Mining and agriculture in Ghana: a contested terrain

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Abstract: There is a growing concern that mining is decreasing agricultural lands and crop production, and thereby contributing to periodic food shortages in Ghana. This study combined evidence from literature, national-level data (1989–2007) and empirical findings. The national-level data was analysed using SAS version 9.2, including trend analysis, simple linear regression and correlations. The research question was: is there a relationship between expansion of the area under mineral concession (mining) and decline in national crop production? Results revealed that increases in both mineral output and crop production have closely followed expansions of the area under mineral concession. At the national level, no statistical evidence was found to support the argument that mining has reduced total acreage cropped. However, a statistical relationship was found to exist between expansion in area under mineral concession and decline in production of the staples: maize, sorghum and cocoyam (cocoyam: R^2 = 0.8086, r = –0.8992, p = 0.0378; maize: R^2 = 0.7655, r = –0.8749, p = 0.0502; sorghum: R^2 = 0.4098, r = –0.64015, p = 0.0249). We subscribe to the notion that resource curse occurs conditionally, and may be offset by proactive policies, initiatives and sufficiently good institutions.

Keywords: economic recovery program; ERP; mining; agriculture; resource curse; Ghana.

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1 Introduction

Many governments have implemented major mining sector reforms, often alongside sustained programs of economic stabilisation and structural adjustment (Hilson and Banchirigah, 2009). Under such reforms, the capacity of relevant government agencies has been boosted, outdated legislation redrafted, new laws enacted and mineral development policies have been revised to attract financial incentives and foreign investors. The World Bank alone has provided US$ 3 billion in financing to 22 mining sector reform projects in 16 developing countries (World Bank, 2004), and more than 90 – mainly developing countries – have redrafted their mineral codes in order to attract outside investment (Bridge, 2004). The influx of foreign investment has facilitated unprecedented increase in mineral production throughout sub-Saharan Africa, Asia and Latin America (Hilson and Banchirigah, 2009). In Zambia, for instance, copper production has remarkably increased over the past decade; and in Peru rapid expansion of gold mining has also been witnessed.

In Ghana, the connections between the economic recovery program (ERP), structural adjustment program (SAP) and the performance of the mining industry are well recognised (Botchie, 1994; Aryee, 2001; Hilson, 2002; Hilson and Potter, 2003). Under Ghana's ERP, the Mining Sector Reform Programme was initiated to restructure mining laws and regulations. Policies were aimed, among other things, at:

a restructuring mining sector legislation to make it more attractive to investors

b strengthening mining sector support institutions

c de-emphasising state control in the mining industry

d recapitalising funding for mines to enhance the mining sector fiscal regime

e formulating environmental guidelines in the mining sector.

To secure the requisite levels of foreign investment in large-scale mining projects, particularly those emphasising the extraction of gold, the Ghanaian government, under the guidance of the World Bank, modified 78 acts, ordinances, decrees, codes and laws regulating the sector (Hilson, 2002). As a result, since mid-1980s, Ghana has witnessed:

tremendous inflows of investments, sharp increase in mineral production (particularly gold) and modest improvement in socio-economic development associated with increased investments in the extractive sector (Owusu-Ansah, 2012). Acknowledging the achievements made by the mining sector and the colossal revenue generated for the Ghanaian economy, the Ghana Chamber of Mines in collaboration with allied organisations celebrated the 80 years of mining in Ghana under the theme: "life without mining is impossible"[1].

This notwithstanding, there is a growing concern with regard to the real impact of the mining industry on agriculture in Ghana and other parts of the world. Large-scale mining and mineral exploration have displaced hundreds of thousands of rural dwellers in the developing world: the farmlands and rangelands on which they have long subsisted have been demarcated to multinational mining companies (Hilson and Banchirigah, 2009) by the government. In Ghana, the expansion in the mining sector has not only led to the degradation of agricultural lands, but also to a decrease in land for agricultural production, resulting in shortening of the traditional fallow from a period of 10–15 years to one of 2–3 years (Aryeetey et al., 2004; SAPRIN, 2002). It is contended that surface mining, in all its forms, has posed the greatest threat to both commercial and subsistence farming, and thus agriculture in Ghana is in serious crisis – resulting in periodic food shortages and famine (Kasanga, 2001). Moreover, it has been argued that the Ghanaian government has made available 70% of the country's agricultural lands to large-scale miners (Hilson and Banchirigah, 2009), and this to a large extent, has affected agriculture adversely. In a periodic review of Ghana's human rights violations within the context of large-scale mining operations, an international organisation [Food First Information and Action Network (FIAN)] joined a Ghanaian civil society group [Wassa Association of Communities affected by Mining (WACAM)] in reporting that gold mining companies in Ghana are destroying agriculture, implying that mining is rather a curse than a blessing[2]. From the perspectives of these non-governmental organisations (NGOs), farming communities in the Western, Eastern, Ashanti and Brong Ahafo regions formerly constituted the food basket of the nation, but now these regions have become areas of net food deficit due to increased mining. Thus, Ghana seems to be sacrificing its enormous agricultural potential to mining in a time of soaring global food prices (FIAN International and WACAM, 2008; IOL News, 2008). In a more recent study, Owusu-Ansah (2012) investigated impacts of large-scale surface mining operations on the livelihood of small-scale household farmers[3] in three farming communities in the Brong-Ahafo region of Ghana. According to this researcher, 80% of household farmers (who participated in his survey research) agreed that they are likely to be impoverished due to loss of their agricultural lands to mining operations. He further asserted that over 80% of the household farmers perceived mining as a threat to agriculture nationwide. Excerpting from one of his quotes of an affected household farmer:

> "mining is destroying our agricultural lands and the farming business…we are over nine thousand (9,000) farmers who have been displaced by the mining company, and our farm lands taken….if on the average each farmer cultivates two acres of land… you can imagine the number of acres of farm lands taken by mining operations in this district alone." (Owusu-Ansah, 2012)

The above discourse indicates a growing sense that mining is threatening agriculture in Ghana. However, the question this study seeks to address is: to what extent are trends in cultivated land area and crop output related to expansion in the extractive sector?

2 Scope and objectives of research

This study examines the mining-agriculture relationship in Ghana. It analyses the extent to which trends in cropped area and crop production are linked to mining (expansion in the area under mining concessions) through the lens of resource curse theory. A large literature suggests that there is a 'resource curse': natural resources abundant countries tend to grow slower than resource scarce countries (Gylfason et al., 1999; Sachs and Warner, 2001; Collier and Goderis, 2007). Discussions on resource curse theory have varied, ranging from economic issues to political concerns. From the economic view point, mining booms can induce a mineral-dependent economy, and this stifles the non-mining sectors of the economy, including agriculture and manufacturing (Ballard and Banks, 2003), with agricultural exports becoming less competitive. On the other hand, mismanagement of the economic boom has been mentioned as the key political concern (Ballard and Banks, 2003). According to Ross (1999), increased government revenue (from mineral exports) can lead to: myopic policy formulation, greater rent-seeking behaviour by interest groups, general weakening of state institutions, and less emphasis on accountable and transparent systems of governance.

Mining has been central to the notion that resources can be a curse, giving rise to lack of development, internal tension, human rights abuses, and conflict at both local and national levels. Drawing on the historical experience of mineral economies in Zambia, Bolivia, Saudi Arabia, Kazakhstan, Peru, Chile, Botswana and Papua New Guinea, some authors have argued that mineral-rich countries perform less well (by both simple growth measures and sophisticated measures of wealth distribution) than economies that are resource poor (Auty, 1998, 1994, 1991). Thus, the resource curse theory questions the perceived wisdom that 'the extraction and processing of natural resources are at the heart of economic development' and suggests that this belief may be mere 'folk economics' rather than sound policy advice (Power, 1996). Whereas the resource curse literature reports negative effects of commodity booms on economic development and distribution, one empirical study by Deaton and Miller (1995) for Africa and another by Raddatz (2007) for low-income countries found that commodity booms significantly raised growth, as measured by the GDP. Other scholars conclude that the resource curse occurs conditionally, and may be offset by proactive policies and sufficiently good institutions (Ross, 1999; Collier and Goderis, 2007).

