The consequences of cocoa production on soil fertility in Ghana: A review

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SUMMARY

Cocoa cultivation over the past 20 years has been concentrated in the Western Region of Ghana where most of the soils have been found to be unsuitable for the crop. During the 10-year period (1982-92), the estimated total amounts of major nutrients removed from the soil through the harvested beans alone were 76 000, 4 700 and 18 000 tonnes of NPK respectively. The non-use of fertilizer has led to decline in soil fertility with consequential decrease in production. The paper reviews and discusses the effects of cocoa production on soil fertility in Ghana and offers possible solution to the declined soil fertility.

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RÉSUMÉ

APPIAH, M. R., SACKEY, S. T., OFORI-FRIMPONG, K. & AFRIFA, A. A.: *Les conséquences de la production du cacao sur la fertilité du sol du Ghana: Une revue.* La culture de cacao au cours de 20 années passées a été concentrée dans la Région Occidentale du pays où la plupart des sols ont été trouvé d' être non convenable pour la culture. Pendant la période de 10-années (1982-92), les quantités totales estimées de nutritives majeures enlevées du sol à travers uniquement les haricots récoltés étaient 76 000; 4 700 et 18 000 tonnes de N, P, K respectivement. Le non usage d' engrais a mené à un déclin en fertilité du sol avec une diminution consécutive en production. Ce document revoit et discute les effets de la production de cacao sur la fertilité du sol au Ghana et offre des solutions possibles au sol diminué en fertilité.

Introduction

Cocoa has been the mainstay of Ghana's economy for nearly three quarters of a century after it was first introduced into the country in 1879; and the sector employs about 70 per cent of the agricultural labour force (Manu, 1973). However, since the 1970s, there has been a considerable decline in cocoa production. Among the factors identified as being the causes of the decline are the old age of the farms and the farmers, illiteracy status of many farmers which delays the degree of technology adoption with regard to disease and pest control, unfavourable land tenure system, small hectarage of farms, the inadequacy of good planting materials for rehabilitation, lack of a well-defined rehabilitation policy, inadequate husbandry practices, lack of credit facilities for the farmers, and consistent absence of remunerative domestic producer price (Ghana Cocoa Board Special Report, 1994).

The average annual yield in Ghana which has remained around 280 kg/ha from the earliest recorded times up till now is very low compared to 800 kg/ha in Cote d'Ivoire, or 1700 kg/ha in Malaysia even though a large proportion of Ghana's land resources is committed to growing cocoa (Cocoa Services Division, 1981). A recent study conducted by Ghana Cocoa Board Task Force in 1994 indicated that about 49.3 per cent of the farmers interviewed produced less than 256 kg/ha in the 1991/92 season and 23 per cent produced between 256 and 384 kg/ha. However, in 1992/93, as many as 64 per cent of the farmers produced less than 256 kg/ha. Between 1969 and 1979, the Cocoa Services Division of Ghana Cocoa Board surveyed 1 976 940 ha of cocoa during the cocoa swollen shoot virus disease (CSSVD) survey (Cocoa Services Division, 1981).

Regrettably, one important factor which has been overlooked over the years is the relationship between soil fertility and cocoa production. Cocoa in Ghana is mainly produced by small-scale (peasant) farmers on fertile virgin forest soils under low level of management and subsistence economy in which no fertilizers are used. The removal of essential plant nutrients, through harvesting over long periods without replenishment, could be one of the major causes of decline in productivity on cocoa farms. Nutrient deficiencies of potassium, zinc and boron were detected at the Cocoa Research Institute of Ghana (CRIG) when new cocoa varieties with higher yields were cultivated (Ahenkorah, 1969; Asomaning & Kwakwa, 1967; Acquaye, Smith & Lockard, 1965).

The objective of this paper, therefore, is to discuss the consequences of cocoa production on soil fertility in Ghana and to offer possible solutions to the decline in production through soil fertility restoration.

