Land-use intensification and its sustainability: A full-sun cocoa farming system and tree plantations in southwestern Ghana

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The sustainability of intensive land use that was recently introduced to southwestern Ghana is discussed, based on field observations and interviews within a forestry project. Cocoa, a major crop in Ghana, was traditionally cultivated under natural shade trees, forming a forest-like landscape. However, due to land shortage and the introduction of modern farming systems, these shade trees now tend to be removed from the cocoa farms, leaving a high-input full-sun farming system, which is less sustainable. Moreover, a recent trend toward tree plantations is growing especially in areas damaged by wildfires. While this will increase the timber resources and improve farmers’ livelihoods in some cases, the negative impacts include a decrease in biodiversity and an increase in land conflicts. To secure the sustainability of land use, forest resources should be more integrated into farming systems. The government should strengthen the extension services and improve administrative regulations. At the field level, the planting of shade trees and small-scale plantations by farmers should be promoted, and the land tenure issues resulting from tree plantations should be monitored.

Key words: cocoa, cacao, shade tree, agroforestry, land use, sustainability, tree plantations, teak, timber, monoculture, extension, land tenure, Ghana

INTRODUCTION

Demand for forest and agricultural products is increasing due to global economic growth and population expansion. To satisfy the demand, intensification of land use is proceeding throughout the world. In the tropics, the intensification often includes the transformation of natural forests to expanded plantation forests, and a change from extensive slash-and-burn farming to intensive sedentary agriculture. Such changes in land use may be unfavorable to sustainable development, one of the most important concepts in the world today. Can sustainability be secured under intensive land use? To answer this question, it is necessary to monitor land-use changes and the effects on sustainability.

I was engaged in a forestry project by the Ghanaian government and the Japan International Cooperation Agency (JICA), and obtained information on land-use intensification processes in southwestern Ghana, which involved changes in the cocoa (*Theobroma cacao* L.) farming system and the introduction of tree plantations on farmlands. This study describes these land-use changes and discusses the effects on sustainability. The sustainability of land use is evaluated in terms of yield of forest products, farming systems, biodiversity, and livelihoods of farmers who depend on the land. Information was collected through field observations and interviews with relevant personnel from 2004 to 2006, as well as a review of the literature. The main targets of the interviews were farmers in the study site and officers from the government and nongovernmental organizations (NGOs).

STUDY SITE

Vegetation classification of the study site

Vegetation in Ghana can be roughly classified into two zones: the High-Forest Zone and the Savanna Zone, with the boundary between them called the Transitional Zone. The High-Forest Zone, which includes the Transitional Zone, occupies about one-third of the southwestern part of Ghana (Fig. 1), receives 1,200 to 2,500 mm of precipitation annually and was originally covered with evergreen or semi-deciduous tall trees. Although accurate data on the High-Forest Zone are not available, Ghana recorded a forest loss of as much as 2.0 % per annum from 2000 to 2005 (FAO, 2005).
The base for the forestry project was Sunyani (Fig. 1). Field observations on the cocoa farming system were carried out mainly in Bechem and Sunyani Districts, located in the High-Forest Zone. Observations on tree plantations were performed in Sunyani and Wenchi Districts, in the Transitional Zone. These study sites are less than 60 km from Sunyani town.

Social and administrative background of the study site related to land and forest management
The local administration in Ghana consists of two parallel systems: a traditional chieftaincy system and a modern administration system, with the traditional chiefs strongly influencing the local society. The land tenure system is complex (Otsuka and Quismbing, 1998; Amanor, 1999), and primary land tenure is controlled by the paramount chiefs.