Over the years, Ghana has initiated various government policies and economic reforms aimed at reducing rural poverty. The mining reforms continued this practice, aiming at 'using mining as a conduit for rural development' (Acquah, 1995), with the long term objective being to reduce rural poverty and improve the quality of rural life. Given the important role that the mining sector plays in the socio-economic development of the nation, the mining sector was one of the areas that received the greatest attention under the ERP. These proactive initiatives taken by the Ghana Government made the mining business very attractive to investors and simultaneously instituted government policies to counteract the negative externalities associated with mining. As a result, Ghana has witnessed: tremendous inflows of investments, sharp increase in mineral production (particularly gold) and modest improvement in socio-economic development. By the end of 2002, the mining industry was by far the largest earner of foreign exchange, accounting for over 40% of the nation's export earnings. However, there is a growing concern with regard to the real impact of the mining industry on agriculture (particularly, crop production and cropped land) in Ghana.

In this study, we seek to contribute to the 'resource curse' debate within the Ghanaian context through our comparison of trends in the expansion of area under mining concession and increases in agricultural productivity as measured by increasing crop production per hectare and expansion of the total cropped area nationwide.

Several factors other than mining have been reported by different authors as limiting crop productivity in Ghana. These include: biophysical factors, pests and diseases, absence of agricultural financing and credit, decreases in cropped area, lack of land tenure security and withdrawal of government subsidies for agricultural inputs (seeds, fertilisers and agrochemicals). Other factors that have been reported are: poor farm management and agronomic practices, absence of better technologies, absence of certified seeds of high yielding varieties, inadequate extension education, inappropriate land preparation practices and weed management, urbanisation and infrastructure development (Quaye et al., 2010; Braimah, 2009; Bugri, 2008; Seini, 2002).

As a tropical country, rainfall and mean ambient temperature are by far the most significant environmental factors affecting crop production in Ghana. According to FAO (2002), most cereal crops suffered yield reductions in 2001 due to a decline in the amount of rain received that year. Quaye et al. (2010) have also reported that the increase in amount of rainfall between 1984 and 1991 resulted in sharp increase in crop production. However, we were unable to find reliable data on these climatic variables for the years from 1983 to 2007, the period of our study. We were able to find data on fertiliser, which is thought to be one of the most important inputs of contemporary agriculture, significantly improving crop yields; however, the levels of fertiliser use per hectare of cultivated land is reported to be low in Ghana (Owusu-Ansah, 2012). Moreover, there is less data comparing crop production and fertiliser use in Ghana. Thus, the increases in production of most crops in Ghana (especially between 1992 and 2007) cannot be adequately explained by or related to fertiliser consumption. This observation is consistent with the findings of other researchers (Braimah, 2009; Seini, 2002; Quaye et al., 2010). Another factor that has remarkably influenced crop production in Ghana is the increase in total area under cultivation. The idea that cropped area has expanded over the years, and that, this expansion has led to an increase in production has been reported (Owusu-Ansah, 2012; Quaye et al., 2010). Other factors often reported in the international literature as affecting cropped area are urbanisation and infrastructural development. However, we were not able to find data on these factors and their impacts on the national agricultural productivity in Ghana; hence these variables are not included in this study.

Perhaps, another important dimension to the mining-agriculture debate is the issue of small-scale miners and the impacts of their activities on agricultural land. In most parts of the sub-Saharan Africa, small-scale mining has proved to be an alternative source of income for those whose former livelihoods (particularly farming) were destroyed by the mining reforms. According to Hilson and Banchirigah (2009), this informal mining sector has grown rapidly over the past decade alongside expanding large-scale mining operations. In Ghana, small-scale mining was regularised in 1989, and over 1.5 million troy ounces of gold and 8.0 million carats of diamonds have been produced by the sector. By the end of 2001, 420 small-scale mining concessions had been licensed, generating over 100,000 miners in the country (Amankwah and Anim-Sackey, 2003). Ironically, it is hard to find reliable data that shows trends in total landmass under small-scale mining concessions over the years. Moreover, it has been argued that alternative livelihood projects initiated in many parts of the developing countries, including Ghana, have

improved the understanding of poverty in small-scale mining communities, informed policy, promoted agrarian activities, enhanced training in skills important for securing employment and enabled most displaced households to earn consistent incomes (Hilson and Banchirigah, 2009). Thus, in Ghana, impacts of small-scale mining on agriculture are anticipated to be very minimal in the years to come. Therefore, this study does not include the total land area under small-scale mining as part of the yearly total of land used for mining.

The heart of this current study is to understand how large-scale mining is affecting agriculture in Ghana. We propose that the feasibility of mineral production is obviously dependent upon the presence of the resources in the ground. Hence, the expansion in area under mining concession can be used to predict impacts of mining on the area under cultivation and crop production. For the purpose of this study, the analysis of agricultural productivity concerns mainly nine selected commodities – cassava, plantain, cocoyam, yam, maize, paddy rice, millet, sorghum and cocoa (a traditional cash crop). These crops are known to be the major crops produced in Ghana. Their selection is based on their agro-ecological, socio-economic and industrial significance.

This study, therefore, has two main objectives:

1 to provide some insights on how the mining and agricultural sectors have performed or responded to changes in economic reforms – particularly the ERP and the SAP over the past two decades (1983–2007)

2 to offer some preliminary answers to the question raised concerning the impact of large-scale surface mining on food security in Ghana.

To meet these objectives, we used the following key indicators:

a the yearly cumulative land mass officially demarcated for large-scale mining operations (expansion in area under mining concessions)

b trends in production of four major mineral products (gold, diamonds, bauxite and manganese)

c trends in total land mass under active cultivation (cropped land) of eight major food crops

d trends in production of eight major food crops and one traditional cash crop listed above.

We tested the hypothesis that cultivated land area and crop production trends are inversely related to expansion in the extractive sector, controlling for other plausible influences on agricultural productivity and land loss. It is worthy to note that Ghana's ERP was officially launched in 1983 – the year during which the government formally endorsed and targeted the mining sector as a key player for rural development. However, our dataset covers only the period between 1989 and 2007. This is because, data on:

a area under mining concession

b crop production

c cropped area for the period 1983–1988

were not readily available when investigators visited the relevant government institutions.

To the best of our knowledge, the above research question and hypothesis have not been addressed by previous researchers in Ghana, and no empirical evidence exist that links mining and agricultural production on a national level in Ghana. However, we wish to indicate that the answers given in this study are preliminary, providing some insightful dimensions that need to be resolved in order to obtain improved answers. The rest of this paper is structured as follows: Section 3 describes the profile of Ghana (highlighting its various agro-ecological zones and describing its agriculture and natural resources). Section 4 outlines research methods, data sources, and data analysis. Section 5 reports on findings in the empirical literature, and compares it with our results from data analysis. Section 6 gives a summary of our results, discusses policy implications and provides suggestions for future research to improve understanding of the relationship between mining and agriculture. Section 7 concludes.

3 A profile of Ghana

Ghana is centrally positioned among the countries along the Guinea Coast of Africa. It is a small country with a total area of 238,533 km^2 (equivalent to 23,853,900 hectares) of which 227,533 km^2 constitutes land and 11,000 km^2 covered by water (The World Fact Book, 2011). As of 2010, Ghana had a total population of 24,791,073 with a growth rate of 1.822% per annum. The population distribution varies across the ten administrative regions and eco-zones of the country, with 68% and 32% living in the rural and urban areas, respectively (Owusu-Ansah, 2012). 56% of the labour force in Ghana is engaged in agriculture (providing over 90% of the food needs of the country), 29% in services and 15% in industry. As a developing nation, the GDP (real growth rate) of Ghana is about 4.7% with per capita (PPP) of $1,600 (The World Fact Book, 2011).

