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BOSERUP VERSUS MALTHUS REVISITED: EVOLUTION OF FARMS IN NORTHERN CÔTE D'IVOIRE

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Abstract

The literature on the evolution of farming systems in West Africa shows a large diversity of general theories on rural development. The purpose of this study is to revisit the theses of Malthus and Boserup and empirically test them on a case study of Northern Côte d'Ivoire. We have at our disposal a database spread over three agricultural seasons (1995-1998) in four villages. These villages differ strongly regarding their population density and historical genesis. The comparison between these villages permits to track down their stage in the evolution of farming systems and to identify population pressure as a key factor of the evolution process of farms. Our empirical analysis shows that Boserupian and Malthusian processes coexist, rather than contrast. Labour is the key factor for escaping Malthusian mechanisms and induces Boserupian innovations that are crucial to the evolution trajectory of farms.

Introduction

The literature on the evolution of farming systems in West Africa shows a large diversity of general theories on rural development. On the one hand, Malthus (1798) proposes that population, when it is not controlled, increases following a geometric ratio, while agricultural production growth follows an arithmetic ratio. This growth differential engenders crises (famine, war, migration) leading to an endogenous "natural control" of population. On the other hand, Boserup (1965) contends that population pressure urges farmers to adopt more intensive cropping systems and hence, to innovate. The purpose of the present study is to revisit the theses of Malthus and Boserup by testing them empirically on the case study of Northern Côte d'Ivoire.

Data

During the period 1995-1998, the project IDESSA-K.U.Leuven (Institut des Savanes, Côte d'Ivoire - Catholic University of Leuven, Belgium) was active in the Dikodougou region, south of Korhogo. A representative sample of villages was chosen in function of the geographic diversity of physical and social conditions of farming (soil, presence of a cash crop, population density, etc.). Next, for each of the villages, a representative sample of farms was selected and surveyed during three agricultural seasons. For each farmer, field area, crops, yields, input use, capital costs, family structure and labor allocation were surveyed. Moreover, numerous surveys and informal interviews were carried out on historical, sociological and commercial aspects of farming in the Dikodougou region. As a result, we dispose of an extensive database of data on four villages and 47 farms, surveyed during three agricultural seasons (1995-1998).

These villages differ strongly as far as their population density and historical genesis is concerned (Table 1). The southern part of the Dikodougou region (Ouattaradougou and Farakoro) is located in the pioneer zone of forest land clearing. While this zone has remained "underpopulated" up to the eighties, since then it is characterized by an important demographic growth rate, due to a progressive colonization of uncultivated land by *Sénoufo* immigrants coming from Northern Côte d'Ivoire. As a result, the southern villages are relatively recent as compared to the northern villages (Tapéré et Tiégana) founded in the nineteenth century.

Methodology

This intraregional diversity (Table 1) constitutes the basis of our methodology. As Jouve and Tallec (1996, p. 24) observed in numerous cases, "*in Sub-Saharan Africa, due to interethnic conflicts* […] *density of occupation of land is far from being homogenous and only partly reflects the agricultural potentialities of the land*". This is also the case for our region of study, where the distribution of the population is the result of a history of war during the nineteenth century. "*This heterogeneity of population translates into a diversity of farming systems, allowing tracking down the different evolutionary stages in function of population pressure*". Our methodology is inspired by these observations: it consists of "*valorizing the geographic diversity of farming systems to reconstruct their historical evolution*". Comparing the villages allowed tracking down their stage in the evolutionary process of farming systems and identifying the key factors responsible for this process. The proximity of the four villages allows assuming factors like climate, market access, agrarian system, etc. to be *ceteris paribus* and isolating the effects of factors that change from one village to another, like population density and historical genesis.

Results

Figure 1 graphically shows how the average cropping mix of the farms changes when population pressure increases. In the most sparsely populated village, the cropping systems are dominated by three crops in shifting cultivation cycles: yam, rainfed rice and groundnut. According to Le Roy (1983), these crops constitute the basis of the "ancient yam-rice-groundnut (*YRG*) cropping system", characterized by three-year rotation cycles and dominating in sparsely populated areas. When population density increases, yam is substituted for other food crops or cash crops like cotton. What are the underlying factors explaining these differences?