The forestry administration system was developed during the British colonial era, and the Forestry Department, which is the current Forestry Commission, was established in 1908. The Forest Ordinance, the first basic law on forestry, was developed in 1927, and forest reserves, which currently occupy 11 % of total land area, were mainly demarcated in the 1930s. A forest reserve is an area that is to be managed for production and protection. Owing to the distribution of the timber resource, most were established in the High-Forest Zone. Trees and the land in forest reserves are formally owned by the paramount chiefs. However, timber resources are managed by the government under Act 124, which stipulates that “all rights with respect to timber or trees... shall vest in the President” (ECO-Consult, 2001). In addition to the forest reserves, protected areas such as national parks and wildlife sanctuaries occupy 5 % of the total land area, and tend to be located in the northern Savanna Zone. Dwelling in and farming are prohibited in the forest reserves and protected areas.

The area outside the forest reserves (and some protected areas) is customarily called the off-reserve area, while the area inside the forest reserves is referred to as the on-reserve area. The off-reserve area occupies as much as 84 % of the total land area and is considered land for agricultural development; most forest in the off-reserve area of the High-Forest Zone has already been converted to farmlands. In the process of conversion, the timber was a target for "salvage felling" to "liquidate" the resource, as stipulated in the Forest Policy established in 1948 (Smith, 1996). All natural timber trees in the off-reserve area are under government management (ECO-Consult, 2001) and have contributed much to the timber supply through liquidation. However, since the harvest is considered a salvage operation, attention has not focused on the sustainable use of the forest resources (Smith, 1996). A considerable amount of timber trees still remains on farmlands, but salvage felling is continuing.

As far as land management is concerned, encroachment into the forest reserves in the High-Forest Zone was not a serious offense until recently. It is thought that the authority of the traditional chiefs prevented major encroachment. While problems have recently arisen, especially in the Transitional Zone, the boundary of most forest reserves can still be seen on satellite images (Fig. 2).

CHANGE IN THE COCOA FARMING SYSTEM
Cocoa agroforestry and the forest-like landscape
The main crops in the High-Forest Zone include plantain, yam, cocoyam, cassava, maize, cocoa, oil palm, and citrus. The major traditional farming system is extensive slash-and-burn, with a fallow period. Farmers around Sunyani call the farmland "bush." In fact, boundaries between farms under cultivation and in fallow cannot be seen clearly, demonstrating the extensiveness of the current farming system. After land preparation, mixed crops, both annual and perennial, are usually planted in the same plot.

Cocoa is a low-growing tree whose original habitat is under the canopy of the tropical rain forest in the Amazon basin. It was introduced to Ghana in the late 19th century, and has spread throughout the High-Forest Zone as the main cash crop. Ghana became the world’s top producer
of cocoa in 1910, and kept this position until 1976 (Amoah et al. 1995), when it was overtaken by Côte d’Ivoire. Currently, Ghana is competing with Indonesia for second place. The cocoa farming area is estimated at 1,200,000 ha (Appiah, 2004), which is equivalent to approximately 15% of the land area in the High-Forest Zone. Many small family farms support the cocoa production (Takane, 1999).

Since cocoa prefers a shaded environment, it has generally been grown under shade trees. At the same time, cocoa requires a fertile soil. In the search for natural shade trees and rich forest soil, cocoa farms were usually established by converting natural forest areas (Rice and Greenberg, 2000). When the forest is opened up, selected high trees are left for shade in the cocoa farms. The Ministry of Food and Agriculture and the Ghana Cocoa Board recommend leaving about 16 trees per hectare (interview with officers of the relevant institutions in Sunyani, 2006). Cocoa only starts fruiting 4–5 years after planting in a shaded environment. If cocoa is planted with maize, cocoyam, cassava, and plantain, the farmer enjoys a harvest of maize and cocoyam in the first year, cassava in the second, plantain after 3–4 years, and cocoa for the following 30–40 years. The shade trees repress pests and diseases, maintain soil fertility, and extend the longevity of the cocoa farms. At the same time, the shade trees on the farm form a forest-like landscape, which sustains considerable biodiversity (Rice and Greenberg, 2000). The landscape sometimes functions as a buffer to protected areas for conservation of wildlife species (interview with officers of a NGO, 2004). The cocoa farms in this forest-like landscape have a reputation for being more sustainable than any other farming system in the tropics (Becker, 1999; Duguma et al. 2001).