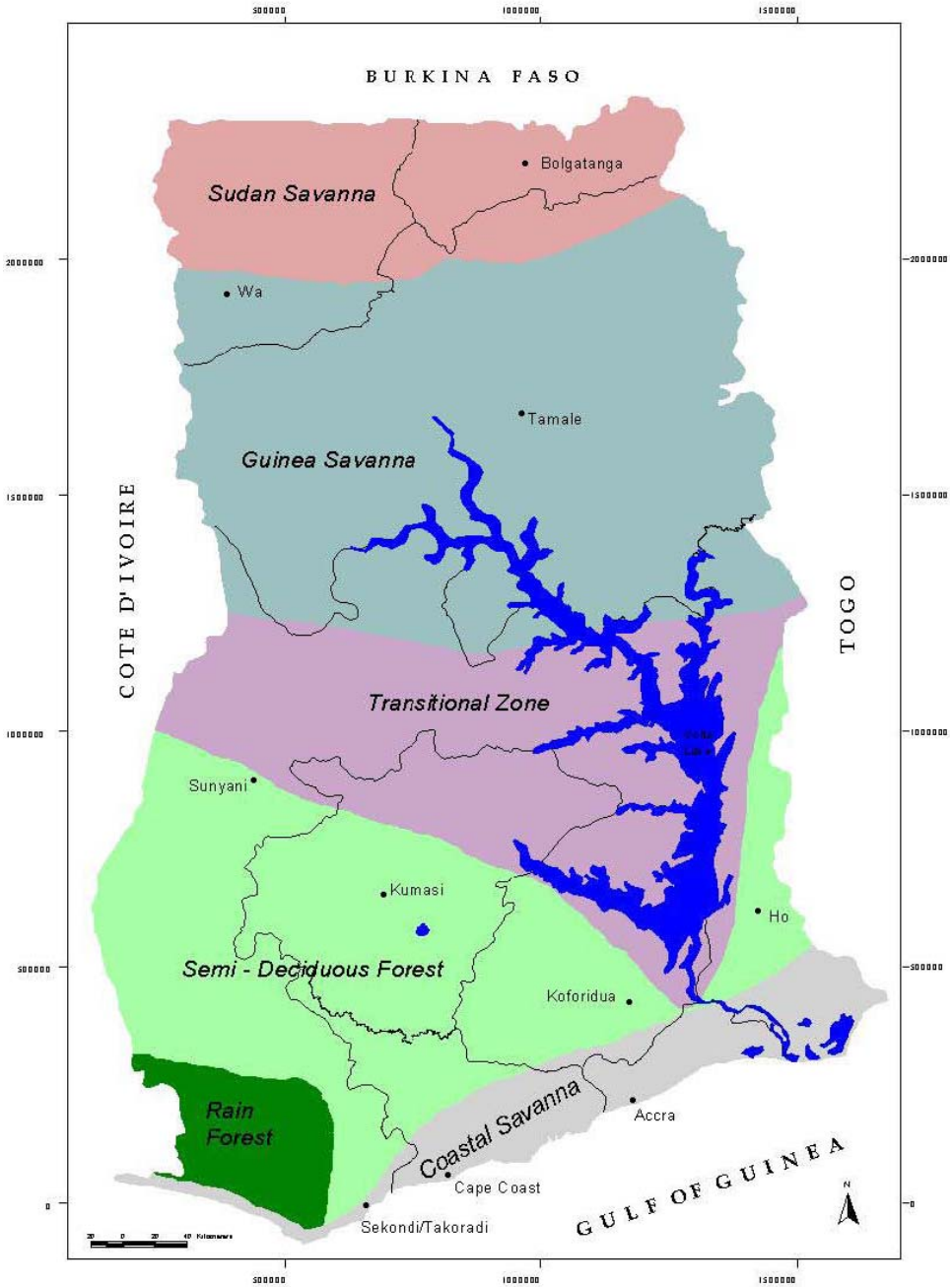
3.1 Agro-ecological zones and agriculture

As a tropical country, Ghana is characterised by six agro-ecological zones: Sudan Savannah, Guinea Savannah, Forest-Savannah Transition, Semi-deciduous Forest, Rain Forest and the Coastal Savannah (Figure 1).

These zones are based on differences in climatic conditions, natural vegetation cover and soil types. They define the major farming systems (including rotational bush fallow systems, permanent tree crop system, compound farming system, mixed farming system, special horticultural system), and determine the types of crops that can productively be cultivated in them.

Agricultural activities constitute the main use to which Ghana's land resources are put. Out of the total land area of 227,533 km^2 (land uncovered by water), 136,300 hectares constitute total agricultural land – representing 57%. Agricultural land use patterns include cultivated annual crops, mixed tree cropping, bush fallow, mixed smallholder farming, horticulture, small-scale fishing and animal grazing (unimproved pasture). The non-agricultural land use consists of forest reserves, wildlife reserves, unreserved closed forest, unreserved savannah lands, mining, settlements and institutional uses.

Figure 1 Agro-ecological zones in Ghana (see online version for colours)



Source: Benneh and Agyepong (1990)

Generally, agricultural produce in Ghana can be categorised into four major groups:

1 industrial crops – such as cocoa, oil palm, coconut, coffee, cotton, tobacco, sheanut and cola nut

2 staple food or subsistence crops – consisting of cereals crops (rice, maize, millet, and sorghum) and starchy staples (cassava, cocoyam, yam, plantain and sweet potatoes)

3 legumes and pulses – like cowpea, bambara nut, groundnut, and soybean

4 fruits and vegetables – including pineapple, citrus, banana, cashew, pawpaw, mangoes, tomatoes, pepper, okro (okra), garden eggs, onions, papaya, avocado, watermelon, cabbage, lettuce and carrots.

These crops are produced mainly for three reasons:

a for consumption

b for industry (as sources of raw materials)

c for export (as sources of foreign exchange earnings).

Exportable traditional cash crops are palms for oil production, coffee, rubber, tobacco, coconut, cotton and cocoa (the country's main export crop). The country also produces substantial amounts of bananas and timber for export. The major non-traditional export crops are also known, as horticultural crops such as pineapples, mangoes, citrus, peppers and tomatoes. Although the majority of rural households keep some sort of livestock, livestock farming is adjunct to crop farming. Poultry, sheep, cattle and goat production is generally widespread throughout the country and is consumed by the farm family or sold to the neighbouring communities.

3.2 Natural resources and mineral endowment

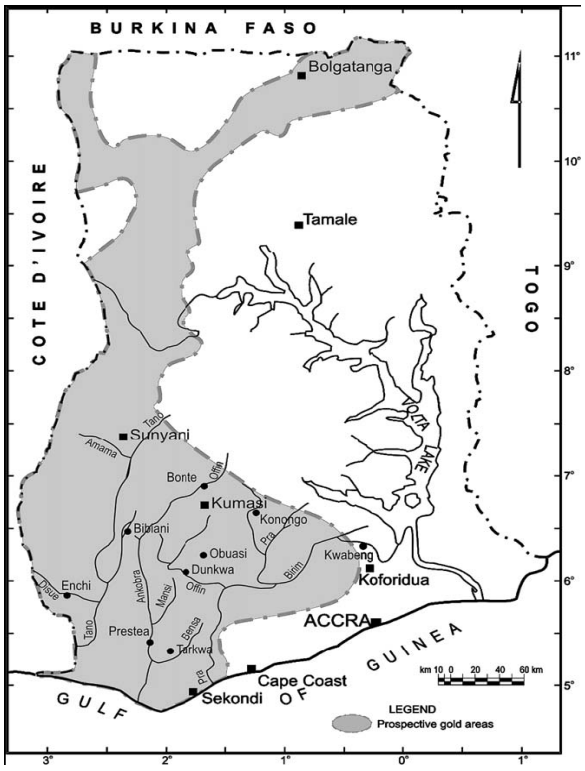
The nation is well endowed with natural resources, mainly minerals, forest and forest products (including timber and rubber), fish, hydropower, silver, salt, limestone and petroleum.

A profile of Ghana's mineral potential has been extensively discussed (Grubaugh, 2003). The relative geological as well as geographical location of Ghana, which falls within the Precambrian Guinea Shield of West Africa, makes the country unique in terms of its mineral endowment. For many years, this mineral belt has been, and is still, home to a host of mining companies in Ghana. Gold is the main mineral product of Ghana; however, manganese, bauxite and industrial diamonds are also produced. Figure 2 shows prospective gold areas in Ghana. Mineral commodities such as iron, granite, kaolin, limestone, feldspar, oyster shells, silica sand, sandstones, mudstones, conglomerates and tillites also exist in various rock types from which they are extracted.

In Ghana, every mineral in its natural state is the property of the Republic of Ghana, and is vested in the president for and on behalf of and in trust for the people of Ghana. Ghana's mineral sector policy, during the past two decades, has focused on using mining as a conduit for rural development. The country expects the mining industry to expand and continue to play a key role in the nation's socio-economic development agenda. The Ghana's Minerals Commission, established under Article 269 of the 1992 Constitution and the Minerals Commission Act, provides inputs on national mining issues, monitors

activities and assists with drafting of policies and regulations. The Commission functions under the direction of the Minister for Lands, Forestry and Mines, who makes the final decisions on reconnaissance, exploration (prospecting) and mining licenses (Hilson and Banchirigah, 2009).

Figure 2 Prospective gold areas in Ghana



Note: Shaded area shows prospective gold areas.

