana Statistical Service., 1989, *1984 Population census of Ghana. Special report on localities by local authorities*. Accra: Eddy Williams Ltd.

[6]. Dadson, J.A., 1988, *Population and food in Ghana*. Population Impact Project, University of Ghana, Legon.

[7]. ILO,. 2004, *A fair globalization: Creating opportunities for all*. International Labor Office, World Commission on the Social Dimension of Globalization, Geneva, Switzerland. http://www.ilo.org/public/english/fairglobalization/report/index.htm.

[8]. McCann, J.C., 1999, *Green land, brown land, black land: an environmental history of Africa, 1800-1900*. Heinemann, Portsmouth, N.H. and James Currey, Oxford. 201p.

[9]. FAO. 2004, *Food Balance Sheet, Ghana 1961-2002*. Last updated, February. www.faostat.fao.org.

[10]. Government of Ghana., 2005, *The budget statement and economic policy of the government of Ghana for the 2006 financial year*. Ministry of Finance.

[11]. FAO. 1989. *Structural adjustment policies and the agricultural sector, theoretical concepts for analysis of economic policies, The Salter-Swan-Model*. www.fao.org/tc/tca/31chap8.htm.

[12]. OXFAM., 2002, *Cultivating poverty. The impact of U.S. cotton subsidies on Africa.* OXFAM briefing paper No. 30. OXFAM International. http://www.oxfam.org.uk/what_we_do/issues/trade/bp30_cotton.htm.

[13]. Kousari, K., 2004, *Trade performance and commodity dependence*. FAO Regional Conference 2004. Trade and Development Workshop, 28th February, Johannesburg, South Africa.

[14]. Palmer, H. and Kline, S., 2003, *Time to declare war on poverty in Africa*. OXFAM Briefing Paper No. 47. OXFAM International. www.oxfam.ca/news/G82003/Evian%20briefing%20paper.pdf.

[15]. Boateng, E., Ayamga, T., Chidley, T., Elgy, J., Savory, D. and van Velthuizen, H., 2001, *Geo-spatial modelling for agro-ecological assessments and decision support for development planning in Ghana. Land suitability analysis*. Soil Research Institute, Ghana.

[16]. Ehrlich, P. and Holdren, J., 1971, The impact of population growth. *Science* **171**, 1212-1217.

[17]. Ehrlich, P. and Holdren, J., 1974, Human population and the global environment. *American Scientist* **62**, 282-292.

[18]. Harrison, P., 1992, *The third revolution: environment, population and a sustainable world*. London and New York: IB Tauris and Co. Ltd.

[19]. Commoner, B., 1991, Rapid population growth and environmental stress. In: *Consequence of rapid population growth in developing countries*: Proceedings of the United Nations/Institut national d'études démographiques. Expert Group Meeting, 23-26 August 1988, United Nations, Taylor and Francis, New York. 161-190.

[20]. Commoner, B., 1992, *Population, development and the environment: Trends and key issues in the developed countries*. Paper presented at United Nations Expert Group Meeting on Population, Environment and Development, 20-24 January 1992, New York.

[21]. Tonah, S., 2002, *Migrant Fulani herdsmen, indigenous farmers and the contest for land in northern Ghana*. Draft paper submitted to the Biennial Conference of the "African Studies Association in Germany (VAD)" held in Hamburg, May 23-26, 2002. http://www.vad-ev.de/papers/tonah.pdf.

[22]. Boserup, E., 1965, *The conditions of agricultural growth*. London. Allen and Unwin.

[23]. Blaikie, P. and Brookfield, H. (Eds)., 1987, *Land degradation and society*. New York: Metheun and Co. Ltd.

[24]. Bilsborrow, R., 1992, Population growth, internal migration, and environmental degradation in rural areas of developing countries. *European Journal of Population* **8**,125-148.

[25]. Benneh, G., 1997, Toward sustainable agriculture in Sub-Saharan Africa: Issues and strategies. *IFPRI Lecture Series No. 4*. Washington, DC: International Food Policy Research Institute. http://www.ifpri.org/pubs/pubs.htm#lecture.

[26]. Gruhn, P., Goletti, F. and Yudelman, M., 2000, *Integrated nutrient management, soil fertility, and sustainable agriculture: Current issues and future challenges*. Food, Agriculture, and the Environment Discussion Paper 32. International Food Policy Research Institute, 2033 K Street, N.W. Washington, D.C. 20006 U.S.A. http://www.ifpri.org/2020/dp/2020dp32.pdf.

[27]. Codjoe, S.N.A., 2004. Population and Land use/cover dynamics in the Volta river basin of Ghana, 1960-2010. Ecology and Development Series, No. 15. Cuvillier Verlag Gottingen.