Trends in cocoa production

The first exports of cocoa from Ghana were 36.3 t in 1891 and by 1900 exports had risen to 540 t, reaching 218 000 in 1925. In 1936, 311 000 t of cocoa was exported but thereafter production dropped to between 200 000 and 300 000 t owing to drought, diseases and pests. Between 1960 and 1970, production rose to between 200 000 and 400 000 t after the mass spraying scheme against capsids with peak production of 580 000 t in 1964 to 65. In the 1970s and 1980s, cocoa production slumped back to the 1930s production levels of 200 000 t per annum due to unattractive producer price and destruction of farms through bush fire.

Fig. 1 and 2 show the cocoa production patterns from 1980 to 1991 on national and on regional basis. Fig. 1 shows that on a national scale, production increased quite significantly between 1988 and 1990, and this could be attributable to more favourable weather conditions and increase in producer price. Moreover, the young farms in the Western Region which had started bearing also

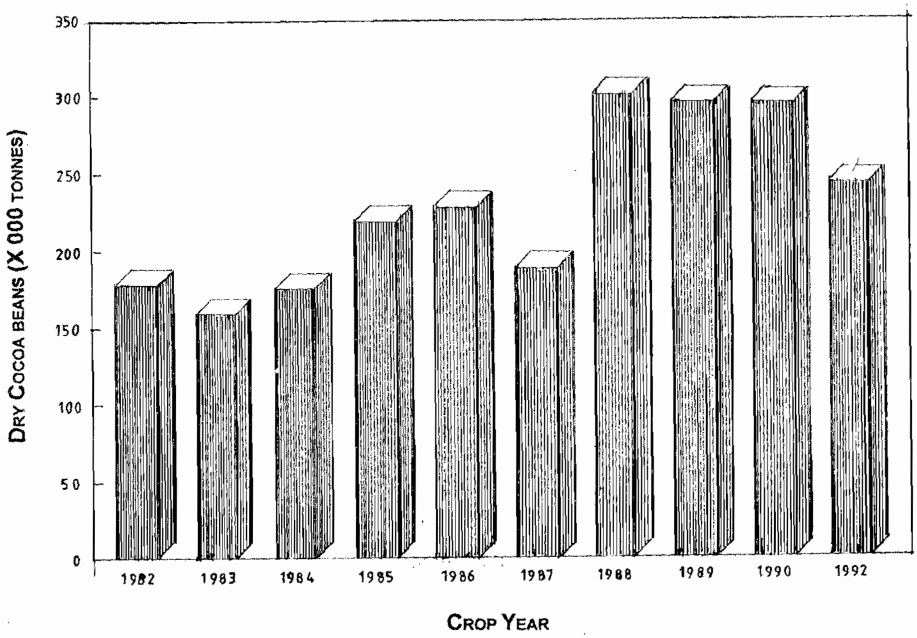

Fig. 1. Cocoa production trends in Ghana (1982/83-1991/92).

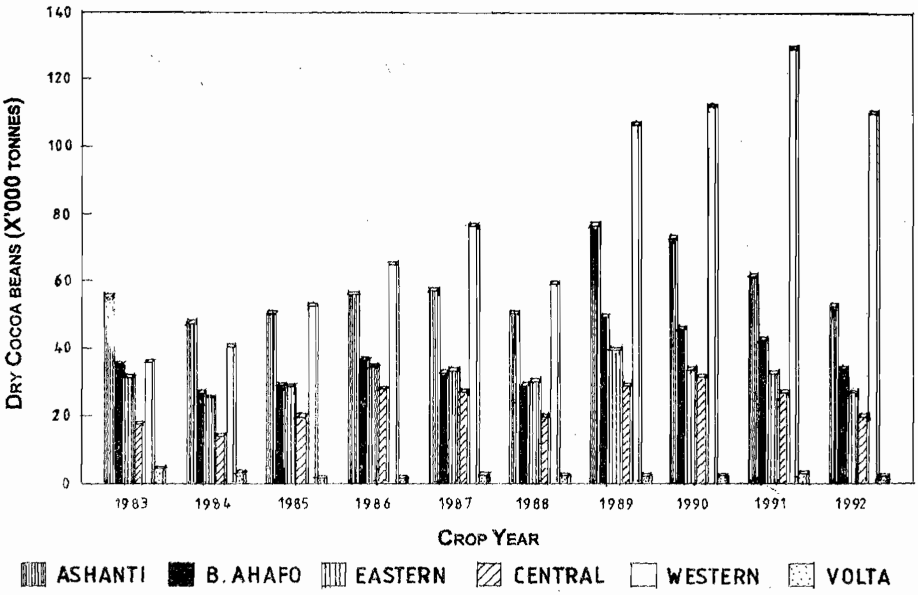

Fig. 2. Cocoa production in Ghana on regional basis (1982/83-1991/92).