Source: Adopted from Hilson (2002)

The Chamber of Mines is the main association of the minerals industry in Ghana. The Chamber represents the collective interests of companies involved in mineral exploration, production and processing, and has represented the industry's interests since 1928. Member companies' produce over 90% of the Ghana's mineral output and by the end of 2006, 31,237 km^2 (31.1%) of the country's land was under concession to the country's large-scale mining sector (Ghana Chamber of Mines, 2010). The large-scale mining companies include members of the Chamber that are into commercial production. However, there are other groups of mining companies that also operate in Ghana under the Chamber. These include: pre-production category (mining companies that are about to go into commercial production), contract mining group (companies that provide contract mining services), exploration group (a class of mining companies that are into prospecting or exploration), and affiliate category (members that provide mining and minerals related service, also known as services industries).

Within the Ghanaian context, a mining concession is an area of land that is allocated for mining purposes, whereas mineral rights confer to the holder (in this case the mining company) the right to exploit an area for minerals (Ghana's Mining Portal, 2013; Ghana Chamber of Mines, 2010). The following rights, licenses and permits exist:

a reconnaissance license – this confers on the holder the right to search for a specific mineral within the licensed area by geochemical and photo-geological surveys or other remote sensing techniques

b prospecting license – this gives the holder the exclusive right to search for specific minerals by conducting geological, geophysical and geochemical investigations to determine the extent and economic value of any deposit within the licensed area

c mining lease – this gives the holder the right to mine or extract specified mineral(s) within the leased area

d restricted license – this governs the exploration and exploitation of industrial minerals and building materials

e mine support service company license – this is given in line with Section 59 (Act 703) of the Minerals and Mining Act 2006, which allows the Minerals Commission to register interested investors to provide approved services or activities to companies operating within the mining industry.

4 Research methodology

Two main research methods: literature search and field studies were adopted in this study. Literature search involved a systematic review and analysis of published documents on mining, economic recovery, SAP and agriculture in Ghana. The materials used in this study include reports, academic articles, peer review journals, scientific papers and textbooks. Articles were identified by following up on references and scrutinising the publication lists of some online publishers. Major web resources found useful in this study include: Google Scholar, Science Direct; Springer-Verlag; Web of Science, Discover, Sage publication, FirstSearch and ProQuest. The United Nations and World Bank/IMF publications, FAOSTAT home page, extracts from publications of local and international NGOs, local newspapers as well as international magazines were also valuable sources for this study.

Field studies also involved office-to-office visits, and in some cases executive interviews. Office-to-office visits yielded different data sources (in the form of reports, statistical data, tables, figures, etc.) that enabled us to fill in data gaps. Comparison of similarities and differences in data sources coupled with executive interviews generated primary sources of information that helped us to build a better picture of the relationships between agriculture and mining in the country. Nationally recognised institutions and organisations that are relevant to policies, agriculture, land and mining issues were visited. These included: National Development & Planning Commission (NDPC); EPA-Ghana; Ministry of Food and Agriculture (MoFA); Ministry of Lands, Mines and Forestry; Minerals Commission; Lands Commission; Center for Policy Analysis (CEPA); Institute of Economic Affairs (IEA); Institute of Statistical Social and Economic Research (ISSER); Ghana Chamber of Mines; and Public Records and Archives

Administration (PRAAD). Additional data sources that were used are referenced accordingly.

Data obtained for all the variables used in this study are based on national level figures. We used empirical data on total national agricultural land area, cropped area for each of the major crops and total food production. Other data included national total output figures for gold, diamonds, manganese and bauxite.

We used Time Series (Trend) Analysis Approach and analysed production trends of each individual mineral commodity, trends in area under mining concession, trends in total cropped area and crop production. The use of trend analysis approach enabled us to explore the existence of patterns between mining, cropped area and crop production between 1989 and 2007. This also provided an insight into whether the mining industry has caused a decreased area under cultivation and crop production over the past 19 years (from 1989 to 2007), and if so, how quickly or slowly the decrease has occurred. We used simple regression and correlation analysis to determine the existence and strength of relationships between variables. Level of confidence was determined at 95%. Computer software package used in aiding the analysis was SAS version 9.2. Finally, research findings are composed largely of tables and graphs accompanied by written description and explanations of the tabular results.

5 Results and discussions

5.1 ERP/SAP and performance of the mining sector in Ghana (1989–2007)

Results from the empirical analysis indicate that, the number of mineral rights granted and the total land area demarcated as mining concession increased steadily between 1989 and 2007 (Table 1). In 1989, the total number of mineral rights granted to mining companies was 150, and a total landmass of 31,804.68 km^2 designated as area under mining concession. At the end of 2007, a total of 209 mineral rights had been granted to mining companies to operate in Ghana, whereas a total land area of 68,795.93 km^2 was devoted as mining concession. This figure (68,795.93 km^2) constitutes 28.8% of the total land area (238,533 km^2), and 30.2% of the total dry land (227,533 km^2) in Ghana.

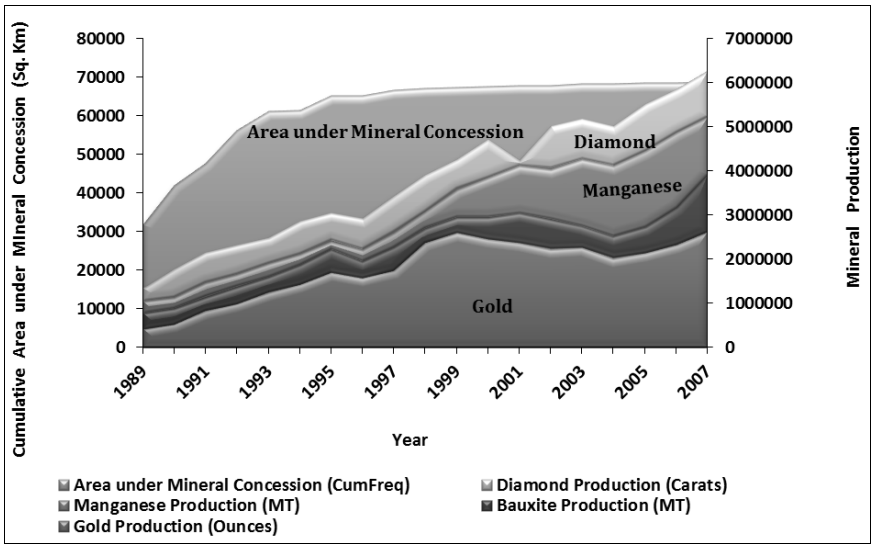
Between 1989 and 2007, mineral production (particularly, gold) increased substantially. The average production rates for Gold, Bauxite, Diamonds and Manganese were 1,791,604.5 ounces per year, 528,582.6 metric tons per year, 742,965 carats per year and 757,508.7 metric tons yearly, respectively. Gold production increased by over 500% (comparing the production levels of 1989 and that of 2007), bauxite production increased by over 240%, diamonds went up by over 260% and manganese production rose by over 370%. Figure 3 illustrates patterns of the yearly measured values of cumulative total land area under mining concession and production of the four major mineral products. Total area of land under mineral concession witnessed an increase of almost an order of magnitude during the first nine years (1989–1997). During this period (1989–1997), an average of 4,352.73 km^2 of land area was converted for mining operation purposes per year. However, between 1997 and 2007, land area under mineral concession increased slightly and steadily, and even appears to level off during the last five years (2003–2007), with an average land mass of 241.04 km^2 converted for mining operations annually.

Table 1 Mineral rights granted and area under mining concession in Ghana (1989–2007)

Year	*No. of mineral rights granted*	*Cumulative frequencies*	
		No. of mineral rights	*Total area under concession (square km)*
1989	150	150	31,804.68
1990	3	153	42,008.16
1991	2	155	47,702.72
1992	7	162	56,103.04
1993	2	164	61,228.36
1994	3	167	61,349.27
1995	4	171	65,135.96
1996	2	173	65,196.76
1997	14	187	66,626.54
1998	3	190	67,077.07
1999	1	191	67,253.00
2000	2	193	67,507.22
2001	2	195	67,760.27
2002	3	198	67,855.22
2003	4	202	68,406.14
2004	0	202	68,406.14
2005	2	204	68,578.98
2006	2	206	68,661.01
2007	3	209	68,795.93

Source: Data obtained from Owusu-Ansah (2012)

Figure 3 Expansion in area under mining concession and mineral production in Ghana (1989–2007)



This probably suggests that, after an initial period of interest in mineral exploration (after the launching of the ERP/SAP), mining activities and for that matter the rate at which land was being converted for mining operations slowed down. Figure 3 further displays that between 1989 and 1995, all four minerals products showed considerable increase in levels of production as more land expanse was being claimed as mineral concession. However, the period between 1995 and 2004 showed quite a different trend from the previous years. There are declining trends in output of all the mineral products (particularly, gold and bauxite) during this period (1995–2004). Between 2004 and 2007, manganese recorded a decrease in volume but the rest of the mineral commodities showed increasing trends in output.