Changes in the farming system
Cocoa can be farmed under full-sun conditions. Comparisons of farming systems between full-sun and shaded conditions have been conducted in several tropical countries for over a century. These studies concluded that if enough fertilizer is applied and pests and diseases are controlled, higher yields can be expected in full sun. However, they also found that full sun tends to shorten the economic life of cocoa trees, mainly due to degradation of soil fertility (Amoah, 1995; Ruf and Zadi, 1998; Rice and Greenberg, 2000; Belsky and

Fig. 2. Forest reserves on satellite images. Top: Clear boundaries are seen (middle of High Forest Zone). Bottom: Reserve boundaries are unclear (Transitional Zone). Left: Forest reserve map by RMSC-Forestry Commission. Right: ASTER (Top: 16/Mar./2004, Bottom: 26/Feb./2003)
Siebert, 2003). These conclusions led farmers in Ghana to cultivate cocoa with shade trees, but they recently started reverting to a full-sun system because of changes in the forestry and agricultural environments.

Decrease in natural trees
Cocoa farms have expanded by converting natural forest in the off-reserve areas. However, forest with fertile soil that is suitable for cocoa farms has almost run out. In addition, a serious drought in 1983, which heavily impacted the lives of the local population in sub-Saharan Africa, caused large wildfires and destroyed many cocoa farms. It is estimated that 30–40% of the cocoa farms in the Transitional Zone were lost to the wildfires (Appiah, 2004), and thus almost the same amount of the forest-like landscape on the cocoa farms also disappeared.

Worldwide, planting shade trees on cocoa farms is a common practice (Rice and Greenberg, 2000). In Ghana, although studies on species selection and planting techniques have been conducted (Amoah et al. 1995; Osei-Bonsu et al. 2002; Anim-Kwapong, 2003), it appears that farmers are not planting shade trees on their farms (field observations, interviews with farmers and the Ministry of Foods and Agriculture in Sunyani, 2006). Therefore, the loss of natural high trees on farmlands means the end of the cocoa farming system with shade trees, except in cases where natural regeneration is expected.

Tree tenure
Management of natural timber trees is under the authority of the government, even in the off-reserve area. While the government and its concessionaires must obtain approval from the traditional chiefs, who are the owners, prior to harvesting the trees, farmers, as tenants, are usually not consulted. Under this tree tenure system, it is difficult for the farmers to manage the shade trees as a part of an agroforestry system. Even worse, the cocoa farms usually suffer damage from the harvesting of shade trees. Although compensation to the farmers is a duty of the concessionaires, in reality, it is not enough or is withheld in many cases (Richards and Asare, 1998; Amanor, 1999). Therefore, to avoid the sudden loss of the shade trees and damage to the cocoa farms, the farmers tend to cut the saplings of natural trees and kill the adult trees by girdling (field observations; interviews with farmers in Bechem District, 2006). This tendency is stronger for high-value timber species, since they are more likely to be harvested (Richards and Asare, 1998).

Increased logging
Pressure to harvest timber from cocoa farms has been increasing. After experiencing worsening economic conditions, in the 1980s and early 1990s the Ghanaian government undertook a “structural adjustment program” (SAP) on the instructions of the World Bank and the International Monetary Fund. Under this program, the industries required to increase national revenue were strengthened (Amanor, 1999). The timber industry was one such industry, since it was the third most important export commodity for Ghana after cocoa and gold. Considering the remaining timber resource, the government set an “annual allowable cut” (AAC) in 1990 of 1.2 million m³; this figure was revised in 1995 to 1.0 million m³, 0.5 million m³ of which was in the on-reserve area and the other 0.5 million m³ in the off-reserve area (Agyarko, 2001). The AAC in the on-reserve area was calculated to be a sustainable level based on natural regeneration and growth (Agyarko, 2001). However, since the harvest of natural trees in the off-reserve area is considered salvage, it is not in line with the concept of sustainability; therefore, timber harvested in this manner is directly linked to a decrease in resources. Since the forest in the off-reserve area has now almost disappeared, timber trees remain only on farmlands, especially on cocoa farms.

