Climate variability, Deforestation and Cocoa Production shifts in Ghana. A threat or a source of innovation?

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Abstract
In the former Gold Coast, cocoa was introduced in the late 19th century in the eastern, sub-humid part of the country. Then cocoa area expanded with a massive influx of migrants, moving into the western regions. The two main motivations of migration are clearly the thirst of land as a patrimony and the thirst of forest to get a successful and rapid growing of cocoa.
Nevertheless, as the western region is wetter, to what extent the climatic east-west gradient was a driving factor of the shifting cocoa frontier? The objective is to clarify this interaction between climate change, markets, public policies regarding migration and cocoa production on the other.
The questions are answered through the analysis of severe droughts that occurred at the regional West-African level in the early 1970s, mostly felt in the Sahelian regions, and in 1982/83 which also severely hit the forest/cocoa regions of Ghana (and Côte d'Ivoire). The methodological principle is to combine rainfall data, elements of public policies, national and regional production statistics and social-economic surveys at village levels, giving insights of farmers' strategies at different periods.
The Sahelian drought in the early 1970s did not trigger migrations from Sahel to Ghana due to the Aliens Compliance Order in 1969, highly unfavorable to foreign migrants. The 1982/83 drought hit Ghana itself and clearly accelerated migration around 1983-85. Besides migration, the 1982/83 also played a role in replanting, followed by various innovations in replanting. The place which was liberated by fire was eventually taken over by a younger generation to replant cocoa or diversify towards rubber and oil palm.
In coherence with the Boserupian principles, ecological change can lead to technical innovations, but also lead to renewed institutional arrangements such as the abunu contract. Both technical and social innovations played a role in the revival of the Ghanaian cocoa production and at the same time in diversification.

1. Introduction

After its introduction in the late 19th century in the former Gold Coast (now Ghana), the expansion of the new cocoa crop took initially place in the eastern, sub-humid part of the country. This area was most accessible from the main export port. Then during the second half of the 20th century, cocoa area expanded with support from a massive influx of migrants from the savanna zone and surrounding countries, the crop moved into the Central, Ashanti and western parts of Ghana. The two main motivations of massive migration are clearly the thirst of land to build a patrimony and plant cocoa and the thirst of forest to get a successful and rapid growing. The internal demographic factor is also important. Once a generation of cocoa farmers has started, the next one needs to migrate where land is available. The construction of roads through the forest by the colonial authorities and logging companies also played a major role in this process. This combination of factors is universal, forms a 'cocoa cycle model' which can reasonably explain all cocoa booms generated since the 16th century, especially the production shift from one region to another (Ruf 1995, Clarence-Smith and Ruf 1996).

This model interacts with a few specificities of each country and each period. Among specific factors in Ghana, the application of a universal model was hindered in the 1970s due to the disastrous impact of the Aliens Compliance Order of 1969, which led to the expulsion of tens of thousands of foreign cocoa workers (Addo 1970). Later on, in the 1980s, a disastrous pricing policy almost killed the industry (Bateman 1998), while the possibility of smuggling cocoa to Côte d'Ivoire, where higher price prevailed in

regions close to the border, may have attracted migrants to the Western region (Fosu 1992, Abdulai and Reader 1995). Finally, the matrilineal structure of several communities in Ghana, especially the Ashanti, encouraged migration: as farms were inherited by nephews, the sons of farmers had to create new farms of their own (Ruf 1995).

Finally, as the western region is wetter than other cocoa regions of Ghana, to what extent the climatic east-west gradient was in itself a driving factor of the shifting cocoa frontier? The 'cocoa cycle model' integrates a microclimate change, a declining resilience of cocoa systems to climatic stress, suggesting that less useful rainfall in old cocoa regions participates to trigger new migration and further forest encroachment but it was not demonstrated in the case of Ghana.

The objective is thus to contribute to clarify this interaction between climate change on one hand and migration and cocoa production on the other. Did climatic degradation in old cocoa zones contribute to trigger migration and further forest encroachment? Besides the search for land and forest, besides demographic and price factors, did the wetter climate in the west of Ghana also help to attract migrants? Then what was the impact in the former cocoa regions?

2. Method

It is proposed here to answer the questions through the analysis of climatic accident that occurred at the regional West-African level in the early 1970s and in 1982/83. The latter drought hit the cocoa zones of Ghana, causing plantation fires, forest fires, even hunger and bankrupts. This drought was triggered by El Nino but its specific magnitude in 1982/83 may be analyzed as a sign of climate change. We wish to identify and demonstrate its impact on cocoa migration, cocoa production shifts, and potential crop diversification.

The methodological principle is to simultaneously use and combine rainfall data, national and regional production statistics and finally social-economic surveys at village levels, undertaken at different periods, giving insights of farmers' migrations and strategies at different periods.