A simple linear regression analysis of the trends between mineral production and expansion in area under mining revealed an R^2 value for gold to be 0.7944, indicating a strong and reliable relationship between expansion in area under mining concession and gold production. A test of the linear trend was also found to be statistically significant (r = 0.89128; p-value < 0.0001). This suggests that there is a greater reliability of predicting trends between area under mineral concession and gold production, and thus, increasing land area for mining operations, particularly for gold mining, may translate into an increase in mineral output.

Some of the accomplishments made by the mining sector since the launching of ERP/SAP (between 1985 and 2008) have been extensively discussed (Owusu-Ansah, 2012). It could be argued that the mineral deposits in the country still provide strong mineral endowment potentials and contribute substantially to the economic progress as well as international trade in Ghana. The ERP/SAP, and for that matter, the passage of the mining and mineral laws have not only boosted investment and production in the sector, but also increased mineral royalties, social investments projects, employee income tax payments, corporate taxes and ancillary levies, as well as inflow of foreign exchange from mineral proceeds. It is interesting to note that Ghana is the most significant gold-producing country in West Africa, accounting for about 70% of regional output. It is also well documented that the country is the second leading gold producer in Africa after South Africa, and ranked 10th in terms of world production of gold-producing about 10% of the world's gold (Acquah, 2007; Ghana Chamber of Mines, 2010).

5.2 ERP/SAP and performance of the agricultural sector in Ghana (1989–2007)

Since 1983, ERP/SAP has been the central focus of development policy in Ghana. Certainly, being the largest sector of the economy, agriculture was one of the sectors that became the target of ERP/SAP. Between 1984 and 1986, an Action Plan and Strategies for Ghana's Agricultural Policy was drafted and put into operation (Seini, 2002). By the end of 1992, a Medium Term Agricultural Development Programme (MTADP) had been initiated. Among other things, Ghana was structured to become self-sufficient in the production of cereal, maximise food security against periods of natural hazards and crop failure, increase productivity, and stabilise internal prices in the agricultural sector.

Notwithstanding these efforts, some authors believe that these policy schemes were disfavour to the agricultural sector. Abdulai and Huffman (2000) have argued that these economic efforts:

1 liberalised food trade and agricultural inputs

2 caused a decline in agricultural sector's share of total budget, which resulted in the decline in agricultural credit

3 removed agricultural subsidies

4 abolished the guaranteed minimum price for maize and rice production that were granted to farmers by government

5 increased the prices of agricultural inputs to local farmers.

Thus, the overall effect of the ERP and SAP on agriculture, particularly on smallholder farmers, appears to be negative. These assertions have been supported by Seini (2002), and echoed by Braimah (2009).

On the other hand, some proponents of the ERP/SAP are of the view that in general terms, the Ghanaian economy has experienced rapid growth and the agricultural sector improved since the launching of ERP/SAP. By the end of 2000, the agricultural sector had become an important source of raw materials for the manufacturing industry. The sector was growing at an average of 4.6%, employed almost 70% of the rural labour force in Ghana, contributed 45% of the GDP, accounted for over 55% of the foreign exchange earnings, and was responsible for meeting over 90% of the food needs of the country (Botchie et al., 2003). Benhin and Barbier (2004) have also echoed that since the launching of ERP/SAP, prices for cocoa and maize have been enhanced, and credit facilities (given to both small-scale farmers and agribusiness firms) have improved. These served as incentives for expansion in crop production. Despite some fluctuations in growth, the sector was said to be the largest in the Ghanaian economy in terms of its GDP contribution in 2007 – comparing the agriculture sector performance with the nations' GDP from industry and services, which were estimated as 25.3% and 37.5% in 2007, respectively (ISSER, 2008).

In this study, we present some of the empirical evidence of how crop production has responded to economic policy changes (ERP/SAP) over the years. The quantities of the selected food crops produced between 1989 and 2007 are given in Table 2. A general observation is that, despite the fluctuations in output, food production in Ghana increased steadily over the past two decades (1989–2007). The most obvious increases in unit production can be found in the output of maize, rice, cassava, yam, cocoyam and plantain. The yearly production of maize appears to be highest relative to the output levels of the rest of the cereal crops. This underscores the assertion that maize is the most widely cultivated and potentially tradable cereal crop in the country.

Similarly, in the case of the starchy staples, the quantity of cassava produced per year is the greatest among staple food crops. This suggests that maize and cassava are the two most popular food crops, widely cultivated and mostly consumed in Ghana. Total production of the four major cereal crops together, witnessed an average rate of increase of 27,556 metric tons per year, while the four major starchy staples recorded an average rate of increase of 708,778 metric tons per year. Comparing the production levels of 1989 and that of 2007, total cereal production went up by over 42%, whereas total output of starchy staples increased by over 180%. Even though growth in total food production was marginally low in some years relative to preceding years, food production in Ghana expanded, and this growth sustained over the years (1989–2007). These findings are

consistent with those of Owusu-Ansah (2012), Quaye et al. (2010) and Seini (2002). The question then is: what factors accounted for increases in crop production over the past two decades (1989–2007), and is mining really threatening crop production in Ghana?

Table 2 Production of selected food crops in Ghana (1989–2007)

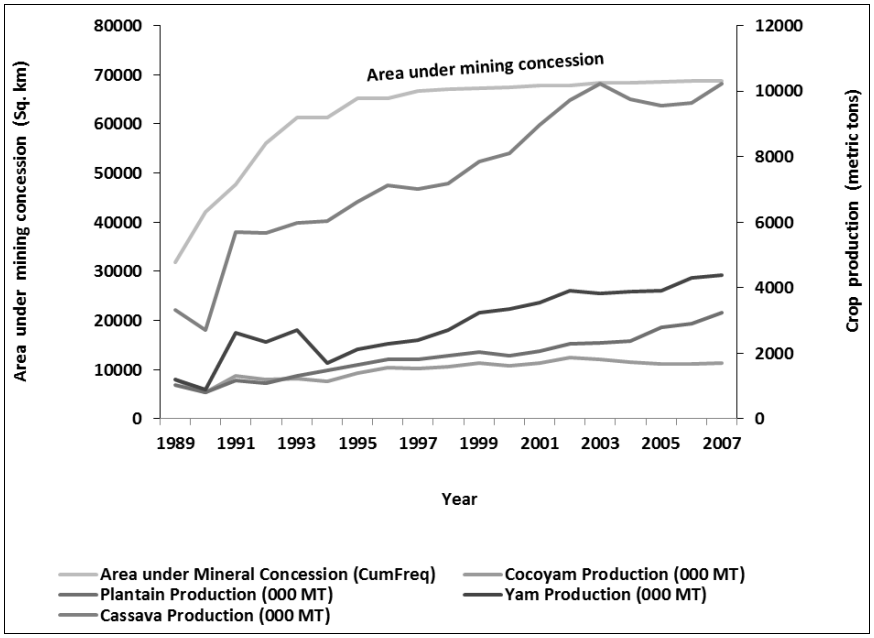
Year	*Crop production (000 metric tons)*							
	Maize	*Paddy rice*	*Millet*	*Sorghum*	*Cassava*	*Cocoyam*	*Yam*	*Plantain*
1989	715.0	67.0	180.0	215.0	3,320.0	1,200.0	1,200.0	1,040.0
1990	553.0	81.0	75.0	136.0	2,717.0	815.0	877.0	799.0
1991	931.5	150.9	112.4	241.4	5,701.5	1,296.8	2,631.9	1,178.3
1992	730.6	131.5	133.3	258.8	5,662.0	1,202.2	2,331.4	1,082.0
1993	960.9	157.4	198.1	328.3	5,972.6	1,235.5	2,720.3	1,321.5
1994	939.9	162.3	167.8	323.9	6,025.0	1,147.7	1,700.1	1,474.7
1995	1,034.2	221.3	209.0	360.1	6,611.4	1,383.2	2,125.7	1,637.5
1996	1,007.6	215.7	193.3	353.4	7,111.2	1,551.8	2,274.8	1,823.4
1997	996.0	197.1	143.5	332.6	6,999.5	1,529.8	2,407.9	1,818.4
1998	1,015.0	281.1	162.3	355.4	7,171.5	1,576.7	2,702.9	1,912.6
1999	1,014.5	209.8	159.8	302.0	7,845.4	1,707.4	3,249.0	2,046.2
2000	1,012.7	214.6	169.4	279.8	8,106.8	1,625.1	3,362.9	1,932.5
2001	938.0	253.2	134.4	279.7	8,965.8	1,687.5	3,546.7	2,073.8
2002	1,400.0	280.0	159.12	316.1	9,731.0	1,860.0	3,900.0	2,278.8
2003	1,289.0	239.0	176.0	337.7	10,239.3	1,804.7	3,812.8	2,328.6
2004	1,157.6	241.8	143.8	287.4	9,738.2	1,715.9	3,892.3	2,380.8
2005	1,171.4	236.5	154.6	299.0	9,567.2	1,685.8	3,922.8	2,791.6
2006	1,188.8	250.0	165.0	315.0	9,638.0	1,660.0	4,288.0	2,900.0
2007	1,220.0	185.0	113.0	155.0	10,218.0	1,690.0	4,376.0	3,234.0