Timber harvests in each year have ranged between 1.0 and 1.5 million m³ since 1995 (ITTO, 1997–2005), which is more than allowed in the AAC. In reality, harvesting through illegal activities must be added to the estimate to obtain the actual quantity. The capacity of legally approved timber-processing facilities is estimated to be 2.0 million m³, and is still increasing (Agyarko, 2001). In recognition of the demand that exists within the timber industry, the government has considered increasing the AAC. However, increasing the AAC in the on-reserve area would lead to abandoning its sustainable forest management policy. Therefore, the off-reserve area has been automatically targeted. Additional pressure on the AAC in the off-reserve area was rampant illegal logging. It was the opinion of policy makers that trees in the off-reserve area should be harvested before they were taken illegally (interview with an officer of the Ministry of Lands and Forestry, 2005), and in 2004, the government increased the AAC on the off-reserve area from 0.5 to 1.5 million m³, giving a total AAC of up to 2.0 million m³. This AAC is supposed to be supplemented by a national tree plantation program (described later) but poses a significant threat and may lead to degradation of the forest-like landscape on cocoa farms.
Introduction and expansion of improved cocoa varieties

Improved varieties of cocoa have been introduced to Ghana since the 1950s, and several varieties were brought in to find those best exhibiting early maturity, high yield, and pest and disease tolerance. The Tafo Hybrids (Series II) were introduced on farms in the 1970s. This improved variety requires high-light intensities and nutrient-rich soil to produce high yields (interviews with farmers in Bechem District, 2006). The strong light conditions increase the need for pest and disease control, resulting in a high-input, full-sun farming system.

The change to the full-sun farming system did not happen suddenly, since agricultural materials, such as chemical fertilizers and pesticides, were not easily available. However, after the economic situation worsened in the early 1980s, the SAP promoted a free economy, giving Ghana the reputation of being a good model economy in Africa (Boafo-Arthur, 1999). As a result, the economy recovered and has since grown steadily. Moreover, access to agricultural materials has become easier. The price of cocoa beans has also supported this trend. After a rise to US$ 2,000–US$ 3,000 per ton in the late 1970s and early 1980s, the international cocoa price declined, and has since been between US$ 500 and US$ 1,500 per ton (Fig. 3). The producer cocoa price in Ghana is controlled by the government, which sets it against the international price each year. In the mid-1980s, the price was about 30% or even lower than the international price, gradually increasing in the 1990s (Seini, 2002) and reaching 70% in 2004 (Ashitey, 2005), which raised the price paid to producers. The farmers and other relevant personnel recognize that the producer price has increased, especially since 2000 (interviews with farmers and officers of the Ghana Cocoa Board in Sunyani, 2006), and the higher price of cocoa beans has enabled farmers to purchase the agricultural materials needed for the new cocoa varieties.

Wildfires remain a threat to the cocoa farms. Most farmers in the Transitional Zone state that wildfires were common after the drought in 1983. Considering the risk of damage by wildfires, the farmers have tended to choose short-term, high-yield varieties of cocoa, rather than varieties that offered long-term, sustainable-yields. With sufficient fertilizer and under full-sun conditions, the improved varieties start fruiting 2–3 years after planting, which is 2 years earlier than the varieties grown under shade trees (interviews with farmers in Bechem and officers of the Ghana Cocoa Board in Sunyani, 2006).

The Ministry of Food and Agriculture and the Ghana Cocoa Board do not promote the full-sun farming system, insisting that shade trees are necessary for healthy cocoa farm management, even when growing the improved varieties (interview with the relevant institutions, 2006). However, the local environment and earlier-yielding varieties support expansion of the full-sun farming system.