[28]. Ghana Statistical Service., 1995, *Migration research study in Ghana. Internal migration. Volume 1*. K.A. Twum-Baah, J.S. Nabila, and A.F. Aryee, (Eds). Social Sector

Policy Unit Ministry of Finance and Economic Planning. Accra: Commercial Associates Limited.

[29]. Ahiadeke, C., 2001, Incidence of induced abortion in southern Ghana. *International Family Planning Perspectives **27** (2), 96-101.*

Figure 1: Districts map of Ghana showing the dry and derived savannah

Figure 2: Map of parts of Ghana showing areas suitable

and not-suitable for agriculture

Table 1: Altitude, Climate and Vegetation by zone

Variable	**Dry Savannah**	**Derived Savannah**
Altitude (meters above sea level)	180-300	60-300
Annual Rainfall	1150 mm	1430 mm
Mean Monthly Temperature (March)	36^{o} C	30^{o} C
Mean Monthly Temperature (August)	27^{o} C	24^{o} C
Relative Humidity (Dry Season)	20-30%	75-80%
Relative Humidity (Rainy Season)	70-90%	90-95%
Vegetation	Predominantly grassland	Open savannah with scattered trees below 5 metres

Source: Dickson, K.B., and Benneh, G., 1995, A *new geography of Ghana*. London: Longman.

Table 2: Description of Variables and Aggregation method used in the Model

Abbreviation	Variable	Description	Aggregation method
Ca	Cropped area	Total cropped area by household (in hectares) – Dependent Variable	Mean calculated and natural log taken
AL	Affluence (Livestock)	Household affluence (measured by ownership of livestock, i.e., cattle, sheep and goat)	Cattle ranked three, sheep, two and goat, one due to level of importance in community. The household score then determined based on ranking.
AC	Affluence (Consumer goods)	Household affluence (measured by ownership of Car, Motorcycle, Bicycle, TV and Radio)	Car ranked five, Motorcycle four, bicycle three, TV two and radio one. Household score was determined based on ranking.
OF	Off-farm income	Monthly household income from off-farm activities	Mean
ON	On-farm income	Annual household income from sale of farm produce	Mean
P	Population of locality	Number of people in locality	Absolute
MF	Major farmers	Proportion of major farmers in household	Percentage
LT	Land tenure arrangement	Land tenure system of household head, i.e., tenancy or ownership	Tenancy = 1, Ownership = 2
TR	Tractor use	Number of hours of tractor use per hectare of farmland by household	Mean
FE	Inorganic fertilizer use	Amount of inorganic fertiliser used by household per hectare (kgs)	Mean
FA	Fallow years allowed	Number of years allowed for land to fallow in household	Mean
DI	Distance to farthest farm	Household distance travelled to farthest farm	Mean
NL	Cultivation of new land	New farm lands cultivated within 5 years of survey (in hectares)	Mean
ED	Household educational level	Educational level of household members	No schooling ranked zero, primary/basic one, JSS/middle two, SSS/secondary three and Tertiary ranked four. Mean household educational score determined

Table 3: Population by agro-ecological zone, 1960 – 2010.

Dry Savannah	Land Area (Km2)	Population 1960	1970	1984	1992*	2000	2010*	Growth Rate (1984-2000)
Builsa	1960	20402	51782	66357	70741	75375	81650	0.8
Sissala	7130	39461	42442	59012	71161	85442	107970	2.3
Wa	5460	48969	55120	141100	178409	224066	300426	2.9
Nadawli	2920	52477	63861	81722	82219	82716	83343	0.1
Bawku East	2097	99159	175154	251221	278318	307917	350002	1.3
Bolgatanga	1460	34275	95010	146658	183761	228815	303332	2.8
Kassena-Nankana	1700	61108	99006	149680	149586	149491	149373	-0.04
Total	**22727**	**355851**	**582375**	**895750**	**1014195**	**1153822**	**1376096**	**1.6**
Derived Savannah								
Sene	7900	12500	31122	61858	71383	82166	98274	1.8
Nkoranza/Kintampo	8880	62244	70556	151801	205746	275730	403231	3.8
Atebubu	5990	35037	59101	104139	130836	163330	217248	2.9
Ejura-Sekodumasi	1350	22854	36866	60997	70430	81115	97087	1.8
Techiman	950	34642	45260	90181	126352	174600	266151	4.2
Total	**25070**	**167277**	**242905**	**468976**	**604747**	**776941**	**1081991**	**3.2**

Source: 1984 Population Census of Ghana, Special Report on Localities by Local Authority and 2000 Population and Housing Census, Special Report on 20 Largest Localities.