Source: MoFA (2005), ISSER (2008) and FAOSTAT Home Page

5.3 Establishing relationship between expansion in area under mining concession and production of four major starchy crops

Trends in area under mining concession and levels of production of four selected major starchy crops are displayed in Figure 4. Between 1994 and 2002, the yearly output of starchy staples generally followed the expansion trend in land area under mining concession, though there were years of decline in outputs. A more pronounced growth trend could be observed in the case of cassava. The period between 2003 and 2006 exhibited a declining trend in the output of cassava and cocoyam. The declining trend in cassava production was more dramatic within this period (2003–2006), setting a downward slope in growth pattern for cassava that lasted without interruption until 2007, where production trend went upward again. The decreasing trend in cocoyam production, on the other hand, was steady with no obvious rebound in output levels in the succeeding years. On the contrary, yam and plantain production exhibited similar growth trends between 1994 and 2007, with only minor fluctuations.

Figure 4 Trends of area under mining concession and production of four major starchy staples in Ghana (1989–2007)

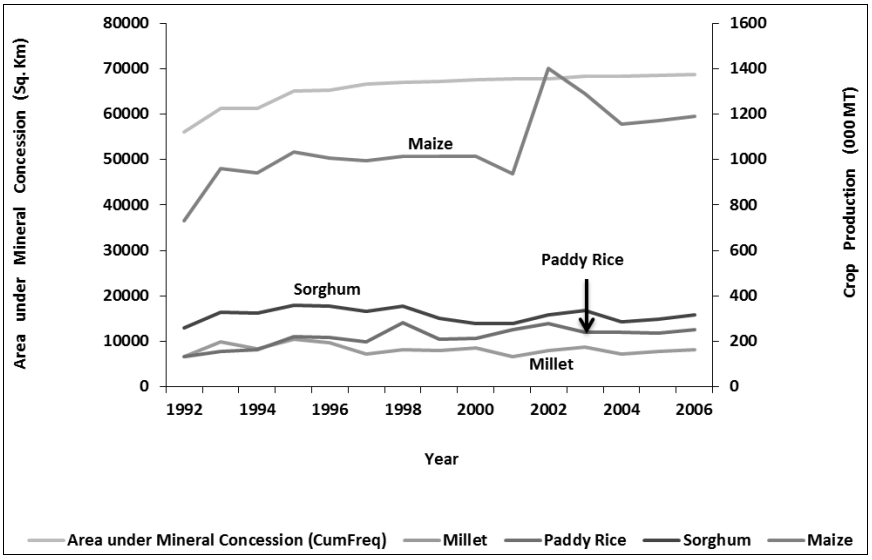


To what extent has the expansion in area under mineral concession influenced the output variability of these four starchy food crops in Ghana? By comparing slopes between variables over short spans rather than the absolute trends in the entire time series (between 1989 and 2007), some relationships were established. A series of simple linear regression and correlation analyses between declining trends in cassava and cocoyam production, and expansion in area under mining concession, particularly between 2002 and 2006, were more pronounced. In the case of cassava, an R^2 value of 0.4666 was obtained. A test of the linear component of the relationship (testing whether the relationship between the declining trend of cassava production and expansion in area under mineral concession is statistically significant) yielded an r-value = –0.68304 and p-value = 0.3170. These findings suggest that the relationship between declining trend of cassava production and expansion in area under mineral concession is not very strong; the coefficient of the declining trend is negative but insignificant. Thus, cassava production has not suffered from a significant 'resource curse' as a result of the mining boom. On the other hand, an R^2 value (0.8086) obtained for cocoyam is stronger, signifying that the regression model (y = –0.2409x + 18216) provides very good predictive power for the relationship. The linear relationship of the coefficient is negative and statistically significant (r = –0.89921; p = 0.0378), which is consistent with the presence of a resource curse effect.

5.4 *Establishing relationship between expansion in area under mining concession and production of four major cereal crops*

Figure 5 exemplifies the trend dynamics of area under mining concession and the potential impacts on cereal crop production in Ghana, particular, between the period of 1992 and 2006. Here again, the area under mining concession expanded steadily from 1992 to 2006, while trends in the year-to-year output of sorghum and millet fluctuated, with gradual decreasing patterns in production levels between 1995 (peak period in each case) and 2006. Production of paddy rice (between 1992 and 2006) did not show a consistent downward trend. The exception is the case of maize production, which exhibited considerable variations from 1992 to 2001, followed by a sudden upward trend that peaked in 2002, and thereafter declined with a steep slope in the production trend.

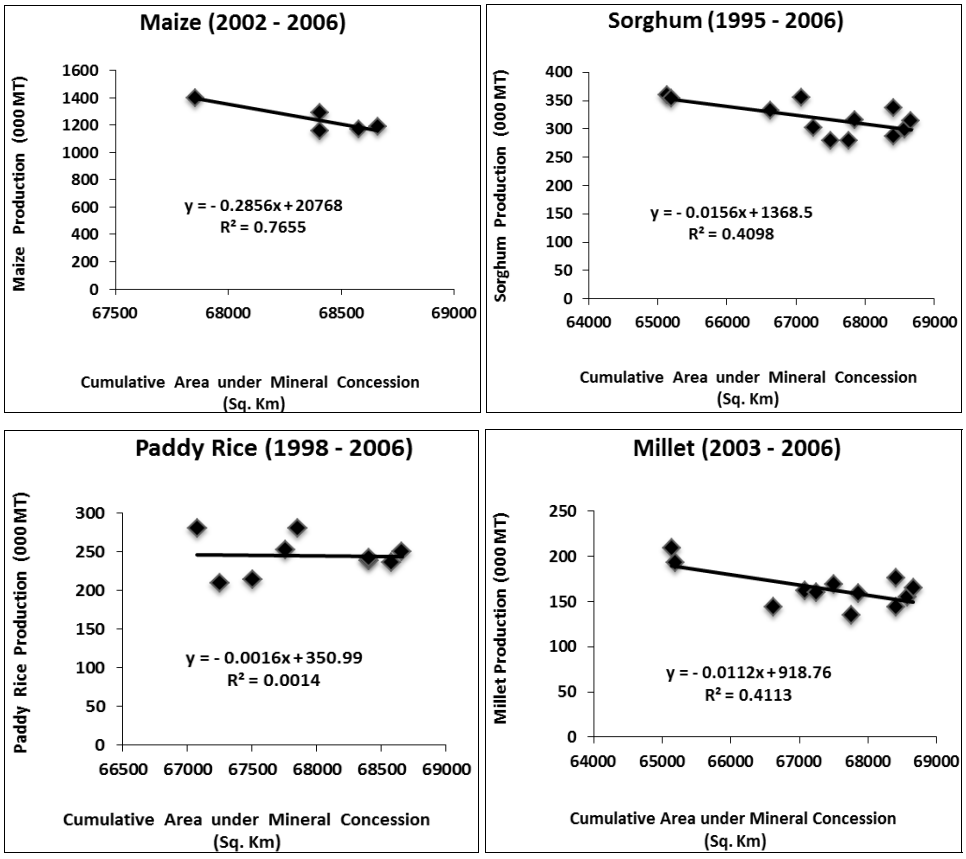
Figure 5 Trends of expansion in area under mineral concession and production of major cereal crops in Ghana (1992–2006)



In statistical terms, can we say that the periods of declining trends in the production of cereal crops are largely due to expansion in area under mineral concession? Figure 6 present the results of the simple linear regression analysis. The R^2 value of 0.7655 in the case of maize indicates that the regression model is quite good in establishing relationships between trends. The coefficient is negative; the downward trend in the data set between 2002 and 2006 is statistically significant (r = –0.87495; p-value = 0.0502), indicating that maize production suffered from a resource curse as a result of expansion in area under mining concession. Similarly, for sorghum (R^2 = 0.4098, r = –0.64015, and p = 0.0249), we find evidence of resource curse effect of mining boom. By contrast, the coefficient for millet production is negative and insignificant (R^2 = 0.4113; r = –0.07638; p = 0.9236). This suggests that expansion in area under mining concession is not a curse analogous to declining trend in millet production. With regard to paddy rice production, the relationship is even weaker, the coefficient is negative but not statistically significant

(R^2 = 0.0014, r = –0.03728, p = 0.9241), and thus, paddy rice has not suffered from the resource curse effect.