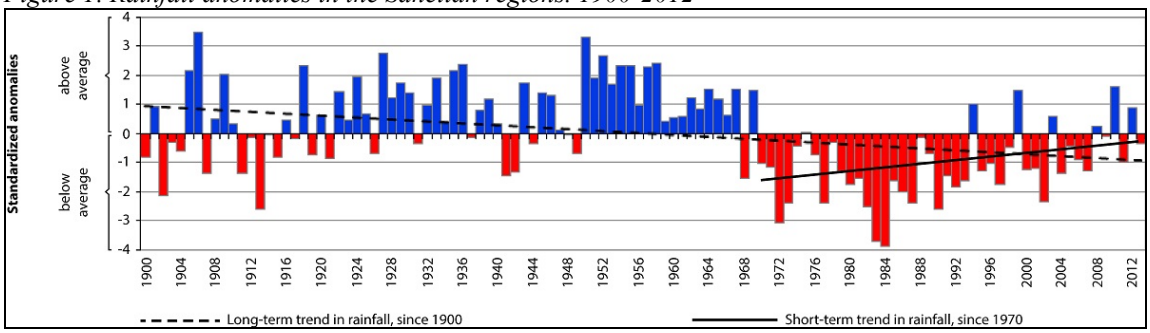
Besides climatic and production statistics coming from various sources, we use our own data collected between 2003 and 2010 in several villages (around 400 farms in different places of the Western region, such as Antokrom, Asampaneye, Pensanum, Obeng) also including 110 farms in Adubrim, part of the N'Zema district which is interesting for its late adoption of cocoa despite abundant rainfall). Surveys were also passed with 120 farmers in the Ashanti region (Villages of Tetrem and Bangko) and 110 in the Central region (Nyamebekyere) and 80 in Nkrankwanta (Brong Ahafo). These social-economic surveys help to understand the impact of rainfall patterns and changes and the conditions that determine migrations. We will also look at the simultaneous impact of migration and ecological change on replanting and diversification, especially in the old cocoa regions partially abandoned (Kade, eastern region in Ghana).

3. Results

3.1 Changes in annual rainfall patterns in West Africa and Burkinabé migrations

As far as annual rainfall data is concerned, different results and conclusions may be obtained depending on the period of observation. Over the long term, the important inflection point has been found around the late 1960s/early 1970s in the Sahelian region and more or less in the whole of West Africa, including Côte d'Ivoire and Ghana (Morel 1995, Brou 2005, USAID 2017) (Fig.1)

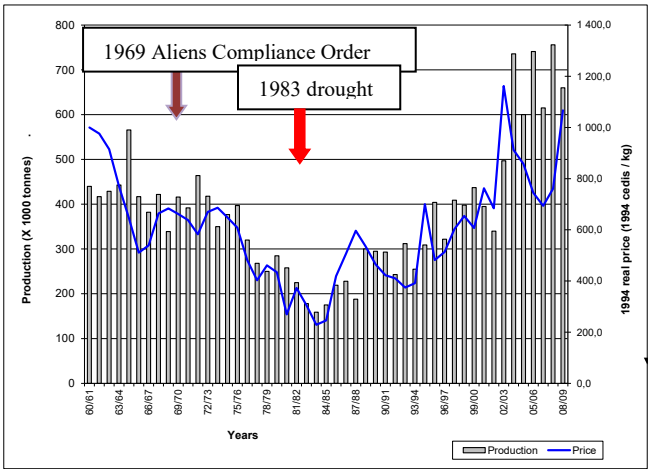
Figure 1. Rainfall anomalies in the Sahelian regions. 1900-2012



Sources : USAID 2017.

This clear structural change in the Sahelian rainfall pattern in the 1970s coincided with an increase in the world cocoa price. This combination triggered massive migrations, mainly from Burkina Faso to the cocoa regions in the south – but predominantly towards Côte d'Ivoire, not Ghana. The main reason was the quite favourable labour and immigration policies in Côte d'Ivoire. In the mid-1980s, almost 50% of the Ivorian cocoa production could be already attributed to Burkinabé smallholders, sharecroppers and other forms of labour (Ruf 1988). Meanwhile, Ghana – with the Aliens Compliance Order leading to the expulsion of foreign workers and with its higher taxation of cocoa – created a highly unfavourable environment for foreign immigrants. In this way, Ghana cut its strong historical link with the reservoir of labour in the former Upper Volta. This policy led to the cocoa bust of Ghana in the 1980s (Fig. 2) and favoured the boom in Côte d'Ivoire (Ruf 1985).

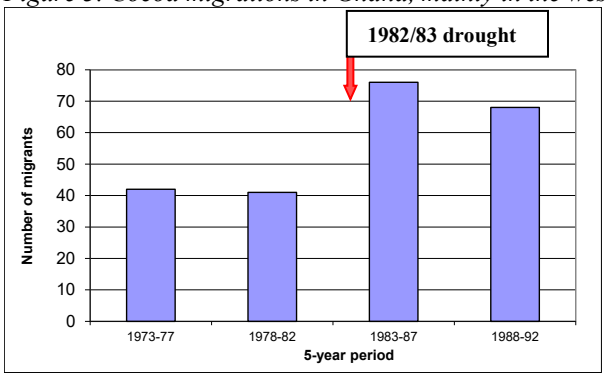
Figure 2. Cocoa Production, Labour policies, Ecological change and real cocoa prices in Ghana.



Much later on, in the 1990s, the Ghanaian cocoa sector started to recover, a result mainly of internal migration, within the country, partly triggered by the 1983 drought; mostly oriented towards its western region (Fig. 3).

Regional rainfall patterns and their variations from one region to another certainly played a role.

Figure 3. Cocoa migrations in Ghana, mainly in the western region



Sources: Ruf 2010, p44.