Certainly, population density directly affects the man-land ratio. Table 2 illustrates that the logical consequence of an increase of population density is the decline of utilisable agricultural land per family work unit. In contrast, cultivated agricultural land per family work unit is more constant across the villages. It is slightly higher in the southern immigration regions (Ouattaradougou and Farakoro), due to the immigrants' anticipation strategies. Cultivation of land implies appropriation. A consequence of population increase and such anticipation strategies is the increase of the degree of residence (Ruthenberg, 1980) in space, by reducing fallow land, and in time, by expanding the length of the cultivation period. For the southern villages, this increase is also the result of a strategic contraction of the fallow period in order to maintain and mark land property. Nevertheless, since labour is the principal production factor in manual or low-mechanized agriculture, the real economic dimension of a farm is defined by the number of work units available and not by the cultivated area as assumed by many studies. However, a logical correlation exists between both indicators (Table 2). Migrations to uncultivated areas can be interpreted

as waves that temporarily mobilize a substantial labour force on an extended surface. As soon as the effects of village land saturation are perceived (decline of yields, proliferation of weeds, development of pests and diseases), this wave moves on to another region and the pioneer zone of forest land clearing shifts.

This intensification engenders a transformation of the biophysical environment[1] and a substitution of the crops, especially those on top of the rotation cycle. The three-year cycle of the cropping system *YRG*, which dominates in sparsely populated areas, is followed by a long fallow of 22 year. In response to increasing population density and market access, a series of cropping systems emerge, based on this *YRG* system. A first group of systems is simply based on the extension of the *YRG*'s cultivation period, a second one on the insertion of one or several years of cotton cultivation.

Through these representations, the role of cotton in the evolution process of farms becomes clear. This crop is not an innovation *in se* in Northern Côte d'Ivoire, where it has been cultivated for a long time (SEDES, 1965). The innovation consists of new farming practices exogenously introduced, diffused and subsidized by the CIDT (Compagnie Ivoirienne de Développement des Textiles) since 1974: monoculture, sowing in rows, mechanization and use of fertilizers, insecticides and herbicides. Labor bottlenecks due to weeding are bridged by the introduction of animal traction. Moreover, fertilizers and herbicides allow extending the cultivation periods in response to increasing population pressure. This partly explains the correlation between population density, the importance of cotton in the cropping mix (Figure 1)

[1] Fallow land gradually evolves from forest to savannah and grassland, losing little by little its capacity to control weeds.

and the evolution of input use (Table 2). Nevertheless, also food crops benefit from the increase in input use.[1]

According to Boserup (1965), agricultural equipment is a "key indicator" of the evolutionary stage of an agrarian system. The increase in the average capital costs of the farms with increasing levels of population density is in line with the thesis of Boserup (Table 2). This increase is essentially the result of growth in amortization[2] costs related to the equipment of animal traction. The labour costs of manual farming (land preparation, weeding and fertility restoration) rapidly increase with increasing cultivation intensity, expressed by the degree of residence (Table 2). The mechanical innovation of combined bedding and weeding breaks up the labour bottleneck of manual farming (Pingali *et al.*, 1987).

What is the repercussion of these effects at the farm level? Following the methodology of Dufumier (1996) and Mazoyer and Roudart (1997), we estimate the investment rate[3] and net value added[4] of the surveyed farms. The village averages are presented in Table 3. As mentioned, the increase of the investment rate reveals a Boserupian process. Next, the highest average net added value is recorded in the most sparsely populated village, where almost exclusively the ancient cropping system *YRG* is maintained. However, the net added value seems negatively correlated to population pressure, a typical Malthusian process. Following standard techniques of

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[1] It is important to note that some farmers grow cotton to have access to inputs which are entirely or partly used for food crops.

[2] We compare the amortization costs because they reflect the real cost perceived by the farmer.

[3] Amortization costs of invested capital not proportionate to the area, expressed per annual work unit.

[4] Gross product minus intermediate consumption minus amortization costs of capital proportionate to the area, expressed per year, hectare and annual work unit.

Data Envelopment Analysis (Charnes *et al.*, 1978) we estimate farm efficiency, expressed in percentage of the most efficient farm. The same Malthusian effect is observed: farm efficiency declines with increasing levels of population density.