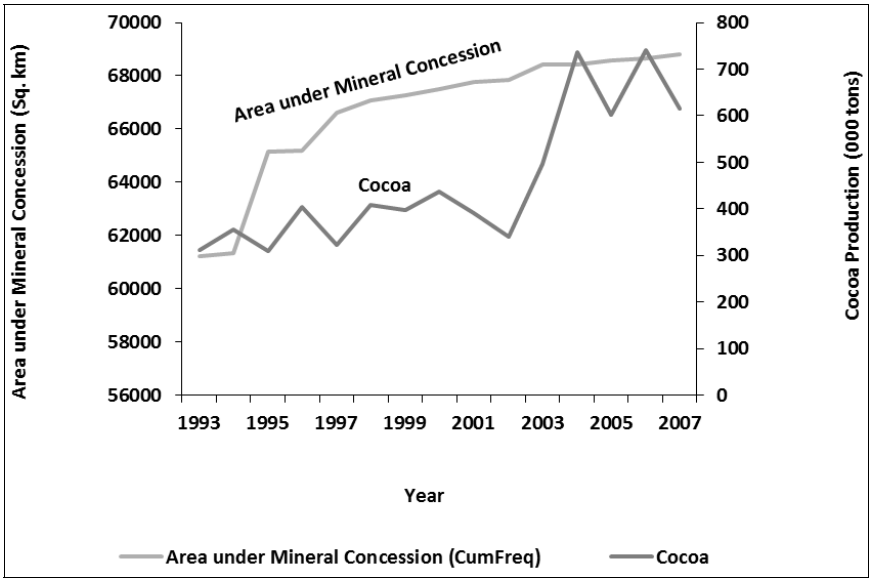
Figure 6 Relationship between periods of declining trends in cereal production and expansion in area under mineral concession



5.5 Establishing relationship between expansion in area under mining concession and cocoa production

Figure 7 compares the yearly cocoa production and area under mineral concession between 1993 and 2007. Two significant features in production trends can be observed in the output of cocoa. The first trend segment, which occurred between 1993 and 2002, was marked by moderate levels of production (an average output of 367,670 metric tons) that fluctuated considerably. Unlike the first segment, the second segment – which lasted from 2002 to 2007 – manifested a short term but dramatic growth trend, during which production of cocoa were consistently higher, exceeding an average output of 580,000 metric tons.

Figure 7 Trends in cocoa production and area under mineral concession (1993–2007)



Again, can we say that the expansion in area under mining concession has threatened cocoa production in Ghana? Simple linear regression was applied for cocoa production and area under mineral concession from 1993 to 2002, and 2004 to 2007. The results showed no evidence of 'resource curse' effect on cocoa production [(1993–2002: $y = 0.0087x - 203.57$, $R^2 = 0.2307$); (2004–2007: $y = -0.2284x + 16344$, $R^2 = 0.2436$)]. A test of the linear relationship did not yield significant results ($r = -0.49359$; $p = 0.5064$).

5.6 Establishing relationship between area under mining concession and area under cultivation of major food crops

The premise here is that, if indeed mining is threatening crop production, cropped area will be diminishing, as more and more agricultural lands are being claimed and converted for mining operations. Trends in cropped area for cereals crops in relation to expansion in area under mineral concession are presented in Figure 8, whereas changes in the pattern of cropped area for starchy crops are displayed in Figure 9. The aggregate agricultural landscape under crop cultivation expanded progressively for both cereals and starchy crops over the years (1989–2007) in spite of expansion in the extractive sector. Trends in cropped areas have had an increasing dominance in favour of maize and cassava production over the rest of the crops. In the cases of millet and sorghum, expansions in cropped area are not easily discernible. With the exception of plantain and paddy rice, cropped area for the rest of the crops recorded declining trends, particularly between 1989 and 1990, and also between peak periods and 2007.

Figure 8 Trends of area under mineral concession and cropped area of four major cereal crops in Ghana (1989–2007)

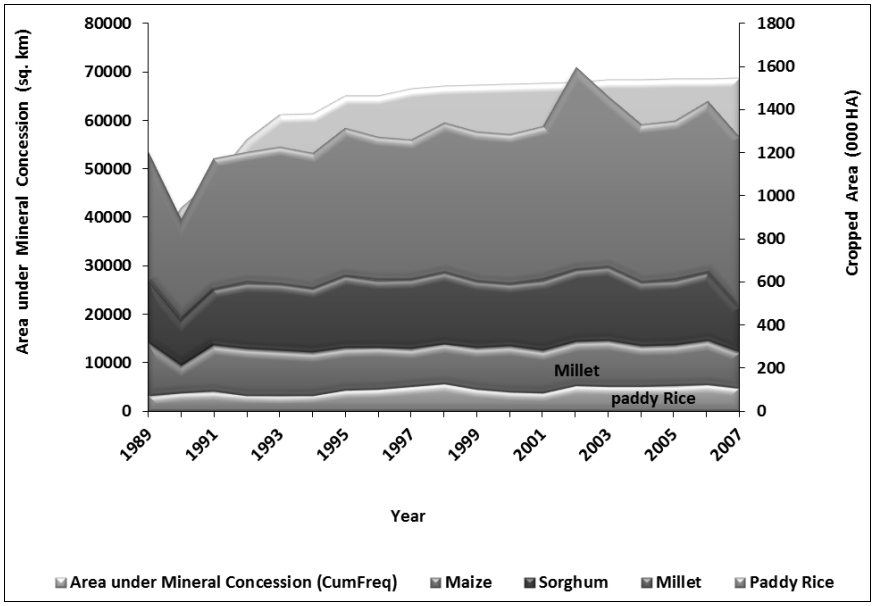


Figure 9 Trends of area under mineral concession and cropped area of four major starchy crops in Ghana (1989–2007)

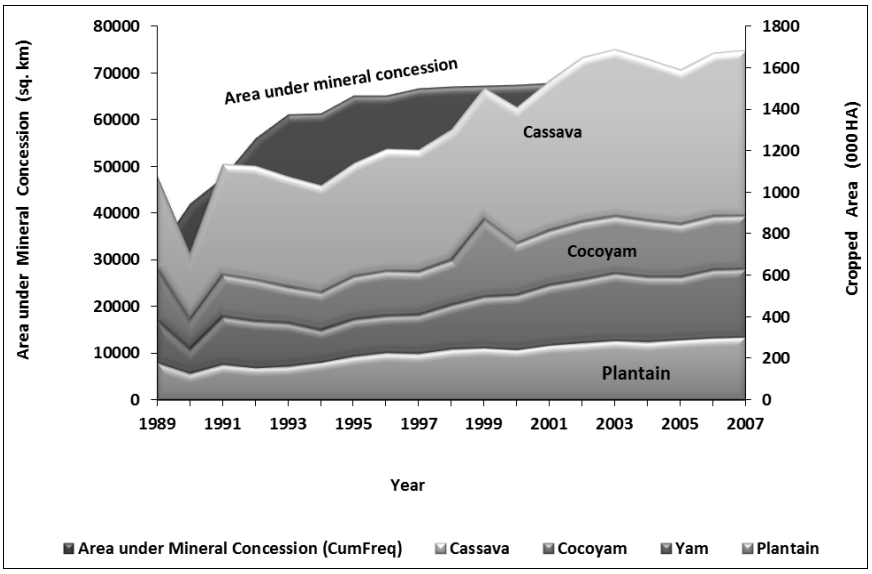


Table 3 Pearson correlation coefficients (*r*) and *p* – *v*alues for trend relationship between cropped area and expansion in area under mineral concession