contributed to the high national production levels. This is reflected in the production pattern for the Western Region for the period (Fig. 2). Although thousands of hectares of new cocoa farms have been developed during the past four decades, the total yields have not increased substantially. Initially, cocoa production was concentrated in the Eastern Region from where it spread to the Ashanti and Brong Ahafo Regions. During the 10-year period, the Western and Volta Regions have recorded the highest and lowest yields respectively (Fig. 2).

Table 1 shows the hectarage under cocoa in Ghana in two national intensive surveys carried out in 1948 to 1969 and 1970 to 1980 by the Cocoa Services Division of the Cocoa Board. It would be observed that land area under cocoa was greatest between 1970s and 1980s, although it was during this period that production was at its lowest ebb. Whilst the cultivation was declining in the Ashanti, Brong Ahafo, and Volta Regions, the Western Region was experiencing a dramatic expansion of cocoa cultivation. The increase in hectarage in the Eastern Region during the period, was the result of replanting and rehabilitation exercises which were carried out under World Bank Cocoa Rehabilitation Project.

Table 2 provides information on the area under

TABLE 1

Distribution of Cocoa Land within the Cocoa-growing Regions of Ghana from 1948 to1980

Region	*Period*	
	1948 - 69 (ha)	*1970 - 80 (ha)*
Ashanti	652,598	553,158
Brong Ahafo	393,244	390,299
Eastern	223,189	358,710
Central	173,008	223,157
Western	126,093	335,485
Volta	140,913	128,746
Total	1,709,047	1,989,555

Source: Cocoa Services Division (CSD), Accra, 1981, Ghana & Report on Intensive Countrywide Surveys for Cocoa Swollen Shoot Virus Disease (CSSVD).

TABLE 2

Different Classes of Cocoa within the Cocoa-growing Regions of Ghana in 1989

Region	Hectares of 'A' class cocoa (0-7 years)	Hectares of 'B' class cocoa (8-15 years)	Hectares of 'C' class cocoa (16-30 years)	Hectares of 'D' class cocoa (over 30 years)	Total hectares
Ashanti	46,019.4	46,155.8	90,154.4	10,355.4	192,685.0
Brong Ahafo	15,131.6	38,847.6	58,526.6	8,574.4	121,080.2
Eastern	47,130.6	8,114.2	62,624.8	11,707.0	129,576.6
Central	10,445.2	8,040.6	60,408.8	40,452.2	119,346.8
Western	82,044.8	101,204.0	43,689.8	6,546.4	233,485.0
Volta	6,231.2	26,396.8	13,368.4	18,297.2	64,293.6
Total	207,002.8	228,759.0	328,772.8	95,932.6	860,467.2

Source: Cocoa Services Division (CSD), Accra, 1989.

cultivation for different classes of cocoa within the various regions. The data indicate that cocoa cultivation over the past 20 years has been concentrated in the Western Region of Ghana with over 234 000 ha during the 1989 survey. Whilst the Western Region has been experiencing new plantings (182 000 ha for cocoa under 15 years old by 1989), cultivation in the Volta and Central Regions has been declining. The Central Region has the highest of cocoa which are over 30 years old with very few new plantings. The Ashanti and Brong Ahafo Regions which are known to have suitable soils for cocoa have less hectarage for new plantings than does the Western Region with less suitable soils.

Soil fertility loss during cocoa production

The suitability of soil for cocoa cultivation depends on both the soil type and soil phase (Adams & Mckelvie, 1955). The soil type is largely conditioned by geology and topography, and soil phase by the previous history of land use. The tropical forest is known to accumulate plant nutrients in the top few centimetres of soil. When the forest is cleared, the nutrients are rapidly released and thus provide the soil with high levels of available nutrients for a few years. Charter (1953) emphasized that the peasant cocoa industry in Ghana has been based on the exploitation of the fertility built up by the forest and that, for cocoa established from virgin forest on fertile soils, fertilizers may not be required for many years.