3.2 Wetter western regions.

The south-western part of Ghana is clearly the wettest. Just like for Brou in Côte d'Ivoire, one can hypothesize that migrants were partly attracted to the west, not only because of land and forest but also because of abundant rainfall. The further west one proceeds, the higher is the rainfall (Fig. 4 to 6). Migrations followed this east-to-west trend (Fig. 7 to 9)

Figure 4

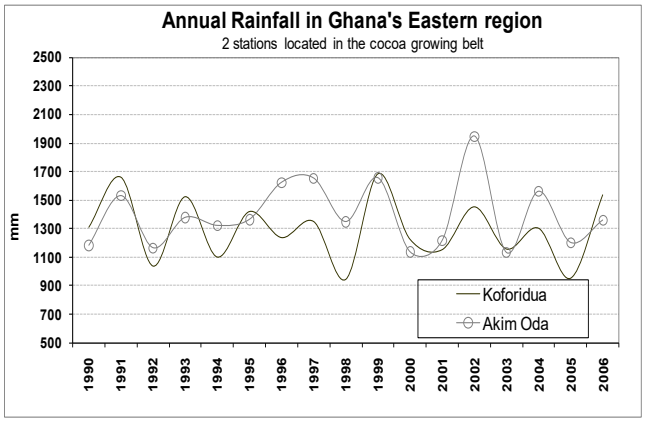


Figure 5

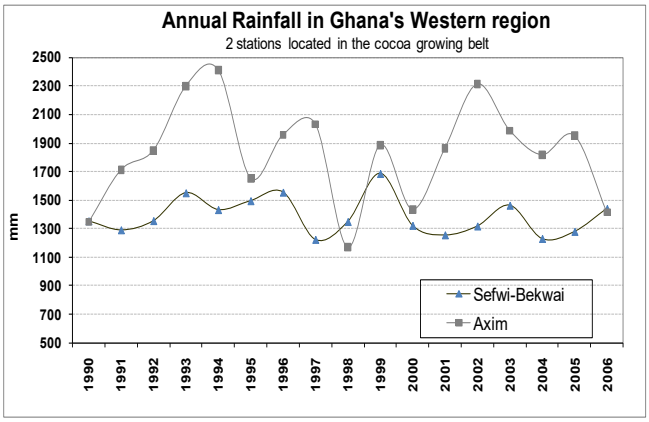
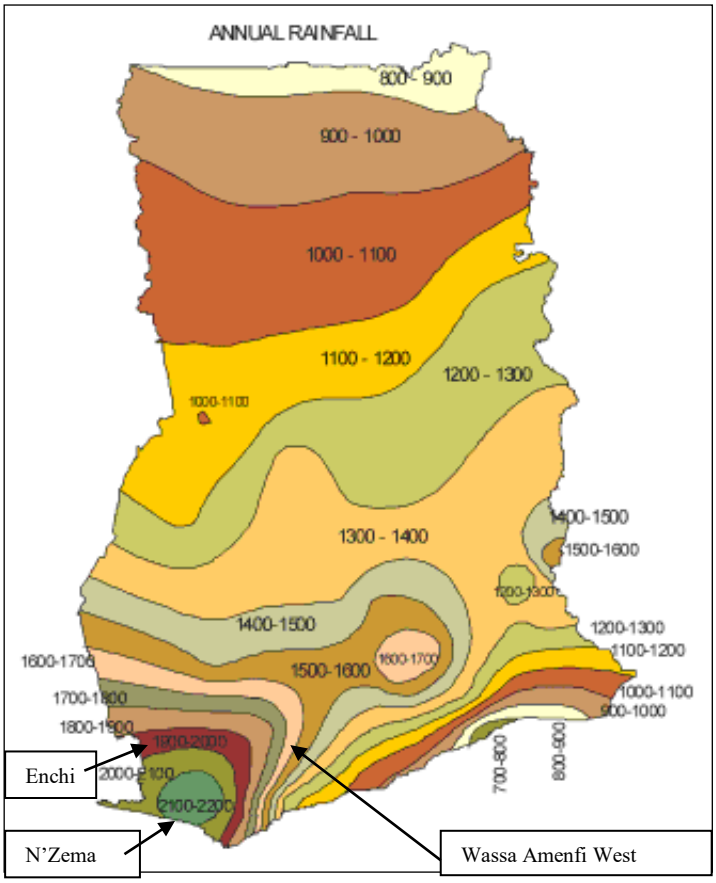
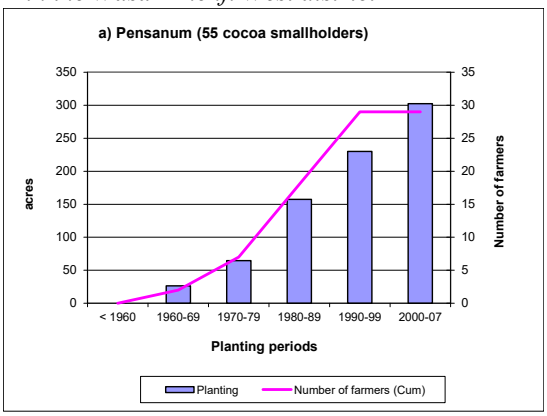


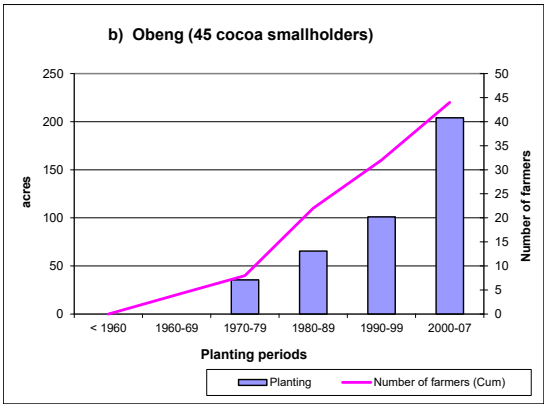
Figure 6. Regional annual rainfall and migration flows



Sources: Author's survey, 2007.