	Response variables (cropped area)							
	Cassava	*Cocoyam*	*Plantain*	*Yam*	*Maize*	*Sorghum*	*Millet*	*Paddy rice*
Predictor (area under mineral concession)	$R^2 = 0.0004$	$R^2 = 0.3234$	–	$R^2 = 0.1149$	$R^2 = 0.5708$	$R^2 = 0.5546$	$R^2 = 0.3435$	$R^2 = 0.0488$
	r = 0.0199	r = –0.5687	–	r = 0.3389	r = –0.7555	r = –0.7447	r = –0.5861	r = 0.2210
	p = 0.9746	p = 0.1101	–	p = 0.5769	p = 0.0823	p = 0.1488	p = 0.1268	p = 0.5395

Notes: This table gives a summary of the statistical measures used to establish the strength of the relationships between declining trends in cropped area for each major crop and expansion in area under mineral concession in a simple linear regression and correlation analysis matrix framework. Most literature assumes an R^2-value of 0.70 and above as strong goodness of fit in determining how well the predictor variable (in this case area under mineral concession) can adequately be used to explain the variability in the response variable (cropped area). The R^2, *r* and *p* -values were determined within specified period (where a declining trend in cropped area was observed after a peak period for each crop). A dash implies no observable declining trend was recorded for that crop (in this case plantain).

To what extend did mining contribute to the reduction in cropped area experienced by each crop? Table 3 displays statistical results of simple linear regression and correlation analyses conducted. With the exception of maize and sorghum – where the values of the coefficient of determination (R^2) were equal to or greater than 0.55, the rest of the crops recorded R^2 – values that are even less than 0.49, indicating that the relationship between cropped area and area under mineral concession is not very strong. A test of the linear component of the relationship between variables did not also provide good predictive power. The coefficients for cocoyam, maize, sorghum and millet are negative but insignificant, whereas the coefficients for cassava, yam and paddy rice are positive but also insignificant at 0.95 confidence level and *p*-value of 0.05.

These findings suggest that, even though declining trends in area under cultivation of cocoyam, maize, sorghum and millet exist, the relationship between the two variables under investigation is not statistical strong to support the argument that mining is reducing or has diminished the cropped area of the eight major food crops produce in Ghana. Given the important effects of the government incentives and modest investments in infrastructure (including irrigation systems) under the 2002 presidential initiative, which necessitated acreage expansion for the cultivation of cassava and some cereal crops, it is not very surprising to note that expansion in area under mining concessions has not overwhelmingly diminished cropped area.

6 Summary of research findings and policy issues

Since the launching of ERP/SAP, increases in mineral output and crop production have closely followed expansion in the area under mineral concession and cropped area. We find strong evidence that expansion in area under mining concession (particularly, between 1989 and 2007) significantly resulted in a corresponding increase in production of manganese, diamonds and gold. There is also a greater reliability of predicting trends between area under mineral concession and gold production, and thus, increasing land area for mining operations, particularly for gold, may translate into an increase in mineral output.

Between 1989 and 2007, total cropped area (for all the eight major food crops) expanded from 2,291,100 hectares in 1989 to 2,957,000 hectares in 2007 – an increase of over 20%. The average rate of expansion is estimated as 36,994 hectares per year. We find statistically supportive evidence that by the end of 2007, expansion in 'area under mining concession' has had no significant impact on 'area under cultivation'. Thus, the 'resource curse' effect has not been felt, due in large part to preventive action by the national government.

During the period under review, total food output increased by an average rate of 736,334 metric tons per year. Comparing the production levels of 1989 and that of 2007, total cereal production went up by over 42%, total output of starchy staples increased by over 180%, and by the end of 2007, the nation's total food production had increased by over 160%. The unit production level of cocoa also increased by 97% – that is comparing the 1993 production level with that of 2007. These findings suggest that, on a national level, crop production has not overwhelmingly suffered from the resource curse effect due to; acreage expansion induced by government initiative, investment in agricultural infrastructure, incentives and credits, which sustained higher crop output over the years.

Moreover, expansion in some major crops in zones not subject to active large-scale mining appears to have offset the loss of cultivated lands in actual mining zones.

We propose that the launching of ERP/SAP resulted in a mining boom. More and more agricultural lands were being claimed and converted for mining operations. This possibly triggered the policy agenda for acreage expansion and production of certain major food crops to compensate for crop production loses, resulting in significant improvement in the production of most major crops; especially in the output of cassava, plantain and yam. Our research findings support the hypothesis that 'resource curse' occurs only conditionally, and may be offset by proactive policies and sufficiently good institutions. However, we wish to submit that clearing of more and more virgin lands also has policy implications: dealing with the issues of deforestation, habitat destruction, biodiversity loss, climate change and environmental sustainability, which need to be taken into consideration by policy advisors, especially in this 21st century when the world is advocating for sustainable development, reduction in atmospheric carbon and suffering from increases in extreme climatic events.

Empirical findings from this research indicate that the relationship between expansion in the area under mineral concession and decline in crop production is a possibility. There is statistically supportive evidence that decreases in production trends in cocoyam, maize and sorghum can adequately be explained by expansion in area under mining concession [(cocoyam: $y = –0.2409x + 18216$; $R^2 = 0.8086$, $r = –0.8992$; $p = 0.0378$); (maize: $y = –0.2856x + 20768$; $R^2 = 0.7655$, $r = –0.8749$; $p = 0.0502$); (sorghum: $y = –0.0156x + 1368.5$, $R^2 = 0.4098$, $r = –0.64015$; $p = 0.0249$)]. This in an indication that the sets of data for these variables provide very good predictive power for tracking decreases in crop production as a result of expansion in area under mining concession.

7 Conclusions and recommendations

Using national-level data from 1989 to 2007, agricultural growth through acreage expansion has not been seriously affected by expansion in the area under mineral concession. Expansion in some major crops in zones not subject to active large-scale mining may offset the loss of cultivated lands in actual mining zones. Although we find evidence that the relationship between mining and decline in maize, sorghum and cocoyam production exist, this study cannot fully subscribe to the argument that mining is threatening agriculture in Ghana. We subscribe to the hypothesis that 'resource curse' occurs conditionally, and may be offset by proactive policies and sufficiently good institutions. We wish to indicate that this study has only provided some preliminary answers to the research questions, and admit that it has some limitations. For instance, only national-level data was used, and thus, does not address the impact on small farmers in the areas where government has given mining concessions. Real impacts of mining operations on agriculture may be more pronounced at the farming community or district level. Thus, additional research that would utilise data from the regional and district levels will help shed further light on the seriousness of mining impacts on crop production in Ghana. Again, the study does not account for how much previously uncultivated land was brought into cultivation outside of sites of mining impact during the period under review. We recommend a spatial analytical approach with the use of

GIS to further investigate whether mining is indeed creating land shortages, and implications for agriculture as well as land tenure systems in Ghana.

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Notes

1 The yearlong series of activities embarked by the Ghana Chamber of Mines was officially launched on 20th May 2008 at the M-Plaza Hotel in Accra. Press Release on Chamber @ 80 is available at http://www.ghanachamberofmines.org/news/main.php?id=00000000010 (accessed 5 June 2011).

2 This was part of the report released by a civil society group – the FIAN in collaboration with the WACAM in January 2008. The report was in response to the Ghana Chamber of Mines' 80th anniversary. FIAN – Ghana is a national section of FIAN International. WACAM is a Ghanaian non-governmental organisation supporting communities affected by mining. A news article [IOL News (2008) *Life with Mining is Hell: Ghanaian NGO*] is available at http://www.iol.co.za/news/africa/life-with-mining-is-hell-ghanaian-ngo-1.402318 and http://www.fian.org/news/resources/documents/others/mining-related-human-rights-violations-ghana/pdf (accessed 5 June 2011).

3 About 60% of all farms in the country are less than 1.2 hectares, 25% are between 1.2 to 2.0 hectares with a mere 15% above 2.0 hectares. The mean farm size is less than 1.6 hectares. Small and medium size farms of up to 10.0 hectares account for 95% of the cultivated land in Ghana (Owusu-Ansah, 2012). A small-scale household farmer, is therefore, a household head whose primary occupation is farming, and cultivates between 1.0–1.6 hectares of productive agricultural land annually, upon which the livelihood of his household members (the head, spouse and all dependents under his/her shelter) depend.