*Projected Figures

Table 4: Affluence among dry and derived savannah households, 1984 and 2000

Affluence	**Dry savannah**		**Derived savannah**	
	1984	**2000**	**1984**	**2000**
Income (000's Cedis)				
Mean annual farm income	-	242.7	-	4682.9
Mean monthly off-farm income	-	193.5	-	152.6
Consumer Goods				
Percent bicycle ownership	30.7	32.5	17.9	19.0
Percent car ownership	0.6	0.5	0.7	1.1
Percent motorcycle ownership	2.8	2.9	0.5	0.4
Percent radio ownership	26.0	27.3	26.8	27.7
Percent television ownership	2.4	3.2	8.7	9.1
Livestock				
Mean cattle per household	9.6	5.1	6.9	22.7
Mean sheep per household	12.3	5.6	17.5	8.5
Mean goats per household	11.0	6.0	14.7	8.9
Mean livestock per household	11.0	5.6	13.0	13.4

Source: Field Survey, 2001 and 2002

Note: €1=Cedis 5,500 at time of interview.

Table 5: Technological farming implements and practices used among

dry and derived savannah households, 1984 and 2000

Farming practices and implements	Dry savannah		Derived savannah	
	1984	2000	1984	2000
Mean household hours spent by tractor on farm per hectare	1.7	3.2	9.5	12.7
Mean household inorganic fertiliser used per hectare (kgs)	60	88	162	243
Mean fallow years per household	2.5	2.3	3.4	2.7
Mean household new farms within last 5 years (hectares)	-	0.1	-	0.7

Source: Field Survey, 2001 and 2002.

Table 6: Selected mediating variables among

dry and derived savannah households, 1984 and 2000.

Mediating variable	Dry savannah		Derived savannah	
	1984	2000	1984	2000
Percent no schooling	-	44.2	-	34.6
Percent major farmers	71.9	72.7	69.9	72.1
Land tenure (ownership)	90.0	89.0	80.1	78.0
Percent who travelled 10 kms or more to farm	-	6.0	-	9.2

Source: Field Survey, 2001 and 2002.

Table 7: Parameters of multiple regression models explaining factors influencing agricultural land use among dry and derived savannah households, 1984 and 2000

	Dry 1984		**Derived 1984**		**Dry 2000**		**Derived 2000**	
Variable	**B**	**SE**	**B**	**SE**	**B**	**SE**	**B**	**SE**
Affluence (Livestock)	0.004***	0.001	0.007***	0.002	0.008***	0.002	0.004***	0.00
Affluence (Consumer goods)	0.001	0.001	0.001	0.001	-0.001	0.001	-0.001	0.00
Off-farm income	-	-	-	-	0.001	0.001	-0.001	0.00
On-farm income	-	-	-	-	0.001	0.001	0.001***	0.00
Population of locality	0.001	0.001	0.001	0.001	0.001	0.001	0.001**	0.00
Major farmers	0.003*	0.001	0.004	0.003	0.003**	0.002	0.005***	0.00
Land tenure	0.136	0.195	-0.099	0.189	-0.087	0.159	0.073	0.13
Tractor use	-0.003	0.002	0.000	0.004	-0.002	0.002	0.003**	0.00
Inorganic fertilizer use	0.001	0.002	-0.001	0.003	0.002*	0.001	0.001	0.00
Fallow years allowed	-0.004***	0.001	-0.003*	0.001	-0.003**	0.001	0.001	0.00
Distance to farthest farm	-	-	-	-	0.055***	0.017	0.037***	0.01
New land	-	-	-	-	-0.064	0.136	0.220**	0.09
Household educational level	-	-	-	-	-0.060	0.062	0.093	0.07
Constant	1.130***	0.404	1.751***	0.505	1.179***	0.395	0.784**	0.38
R^2	0.203		0.123		0.309		0.243	
F	5.531***		2.967***		5.892***		5.564***	
n (Households)	190		190		252		252	
n (Farmers)	609		621		782		786	

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

Table 8: Agricultural land availability status by agro-ecological zone, 2010

District	Projected Population 2010	Agricultural suitability Area (00's hectares) 2000	Predicted Cropped Area (00's hectares)	Annual Difference (00's hectares)	Annual Difference (Percent)	Status
Dry Savannah						
Builsa	81650	941	827	11	1.2	ALA
Sissala	107970	3779	1090	269	7.1	ALA
Wa	300426	3549	3015	53	1.5	ALA
Nadawli	83343	1723	844	88	5.1	ALA
Bawku East	350002	1237	3510	-227	-18.3	ALS
Kassena-Nankana	149491	1105	1505	-40	-3.6	ALS
Bolgatanga	303332	832	3044	-221	-26.5	ALS
Derived Savannah						
Sene	98274	2607	995	161	6.0	ALA
Nkoranza/Kintampo	403231	4262	4045	22	0.5	ALA
Ejura-Sekodumasi	97087	932	903	3	0.3	ALA
Atebubu	217248	1917	2185	-27	-1.0	ALS
Techiman	266151	713	2673	-20	-27.0	ALS

ALA Agricultural Land Availability (Positive values)

ALS Agricultural Land Shortfall (Negative values)