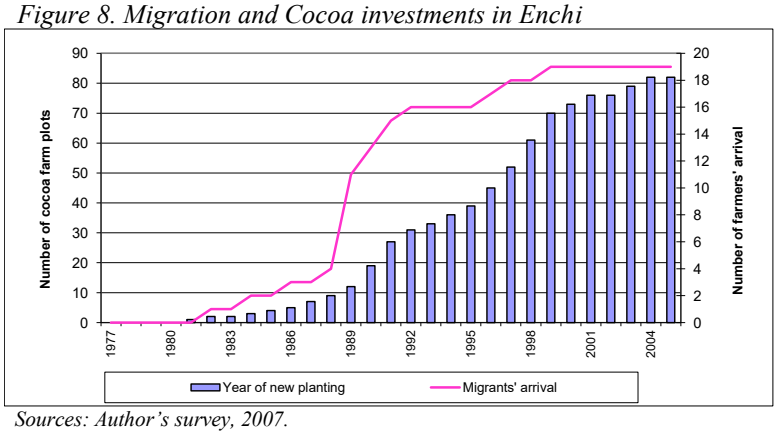
Figure 7. Migration and cocoa planting in the Wasa-Amenfi West district





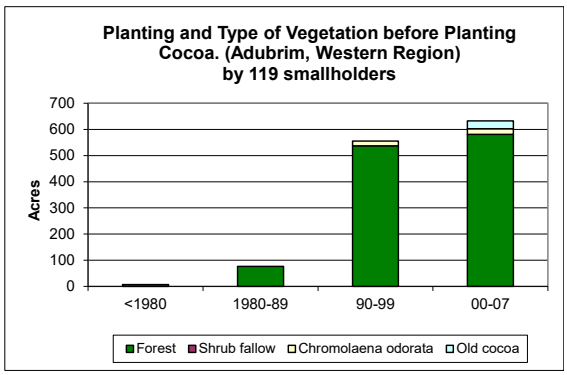
However, even though the migration to the wetter western region and its major role in the Ghanaian cocoa boom in the 2000s and 2010s are well-established facts (Fig. 7 and 8) and even though many famers do mention their motivations to migrate to places such as Enchi when they discover 'that rain never stops' there, it remains difficult to demonstrate a significant impact of the rainfall pattern variations since the other factors, especially the migrants' thirst for land and forest, are quite strong (Fig. 8 and 9).

Figure 8. Migration and Cocoa investments in Enchi



Sources: Author's survey, 2007.

Figure 9. Cocoa investments and deforestation in Adubrim (N'Zema district)



3.3 Wettest among the wetter: the showcase of Adubrim, N'Zema district

In the extreme far-west, at Adubrim (N'Zema district), rainfall is far above the average for the western region. Nevertheless, it remained a non-cocoa district until the 1990s. Interestingly, abundant rainfall, close to 2000 mm per year (Fig. 6) did not attract cocoa migrants before the mid-1990s. Even more interestingly, it became one of the cocoa champions in the 2000s. It illustrates the massive shift of cocoa production to 'cocoa unsuited' soils and regions. What happened? The shift is explained by a three concurrent factors: technical breakthroughs, ecological change and policies (Box 1).

Box 1. Cocoa production shift to 'cocoa unsuited' regions

Several rough periods occurred in the 1960s-1980s. Cocoa was introduced by migrants, but had difficulty taking off. A number of failures led to abandonment or stagnation of the crop. Then cocoa surged again in the 1990s for different reasons,

Technical breakthrough: from « Tetteh Quarshie and Amazonians » to new hybrids

The first reason is technical and varietal. The varieties that were available in the region « Tetteh Quarshie » (amelonado) and « Amazonia » were not suited to the regional ecology. The plants failed to grow satisfactorily or worse, rapidly died. The native inhabitants observed what was happening and took no further interest in cocoa. In the 1970s, the majority of native inhabitants became and remained coconut

planters. But at the end of the 1990s, newly arrived migrants and extension services introduced hybrids that were more vigorous and grew very well under this climate

Ecological change: deforestation and a reduction in rainfall

Abundant rainfall reaching nearly 2000 mm per year makes drying the cocoa difficult. A number of smallholders mentioned that they consider deforestation plays a positive role in that it reduces rainfall and makes post-harvest operations easier.

Most of all, this type of climate often results in cocoa beans of mediocre quality. Badly dried and black, a high percentage becomes moldy.