It is important to realize, however, that plant nutrients are removed annually from the farm through crop harvests. Each year, owing to the removal of pods and beans, the soils cropped to cocoa lose some essential nutrients. This loss is estimated from an average annual marketable harvest of 400 000 t dry cocoa beans (plus testa) to be 16 000 t N, P and K which are not returned to the soil (Ahenkorah & Akrofi, 1969). Malavolta, Malavolta & Cabral (1986) found that 1 kg of dry beans contained 33 g N, 2.1 g P, and 8.1 g K. Urquhart (1955) also reported that from the yield of 560 kg/ha Amelonado cocoa, the amounts of major nutrients removed annually from the soil in the beans were 13.5, 3.4 and 11.2 kg/ha of N, P and K respectively. The loss is considerably higher when the analyses of the husk which is usually left at the pod-breaking points on the farms is included (Malavolta *et al.* 1986; Ahenkorah & Akrofi, 1969).

Table 3 gives the estimated quantities of essential nutrients removed from soil based on the nutrient contents of the exportable beans between 1982 and 1992. During the 10-year period, the total amounts of major nutrients removed from the soil through the harvested beans alone were 76 000, 4700 and 18 000 of N, P and K respectively. When the nutrients in the pod husk are considered, the average loss of N, P and K per year is about 23 000 t.

The importance of maintaining a high level of organic matter especially within the top 15-cm layer has been emphasized (Hardy, 1960). Within this layer is concentrated the major proportion of the active roots of cocoa whilst maximum root activity

TABLE 3

Estimated Amounts of Nutrients Removed by Exported Cocoa Beans and Pod Husks over 10-year Period

Crop year	N		P		K	
	Tonnes (on elemental basis) per year					
	Beans	Husks	Beans	Husks	Beans	Husks
1982/83	5,966	4,979	375	113	1,429	5,431
1983/84	5,309	4,430	333	100	1,271	4,833
1984/85	5,838	4,872	367	110	1,398	5,315
1985/86	7,315	6,105	460	138	1,752	6,600
1986/87	7,607	6,348	478	144	1,822	6,925
1987/88	6,285	5,245	395	119	1,505	5,721
1988/89	10,023	8,364	630	190	2,400	9,125
1989/90	9,854	8,223	619	186	2,360	8,971
1990/91	9,797	8,176	616	185	2,346	8,919
1991/92	8,110	6,768	510	154	1,942	7,384
Total	76,104	63,510	4,783	1,439	18,225	69,223

* Calculated from 10-year (1982-92) cocoa sales (Ghana Cocoa Board bulletins) and based on analytical data of Adomako (1975) and Ahenkorah, Halm & Amonoo (1981b).

occurs within the top 3-cm zone (Ahenkorah, 1975). Ahenkorah & Akrofi (1968) showed that a definite depletion in soil available P occurred after 10 years of continuous cropping of Amelonado cocoa at CRIG. From the shade and manurial trial at Tafo, which was sited on the Wacri soil series (Acrisol - FAO/UNESCO, 1990) considered to be one of the best cocoa-growing soils, Ahenkorah, Akrofi & Adri (1974) found that there had occurred a loss of about 54 800 kg humus/ha within a 15-year period of continuous Amelonado cropping with an apparent organic carbon decomposition rate of 4.67 per cent per annum. Attendant to this was a total depletion of more than 66 per cent of exchangeable bases in the cultivated area than the adjacent fallow.

Appiah (1975) and Appiah & Thomas (1982) noted that total organic P and inositol phosphate contents of soils continuously cropped to cocoa were lower than the adjacent uncultivated samples. Ahenkorah *et al.* (1987) observed that from a shade and fertilizer trial with Amazon cocoa at Tafo on Koforidua soil series (Acrisol - FAO/UNESCO, 1990), there were no appreciable changes in the exchangeable Ca and Mg after 20 years of cropping. However, available P and K dropped to 68 and 38 per cent of their initial values, respectively. As the cropping intensifies, it is anticipated that the cumulative loss of nutrients will increase and hence the older farms are most likely to be deficient in one or more plant nutrients. Once this state is reached, the trees will suffer under any stress, lose vigour and regenerative power, and hence become susceptible to pest and disease damage and eventual death.