In literature, indicators of economic performance of farms are typically estimated proportionally to cultivated area. Comparing performance in terms of cultivated area means adopting Malthus' methodology which logically uncovers the typical Malthusian effects. Boserup contrasts with the Malthusian pessimism by taking into account farmers' agricultural practices. Farmers follow a production strategy in time and space. Shifting cultivation and fallow are the result of farmers' historical observations and experiences with too much intensified and repetitive cultivation cycles that lead to soil exhaustion, weed proliferation and the development of diseases and parasites. Fallow periods constitute an efficient tool to attenuate these risks. This knowledge leads Boserup to reject the concept of "cultivated area" in favor of "utilizable area" which integrates the totality of land contributing to agricultural production. Boserup's thesis fundamentally alters our conception of the dynamics of the farms in the Dikodougou region. The latter adapt to population increase by increasing their value added per unit of utilizable land, in this way consuming less space. While Malthusian efficiency clearly diminishes (with 20,2%), Boserupian efficiency is more constant (variation of 12,1%). As a result, this stage of alteration of the farming system is not simply to be considered as a Malthusian decline of profitability, it also constitutes a Boserupian attempt to prevent the latter from declining even more.

In Table 4, we present a typology of the surveyed farms, based on the degree of mechanization (manual farming or animal traction), the presence of cotton and the crops that occupy at least 75% of cultivated area. The *YRG* system is based on the ancient *YRG* cropping system and its derived systems. The *MR* system (maize-rice) is characterized by the appearance of a monoculture of maize with a cultivation period up to five years. In the *CR+* (cotton-rice-other crops) system, yam substitutes for cotton. This system is characterized by a diversified cropping mix and exists in a manual as well as a mechanical version. Finally, some large farms are specialized in cotton as a cash crop, combined with one or two food crops like rainfed rice (*CR*) and maize (*CRM*).

In Table 5 we compare the economic performance of these farm types. The maize-based systems (*MR* and *CRM*) are characterized by a lower net value added, due to the low price of maize. These systems primarily occur in the southern part of Dikodougou where maize is the staple food crop of the *Malinké* immigrants. Nevertheless, for the native people of the Dikodougou region, yam is the preferred staple food crop. Here, the *YRG* system dominates as far as population pressure allows. The *YRG* system has the highest value added, occupying a minimal cultivated area. Sustainable reproduction of this system requires low population densities. Therefore, only in sparsely populated villages like Tapéré is this system observed.

But not everywhere this condition is fulfilled. Migrations and religious wars have left their blueprints on the geographic distribution of the population such that its density is far from being homogenous and differs considerably from one village to another. When this density increases, utilizable area per work unit declines (Table 2) forcing

the farmers to migrate, extend their cultivation cycles and/or cultivate a part of their fallow land. The ancient *YRG* system is in unbalance and a whole series of derived systems appears. Sustainable reproduction of the ancient system is no longer possible and progressively yields decline. Some innovators decide to substitute yam for another crop which is less demanding regarding soil fertility. By cultivating cotton, the farmer aims at accumulating revenue, sufficient for the purchase of animal traction equipment. Anyhow, the adoption of cotton engenders a profound change of the traditional production system. At the same time, the adoption of cotton translates in a profitability drop[1] and an exacerbation of labor bottlenecks.[2] The result is that not mechanized cotton farms are generally smaller than traditional *YRG* farms. Thus, this stage of the production system change is typically characterized by Malthusian effects. Accordingly, in this stage we generally observe migrations (natural control of population), rather than intensification.

However, this Malthusian approach is not free from criticism. As we did in Table 3, by using the correct denominator, i.e. utilizable agricultural area, we obtain the Boserupian indicators of the economic performance of the farm types. Table 5 shows that the evolution of the ancient *YRG* system to the most specialized *CR* system translates into a progressive increase of the net value added per unit of utilizable area. Our analysis also advances that the ancient *YRG* system consumes a lot of utilizable land and can only survive in combination wit low population densities. The change towards the *CR+* system keeps pace with a halving of utilizable agricultural area, illustrating the role of population pressure. Next, the theory of Malthus ignores the

[1] The average cotton price is lower that the average yam price.