Economic and political change: liberalization of the sector

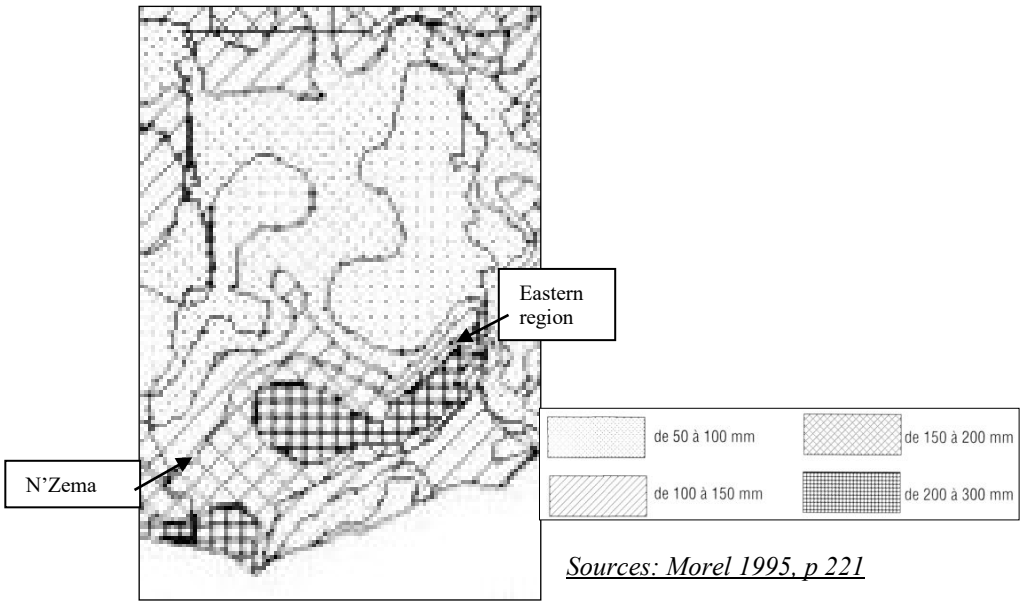
Planters need to be sure of finding a buyer for these cocoa beans. In the 1970s, during the period when the cocoa marketing board had a purchasing monopoly, this quality of bean was refused.

The liberalization of the purchase of cocoa from planters resulted in new opportunities. Several planters spoke openly about better sales conditions for cocoa after the 1990s when several buyers established themselves in the region leading to competition favorable for planters with payment in cash.

Sources: Ruf 2007, p31-32

Indeed, science seems to confirm what famers say about the specific benefit of rainfall losses in this region (Morel 1995, Fig. 10). When an average annual loss of 250 mm occurs in a cocoa region with 1200-1300 mm per year, it becomes a potential zone for emigration and abandonment of cocoa. This is what happened to the eastern region. When an average annual loss of 250 mm occurs in a cocoa region with 2000 mm, it remains or becomes a potential zone for cocoa immigration. This is what happened, in conjunction with technical breakthroughs and liberalization policies, in the N'Zema region.

Figure 10. Annual Rainfall losses between the 1950-1967 and 1968-1990 periods



Sources: Morel 1995, p 221

3.4 The 1982/83 drought

The severe drought of 1982/83 had a drastic impact on the cocoa zones of Côte d'Ivoire and Ghana. Several thousands of hectares of cocoa were destroyed in fires around April 1983. Food crops and even forest plots were damaged, leading to famine and bankruptcies. Even though this drought was triggered by El Nino, its particularly severe magnitude can be analyzed as a sign of climate change.

For instance, the annual rainfall in Asamankese, in the Eastern region, was as follows:

Years	Rainfall (mm)
1981	1384
1982	1432
1983	963
1984	1553

The deficiency is obvious in 1983 but not in 1982 because annual rainfall is not a sufficiently suitable indicator. We need to examine the monthly data to understand why the 1982/83 drought was so severe (Fig. 11 and 12).

Figure 11. Monthly rainfall in Asamankese in 1982 compared to 1981

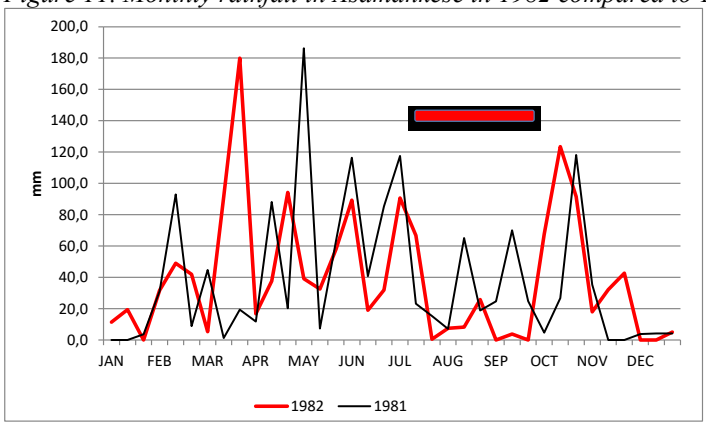
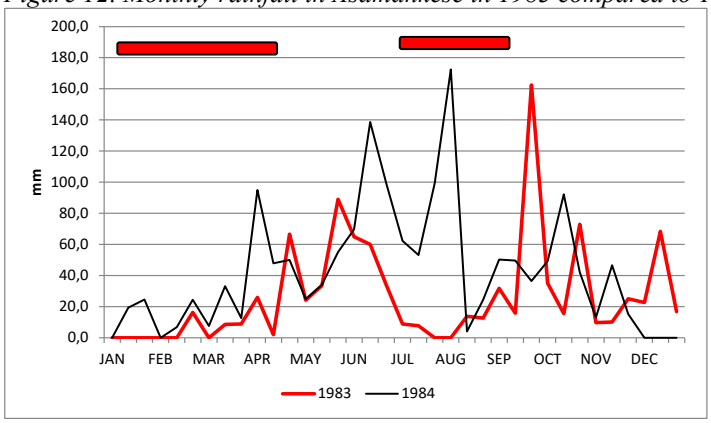