Cocoa on non-suitable soils

Farmers in Ghana believe that soils which support forest are generally suitable for cocoa. As a result, cocoa farms are normally found in climatically good areas with soils which are unsuitable for the growth of the crop. For example, cocoa cultivation is at present intensive in the Western Region of Ghana where virgin forest abounds, although the soils are potentially not suitable for cocoa cultivation. After the significant decline of about 30 per cent in cocoa production in Ghana in the early 1970s, the Ghana Cocoa Board established plantations mostly in the cocoa-growing regions, particularly the Western Region. Ahenkorah & Appiah (1992) observed that these plantations were sited on soils potentially unsuitable for cocoa, since prior adequate feasibility studies were not undertaken. They identified high acidity, susceptibility to erosion, and the probable presence of aluminium on the exchange complex as limitations to cocoa production on these soils. Arhin (1985) interviewed experienced cocoa farmers in the Western Region and found that farmers had expressed serious doubts on the sustainability of cocoa production on some soils in the Western Region.

Fig. 3 shows the main soil groups encountered in the cocoa-growing areas of Ghana. The Ochrosols (Acrisols - FAO-UNESCO, 1990) are subjected to sporadic leaching of nutrients and are the most extensive and more important soils of the forest zone of the country for cocoa cultivation. The Rubrisols - Ochrosol intergrade (Nitisols - Acrisols FAO-UNESCO, 1990), though not extensive, are developed over very rich parent material and are very suitable for cocoa. The Oxysols (Ferralsols - Oxisols FAO/UNESCO, 1990) are the more severely-leached soils and are associated with higher rainfall areas, especially in South West of Ghana. The high acidity and low amounts of nutrients make the Oxysols (Ferralsols) unfavourable for cocoa growth. The Ochrosol-Oxysol intergrades (Acrisol - Ferralsols) which have characteristics more of Oxysol than Ochrosol are less suitable for cocoa than Ochrosol, but better than the Oxysols (Charter, 1953).

Fig. 3 shows that most of the forest Ochrosol-Oxysol intergrades (Acrisol - Alfisols - Ferralsols) (marginally suitable) and forest Oxysol (Ferralsols) (unsuitable for cocoa) in Ghana are in the Western Region, an area which of late has been exposed to the most prolific expansion of cocoa farming. The development has been so intense that the official forest reserves in the region have been encroached upon by cocoa farmers. Available statistics from the Forestry Inventory Unit of the Forestry Department show that in 1990, over 1500 km^2 of forest reserves were con-