Concerns about sustainability with the full-sun farming system

Cocoa production in Ghana peaked in 1964 and fell in 1984, and has gradually recovered. In 2004, Ghana achieved the highest production record in its history (Fig. 3). Increases in the high-input, full-sun farming system under good economic conditions have been an important factor in the recent increase in production. However, the international economy constantly fluctuates, and so does government policy. The good economic environment for the cocoa farms will not continue forever. Once
economic conditions worsen, it is unlikely that the high-input, full-sun farms can be sustained. The full-sun farms are ecologically vulnerable, since both the crop and the soil are exposed directly to strong sunlight (Rice and Greenberg, 2000; Belsky and Siebert, 2003). If it becomes too difficult for farmers to continue applying high material inputs to their farms, they may fail to maintain soil fertility or control pests and diseases, which will result in the end of these farms.

INTRODUCTION OF TREE PLANTATIONS

**Government initiative for tree plantation development**

Until recently, Ghana had rich natural timber resources, and thus plantation forestry did not prosper. In the 1970s, the government promoted plantations of teak (*Tectona grandis* L.), and approximately 50,000 ha were planted in that decade (unpublished document of the Forest Development Centre, Ministry of Lands and Forestry; 2005). However, further tree plantation development was almost nil in the 1980s and 1990s. After recognizing the exhaustion of natural timber resources, the government launched a national tree plantation program in 2001, and set a target for annual establishment of 20,000 ha. The program is being conducted in both on- and off-reserve areas, mainly in the Transitional Zone, which was damaged by wildfires. The taungya system was applied for the establishment. Most plantations consist of teak because of its fire tolerance and economic value. The target has since been revised, and in 2005 was 36,000 ha, 4,000 ha of which was for private sector plantations (unpublished document of the Forest Development Centre, Ministry of Lands and Forestry; 2005).

**Small-scale tree plantation by farmers**

Although shade trees were necessary in the traditional cocoa farming system, farmers tended to view trees as obstacles that hindered other agricultural development. Tree planting was even taboo in their culture (interviews with farmers in Sunyani District, 2005). However, as thinned logs from government plantations were traded as poles for electricity supply, the farmers realized that teak was a beneficial cash crop, and tree plantations on farmlands have gradually became popular since the 1990s (JAFTA, 2005). The national plantation program for off-reserve areas promotes investment by private enterprises, but does not target small-scale farmers. Therefore, in 2005, a pilot program to support small-scale

tree plantations was prepared in Sunyani District through the forestry project. As a result, the farmers were willing to participate, and planted teak trees on their farms (Yoshida, 2005; Antepim-Appiah et al. 2006).

Previously, all timber trees, including planted trees, were under government management; however, the 2002 law (Act 617) made private tree plantations exempt from government management. Hence, today, the trees planted by farmers can be managed by the farmers. While this law assumes that private investors are the main promoters of tree plantations in the off-reserve area, it has also created great opportunities for small-scale plantations on farms.

**Concerns about tree plantations**

To increase the supply of timber, the promotion of tree plantations is inevitable. However, the national plantation program was planned to promote industrial-scale plantations. As a result, it tends to promote large-scale monoculture without consideration for biodiversity. Another concern, especially in the off-reserve area, is related to land tenure. Since lands are primarily owned by the paramount chiefs, negotiations with outsiders, such as the government or private investors, are conducted by the traditional chiefs. Therefore, land allocation for the tree plantations can be decided without involving the tenant farmers, which commonly leads to logging of the shade trees on their farms.

Small-scale plantations established by the farmers are probably more positive, since they increase the diversity of farmland use and cash income for the farmers. However, the farmers do not understand that the law has changed and that their rights to the trees planted are now protected; many still think that all timber trees are still managed by the government (Yoshida, 2005). In addition, no effective local market exists for the farmers’ wood products. So far, few off-reserve tree plantations have reached harvest age. In Sunyani District, the harvesting of tree plantations owned by several farmers in the community was contracted out by the community chief to a large-scale timber concessionaire, which meant that the farmers were unable to sell their trees directly (interview with farmers in Sunyani District, 2005). Forestry officers have resisted changing the status quo, insisting that all timber is a commodity in the same way as cocoa beans, and that this is controlled by the government to generate national revenue (interview with officers of the Forestry Commission in Sunyani, 2005). Such an environment discourages farmers from small-scale plantations.