Figure 12. Monthly rainfall in Asamankese in 1983 compared to 1984

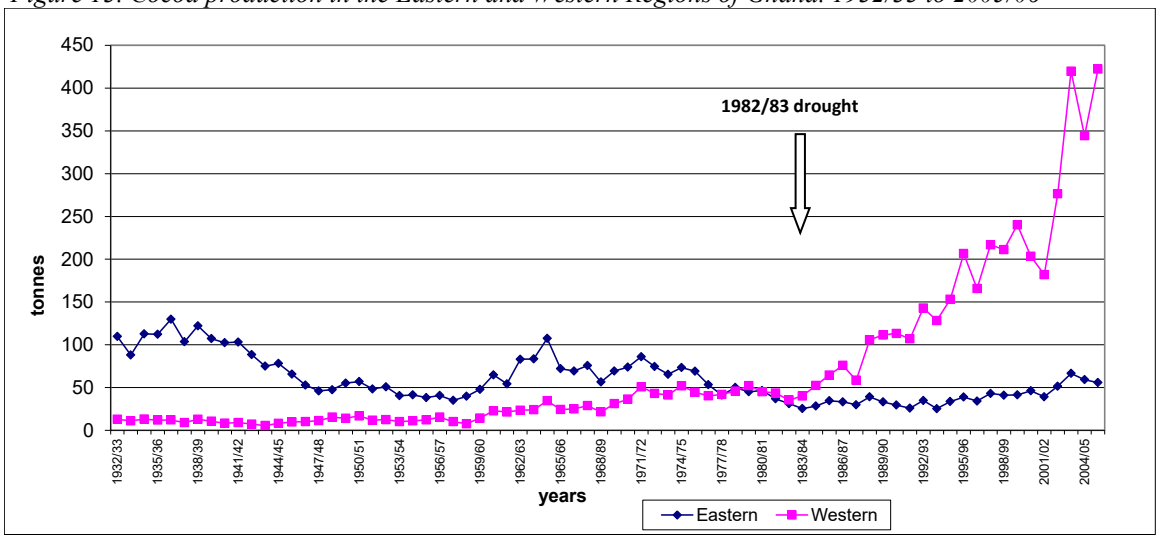


In 1982/83, , the region experienced two periods of between 60 and 70 days with a total precipitation of less than 45 mm (end of July to early September 1982 and July-August 1983). It also experienced a very long dry season of 120 to 140 days with almost no rain (35 mm) from December 1982 to April 1983. Unsurprisingly, plantations everywhere caught fire and famine resulted. The most obvious and immediate solution was migration and further forest encroachment in regions with higher rainfall.

3.5 Impact of the 1982/83 drought on production shifts

The impact of the 1982/83 drought on cocoa production shifts can be – if not demonstrated – at least illustrated through the shift of cocoa belts and production areas. Indeed, the Western region took over from the older cocoa regions around 1982/83. This means that migrations to the wetter and then the forested Western region started far before 1982/83 but the sudden decline in cocoa yields in the old regions intensified the movement (Fig.13)

Figure 13. Cocoa production in the Eastern and Western Regions of Ghana. 1932/33 to 2005/06

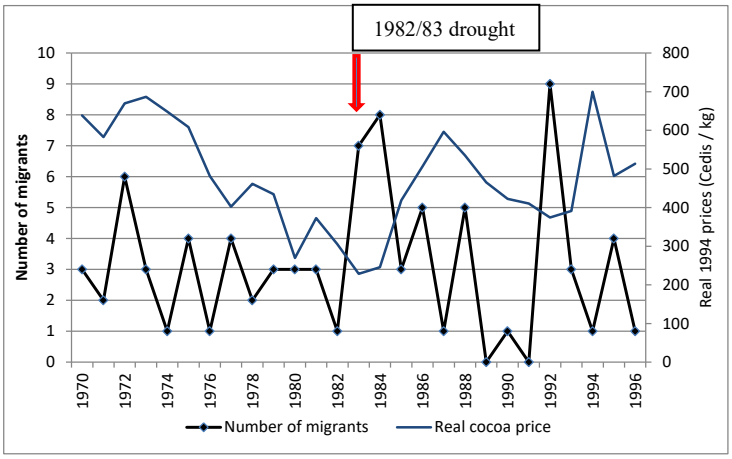


3.6 Drought-driven migration

The production shifts can only be explained by migration data. The acceleration in migration in the 1983-1985 period has been confirmed in many migrant villages of the Western region. Although a minority of migrants come directly from their home villages in the northern part of the country, the majority come from an already established cocoa village. These migrants are either planters themselves or are the planters' sons and workers. This seems to be one more sign of the role of the 1983 ecological disasters in villages of migrants.

This impact of the 1982/83 drought is very visible since the price factor was negative (Fig. 14).

Figure 14. Migration, real cocoa price and ecological change in Nyamebekyere (Central region)



Source: Author's survey, 2005.

3.7 Strategies of migrant farmers

The interviews that confirmed that plantation fires were the driving factor behind migration were undertaken in 2005/06. Twenty-two years after these fires, the memory of this climatic disaster is still very strong. Around 12% of migrant farmers interviewed in 2005 declared a plantation fire in 1983 in their former cocoa village as the main reason to migrate to a new forest region and start a new cocoa farm/cycle. This percentage climbs to 17% when the impact of drought and plantation fires during other years is included (Table 1).