[2] Cotton competes with food crops for labour.

effect of innovations that allow escaping the vicious circle of declining yields and increasing labor costs: mechanization. Thanks to the shift from manual farming to animal traction, farmers are able to surpass technical limits of manual farming and increase cultivated area considerably. Table 5 shows that for this Boserupian reaction, access to land and labor plays a crucial role. Farms endowed with abundant land and labor force more easily adopt the innovation of animal traction. A minority of farms reach the stage of *CR*, thanks to an unequal land endowment. Their entry in this stage of expansion accentuates the already existing polarization. A new social class emerges: the landowners recruit the additional labor force among a new social class: the agricultural workers. But these are long term trends: in the short run, the *Sénoufo* migrates in search for uncultivated land.

Conclusion

Our empirical analysis allows putting the theories of Malthus and Boserup into perspective in a real sample of farms in Northern Côte d'Ivoire. First, the two theses coexist rather than contrast. In a first stage, population growth engenders Malthusian mechanisms (degradation of biophysical environment, proliferation of weeds, decline of fertility and profitability of the ancient production system) leading to migrations and a natural control of population. But at the same time favorable conditions are created for the intensification of cropping systems and other innovations, like the adoption of animal traction.

In a second stage, the change of the production system clearly illustrates the Boserupian response in a situation where the traditional system is not adapted anymore to the new socioeconomic conditions (increased population density and

decline of utilizable area per work unit). Our results show in detail how farmers respond to an increase of population pressure. Labor is the key production factor enabling to escape the Malthusian mechanism and inducing innovations that are crucial for the sustainable reproduction of the farming system. A part of the debate Malthus-Boserup can be reduced to a divergence of opinions concerning the estimation and comparison of the performance of farms. We propose utilizable area, following Boserup, as a correct denominator of the true economic performance perceived by the farmers in production systems based on shifting cultivation in Sub-Saharan Africa.

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Table 1: Main Characteristics of the Four Surveyed Villages

	Tapéré	Ouattaradougou	Farakoro	Tiégana
Genesis	ancient (19th century)	recent (sixties)	recent (sixties)	ancient (19th century)
Population Density (inhabitants/km^2)	14	17	28	40
Native Population	97%	8%	9%	91%
Immigrated Population	3%	92%	91%	9%
Annual Population Growth	- 2,5%	28,1%	9,5%	- 1,3%

Source: Demont and Jouve (2000)

Table 2: Population Density and Farm Economics

	Tapéré	Ouattara-dougou	Farakoro	Tiégana
Population Density (inhabitants/km^2)	14	17	28	40
Economic Dimension of the Farms				
Number of Annual Family Work Units	3,8	4,9	4,3	4,1
Number of Annual Employed Work Units	0,02	0,15	0,14	0,01
Usable Area per Family Work Unit *U* (ha)	8,7	8,4	6,6	3,9
Cultivated Area per Family Work Unit *S* (ha)	1,1	1,6	1,5	1,1
Degree of intensification of the Farms				
Cultivation Period *C* (years)	3	6	6	9
Fallow Period *J* (years)	22	18	16	21
Degree of Residence (%) = $C/(C+J) = S/U$	12%	24%	27%	31%
External Input Use by the Farms				
Fertilizers (FCFA/ha)	316	2.858	3.646	4.224
Herbicides (FCFA/ha)	0	227	482	444
Insecticides (FCFA/ha)	14	978	1.752	1.983
Total Inputs (FCFA/ha)	330	4.064	5.880	6.651
Inputs on Food Crops (FCFA/ha)	55	393	1.134	1.109
Level of Investment in the Farms				
Amortization Cost of Total Capital (FCFA/year)	11.171	72.308	101.356	100.469

Source: Demont et Jouve (2000)

Table 3: Population Density and Farm Performance

	Tapéré	Ouattara-dougou	Farakoro	Tiégana
Population Density (inhabitants/km^2)	14	17	28	40
Degree of Investment (FCFA/work unit*an)	2.698	12.661	11.597	14.214
Performance of the Farms According to Malthus				
Net Value Added (FCFA/work unit*year*cultivated ha)	236.084	184.326	153.267	167.611
Economic Efficiency (%)	73,5%	73,5%	59,9%	53,3%
Performance of the Farms According to Boserup				
Net Value Added (FCFA/work unit*year*usable ha)	30.951	39.934	38.779	49.198
Economic Efficiency (%)	65,7%	72,4%	64,9%	60,3%