Land tenure is also an issue on small-scale
plantations. Allocation of farmlands, which is the very basis of a farmer’s livelihood, is mainly dealt with within the community or families. However, the farmers’ rights to access farmland are uncertain and subject to sensitive power politics in the community. Therefore, farmers always attempt to protect and strengthen their rights to their farms (Takane, 1999). Tree plantations are an inexpensive and long-lasting land use, and this might lead farmers to consider the establishment of tree plantations as a simple way of strengthening their rights to a piece of land. If this does happen, it is likely that increased land conflicts among farmers will occur and that the management of the plantations will suffer.

In interviews with farmers who participated in the pilot program for small-scale plantations, no one affirmed that the objective of their tree plantation was land occupation. Most farmers said that it was for cash income, and some referred to the trees as a kind of insurance in case of financial difficulty in the future (Antepim-Appiah et al. 2006). These answers suggest the farmers’ clear motivations in planting and managing the trees. However, the future of farmland use in relation to the tree plantations was not understood by the interviewees.

**ACHIEVING SUSTAINABILITY UNDER INTENSIVE LAND USE**

This study has highlighted several concerns in relation to sustainability, timber supply, farming systems and livelihoods. The findings show that land-use intensification processes for short-term benefit tend to proceed without adequate attention to their sustainability, probably because the positive effects of sustainability, such as the longevity of cocoa trees and the maintenance of soil fertility, are not evident in the short term. It is not easy for farmers to be aware of the importance of sustainability without help from the government, researchers, and international organizations who should offer services to support them in this regard.

As noted above, the forest policy in 1948 aimed to separate forestry from agriculture. Until now, land management of the forest reserves in this context has been successful (Fig. 2). However, it is now recognized that the 11% of the total land area allocated to forest reserves is insufficient to supply the timber and other services now expected from them. While intensification of farming is necessary, integrating trees into the farming system is recommended to achieve sustainability. Land-use intensification and integration of trees can be compatible if the system is well designed. Policy makers and government officers need to recognize this and promote restoration of forest resources in off-reserve areas.

To promote sustainable land use, the extension service should be strengthened, as the current extension system does not function well. For example, while the issue of timber and plantations is under the control of the Forestry Commission, the Ministry of Food and Agriculture is in charge of agricultural extension. No clear demarcation exists as to which organization should and will promote the restoration (and planting) of shade trees. The same problem exists for wildfire prevention, which should involve the National Fire Service as well as other organizations. Coordination and collaboration between relevant organizations is indispensable to reinforce the extension service.

While the full-sun cocoa farming system is a recent trend and reasonable for economic prosperity today, it is necessary to encourage farmers who want to maintain the low-input system for cocoa farming, even if their management is passive. The current administrative systems, that is, salvage felling and lack of tree ownership, have discouraged farmers from maintaining low-input systems. The government needs to reconsider the increments added to the AAC and should transfer the ownership of the shade trees to the farmers. If the value of the shade trees as timber can be integrated into farm management, more efficient management will be achieved through the farmers’ own efforts. Where cocoa farms with shade trees have such sustainable management, natural trees will regenerate easily (interviews with farmers in Bechem District, 2006). Given increased understanding of the value of shaded trees, restoration of the shade trees can be expected on a considerable number of cocoa farms.

At the field level, the planting of shade trees and small-scale tree plantations by farmers should be promoted. Shade-tree planting has been successfully integrated into many farming systems around the world. Since the ownership of the planted trees has now been secured under the law, it will not be difficult to extend the tree planting, provided that the extension systems function correctly. Meanwhile, unlike the cocoa farming system with shade trees, tree plantations are generally competitive with agricultural production. If tree plantations are to be promoted, this consideration should be recognized by both farmers and government officers. In addition, the land tenure issue should be monitored so that the authorities do not expel small-scale tenant farmers from their farmland.
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