Table 1. Role of plantation fires in the decision to migrate (as declared by cocoa famers)

Fires as a driving factor	Western region		Brong Ahafo	Central region	Total	
	Antokrom	Asampa-neye	Nkran-kwanta	Nyamebekyere		
No (no plantation fire)	29	28	45	109	211	80%
Yes (plantation fire in the farmer's former cocoa village)	11	5	4	12	32	12%
Yes (fire in the savannah zone with food crops destroyed)	1	0	0	1	2	1%
Yes (fires, but not in 1983)	2	0	0	11	13	5%
Opposite process: Fire freed up land, which attracted sons and new migrants	0	4	0	2	6	2%
Total	43	37	49	135	264	100%

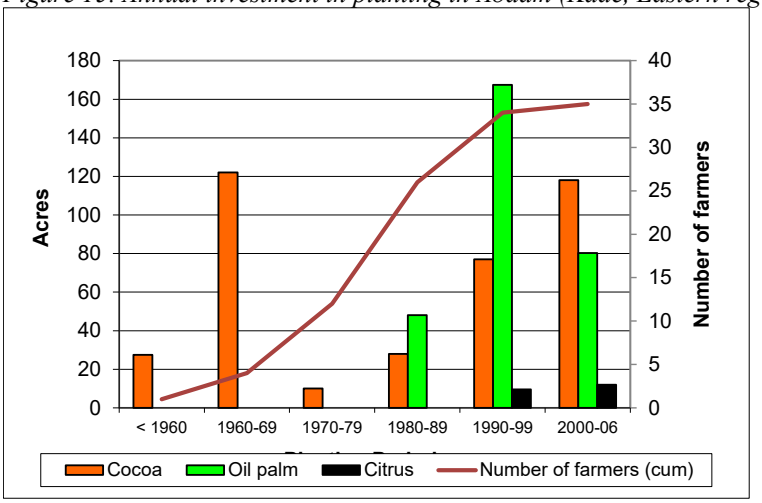
Source: Author's survey, 2005.

3.8 Drought-driven technical innovations: replanting and diversification

In addition to causing migration, the 1982/83 drought also played a role in replanting. For decades, most cocoa farmers had been using the forest as a fundamental production factor. As recalled in the introduction, the forest guarantees a successful and fast growth of young cocoa trees. After the plantation fires of 1983, the first reflex of most migrants was to abandon the land and move westwards to encroach on a new forest plot. However, the spaces that were freed up were eventually taken over by a younger generation, which started to plant and replant some cocoa a few years later. This very significant change, a kind of 'cocoa farming without forest' progressively triggered various innovations. Two decades later, in the 2000s, fertilizers and herbicides started to be adopted. Although limited to some extent by the regular subsidies offered on purchases of chemical fertilizers, the adoption of chicken manure took off in some regions, including at the planting stage. In the 2010s, farmers make deep holes which they fill with chicken manure mixed with soil before the seedlings are transferred from the nursery to the field. Some neighbours decide to combine their efforts and have invested in deep wells at the boundary of their farms.

The 1982/83 fire also played a role in the diversification of tree crops. By 'cleaning' the old established cocoa farms owned by old men, fires also gave an opportunity to the younger generation to plant alternate crops such as oil palm and citrus. This was especially true for the Eastern region, where an oil palm estate offered contract farming opportunities, including to this new generation (Fig. 15)

Figure 15. Annual investment in planting in Abaam (Kade, Eastern region)



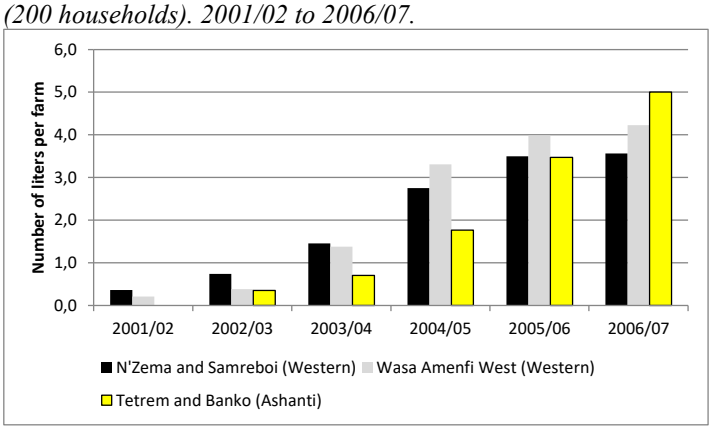
Source: Author's survey, 2007.

3.9 Another major interacting factor: the adoption of herbicides

Even though we may feel ambivalent about it but one of the key technical changes that favoured that transition towards replanting without using the forest as a production factor was the adoption of herbicides. In 2000, the use of herbicides by Ghanaian cocoa farmers was still close to negligible. Then its adoption grew exponentially, especially for replanting and managing young cocoa farms (Fig. 16).

The new cocoa boom experienced by Ghana in the 2000s/2010s is not only due to expansion through forest encroachment but also due to the thousands of hectares replanted with the help of herbicides, mainly by young farmers who may have not attempted it without herbicides.

Figure 16. Adoption of herbicides by cocoa farmers in three Ghanaian regions (200 households). 2001/02 to 2006/07.