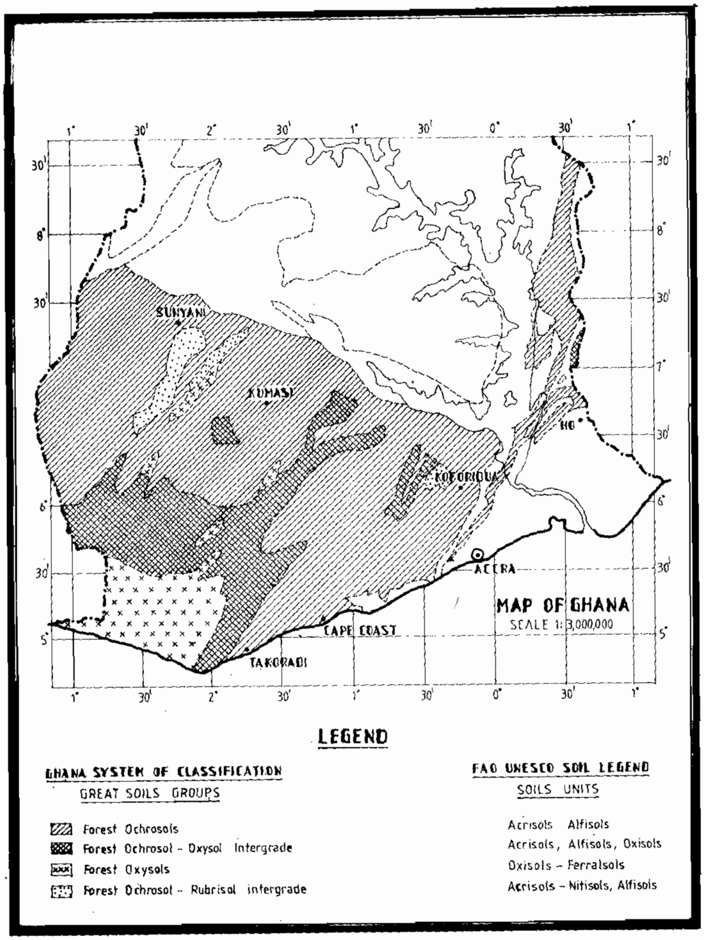

Fig. 3. The major soil groups within the cocoa-growing regions of Ghana.

verted to cocoa farms. Table 1 and Fig. 2 show that the increase in output from the Western Region over the last 10 years was due to expansion of hectarage rather than improved management practices.

Consequences of cocoa farming on soil fertility

Since the soil is the main source of nutrient supply to cocoa trees in Ghana, the non-use of fertilizer usually regarded as the 'mining' of nutrients, has led to soil degradation in cocoa-growing areas with consequential decline in production. It is anticipated that areas of marginally suitable or unsuitable soils such as in the Western Region, will suffer more dramatic decline in yields due to the rapid deterioration in soil fertility. Nye & Greenland (1960) reported that removal of forest vegetation leads to a decline in soil fertility and productivity within 2 - 3 years to below 50 per cent of its initial level.

It is anticipated that once these farms cease to be economic, farmers, consistent with their culture of migration, would search for more suitable soils. The old farms are then either abandoned or used for the cultivation of other crops. In the 1970s, the low producer price of cocoa was the primary reason for farmers cutting out cocoa to cultivate other crops like maize and cassava. However, in many areas of the Eastern and Ashanti Regions, deterioration in soil fertility, coupled with disease and pest infestations, have led to the abandoning of cocoa farming in favour of other crops.

The Western Region is therefore set for a similar situation, with a shift from cocoa to other crops in response to decline in soil productivity. This will eventually lead to a total demise of the forests, as the few trees left traditionally to provide shade for cocoa will be cut down for the new non-shade-requiring crops. The high nutritional requirement of the new crops will place the already deteriorated soils under even greater stress, leading to soil degradation. This situation is inevitable since, due to the high cost of fertilizer, farmers are not inclined towards any conscious effort at maintaining soil fertility by adopting new technological packages. A critical analysis shows that the rate of adoption of new technologies for cocoa production by farmers in Ghana is very low. With the removal of the remaining forest trees and possible failure of the new crops, rain forests may be converted to savanna woodland, possibly grasslands, with the forest flora and fauna lost permanently. Such farming activities, if close to rivers and streams, would contribute to silting and in some cases drying up of nearby streams.

Suggestions

Vast areas of the country's forests could be saved and protected if the cocoa farmer would be advised to use suitable soils and adopt appropriate agronomic practices for cocoa production.

Deforestation by cocoa farmers could also be controlled if the abandoned but otherwise suitable soils for cocoa cultivation could be rehabilitated. Increasing cocoa production per unit area by farmers in Ghana, therefore, requires the proper use of chemical fertilizers and manure.

Ahenkorah, *et al.* (1981a) studied the use of fertilizer on Cocoa Rehabilitation Projects in Ghana and recommended that fertilizers should be incorporated in the rehabilitation exercise on mature farms. The soils which are classified as non-suitable for cocoa, but hitherto were carrying cocoa, may then be used for other crops for which they are classified as suitable.

It may be emphasized that the application of fertilizer must be integrated with effective pest and disease control measures, as well as the planting of more vigorous and high-yielding varieties for the realization of maximum profits. This will enable farmers to adopt recommendations of CRIG for sustainable cocoa production in Ghana.

To ensure a proper base for judicious and effective fertilizer use on cocoa, adequate functional soil test facilities must be provided for the cocoa farmers.

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