Source: Author's survey, 2007

3.10 Drought-driven social innovations, the 'abunu contract' and replanting

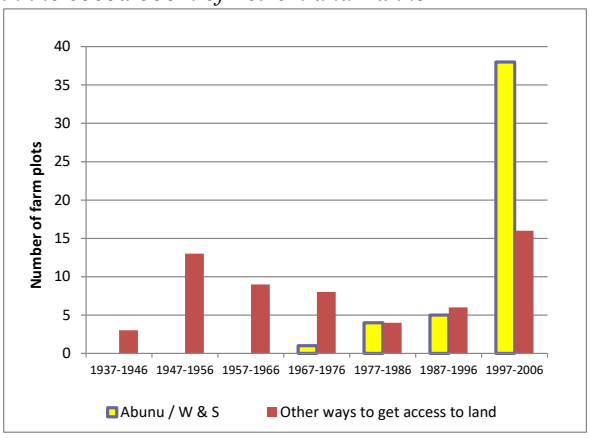
Even though the 'abunu' term encompasses several meanings, today it most frequently refers to a 'land sharing' contract under whose terms the 'sharecropper' receives a plot of land to be cleared and planted, and usually receives half of the plantation a few years later, once it starts producing. In local languages, such a contract is often called the equivalent of 'Plant-and-Share' or 'You Weed, We Share' (W&S).

Takane (2000) raised the hypothesis that, in combination with the real increase in the price of cocoa in the late 1980s, these share contracts contributed to the revival of cocoa production in Ghana in the 1990s thanks to the benefits they provided both to landowners and sharecroppers. Actually, when what is shared is not the cocoa crop but the farm and the land themselves, the 'abunu' contract becomes much more than a sharecropping contract. It turns into an investment multiplier that played an important role in Ghana's new coca boom (Ruf 2009).

In addition, the rapid adoption of the abunu/W&S contract is very likely linked to the massive migration triggered by the 1982/83 drought.

In villages such as Tetrem and Banko, located north of Kumasi, in the Ashanti region, the connection between the fire in 1983 and the emergence of the W&S contract is evident. When the drought and fires destroyed plantations and food crops, large cocoa farms found themselves in a desperate situation. The only strategy to try to rebound and replant was to resort to a mechanism that avoided the need for any expense or cash investment: this was precisely what these Abunu/W&S contracts entered into with young migrants were all about (Fig. 17).

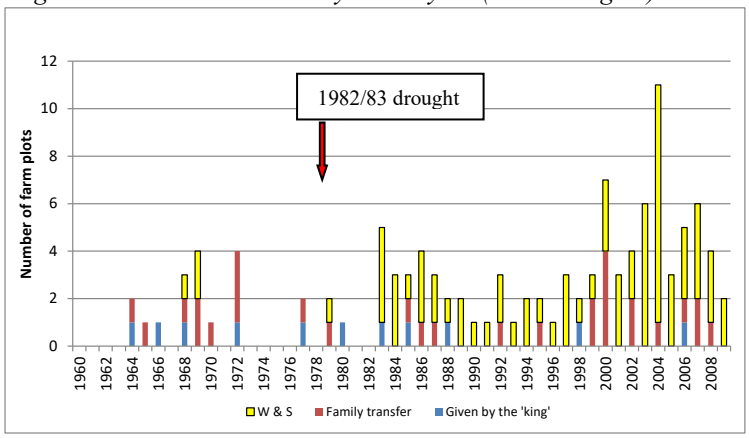
Figure 17. Access to land and place of the Abunu/W&S contract in the cocoa boom of Tetrem and Banko



Source: Author's survey, 2009

There was a clear increase in the number of W&S/Abunu contracts after the 1983 fires in all regions. Another showcase of this development is Nyamebekyere in the Central region. (Fig. 18).

Figure 18. Access to land in Nyamebekyere (Central region)



Source: Author's survey, 2009

4. Conclusion

One preliminary conclusion may well be a warning about the temptation to exaggerate the role of climatic change on migration and cocoa farming. Climatic change always interacts with many other factors such as availability of land, availability of forest, prices, family structure, change in generation, technical breakthroughs, and public policies.

The best example is the symmetrically opposite impacts of the Sahelian droughts in the 1970s in Côte d'Ivoire and Ghana. During this decade, the latter could have consolidated its premier rank among the world's cocoa producing countries with the influx of the Burkinabé immigrants. Instead Ghanaian public policies served this foreign labour force to Côte d'Ivoire on a 'cocoa platter'. Côte d'Ivoire rapidly rose to the position of the top producer with farmers of foreign origin currently accounting for more than 35% of the country's cocoa smallholders and more than 50% of its cocoa production.

However, interacting with these 'other factors', the 1983 drought in established cocoa villages and subsequent droughts played a real role in migrations to forested regions and thus in the acceleration of forest encroachment. The 1983 drought illustrates what climate change represents for cocoa farming: a combination of internal and structural environmental degradation, undermining the system, reducing its resilience to droughts, and of external/global effects of climate change (in this particular case, *El Nino*). To a certain extent, this process is a typical Malthusian spiral of degrading environment, production and revenues.

However, another perspective is also suggested by the surveys. In conformance with Boserupian principles, ecological changes and production declines lead to technical and social innovations, basically new techniques and inputs to replant cocoa with deeper holes and chicken manure, investment in deep wells, and adoption of other tree crops such as rubber, oil palm, and citrus, and hence a beginning of diversification. [Although he did not mention climate change as one of the possible factors, E. Léonard (1998) also shows the relationship between regional cocoa declines in Ghana and Côte d'Ivoire and cannabis diversification in both countries.]

Because they make cocoa replanting more difficult, droughts may also accelerate access to land and investment to a new generation of poor immigrants ready to accept more labour-demanding techniques through these 'abunu' contracts.

On the whole, these ecological disasters, and more structural climatic changes, seem to have been well overcome from an economic and social perspective. However, as reminded by the key role of herbicides, the revival of the cocoa sector in Ghana has come with a cost: increased deforestation, increased loss of biodiversity, and/or increased use of chemicals.

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