Table 4: Typology of the Farms in the Dikodougou Region

	No Cotton	Cotton	
Manual Farming	*YRG, MR, +*	*CR+*	
		Diversification	Specialization
Animal Traction	-	*CR+*	*CR, CRM*

Y = yam, *R* = rice, *G* = groundnut, *M* = maize, *C* = cotton, + = other crops
Source: Demont and Jouve (2000)

Table 5: Economic Performance of the Farms According to Malthus and Boserup

	Cultivated Area (ha/annual work unit)	Usable Area (ha/annual work unit)	Investment Rate (FCFA/annual work unit*year)	Net Value Added (FCFA/annual work unit*year*ha)	
Manual Farming				Malthus	Boserup
MR	1.3	6.5	4,362	79.955	18.155
YRG	1.1	7.0	4.063	228.139	34.021
CR+	0.8	3.1	3.677	157.616	45.531
Animal Traction					
CRM	1.6	5.9	23.987	94.407	41.698
CR+	1.3	4.8	16.728	172.629	49.320
CR	2.2	10.1	29.710	186.596	51.568

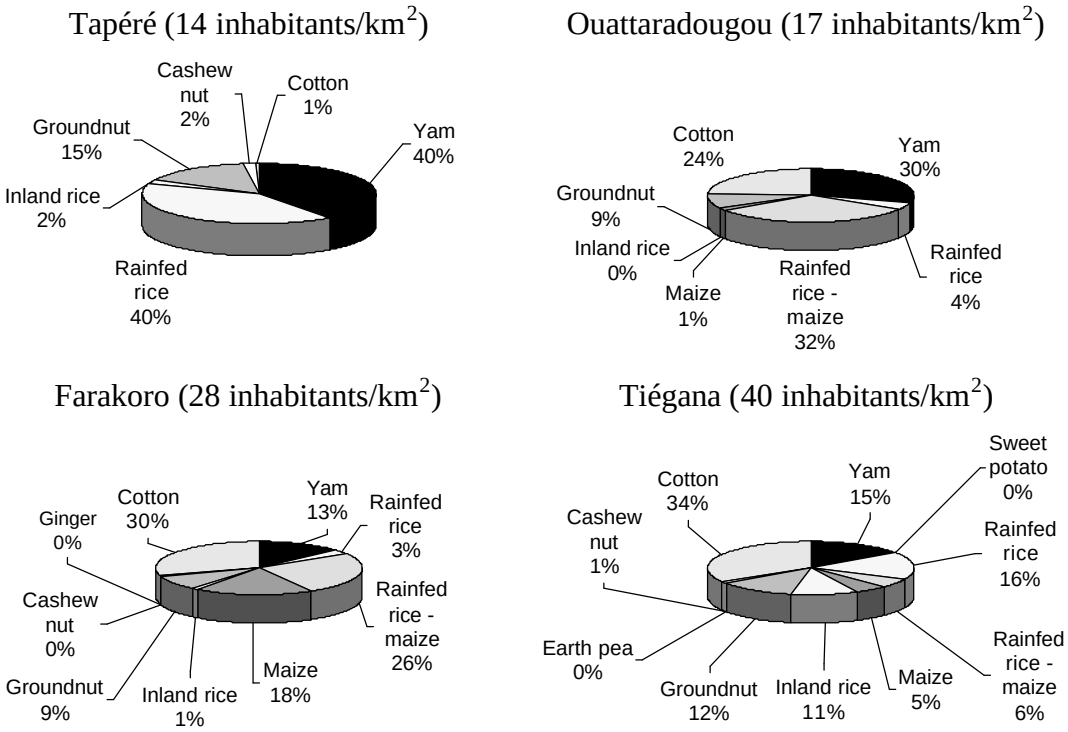

Figure 1: Population Density and Average Farm Cropping Mix (Demont *et al.*, 2000)

List of Available Working Papers

nr. 1 BEERLANDT, H. en L. DRIESEN, *Criteria ter evaluatie van 'duurzame landbouw'*, Afdeling Landbouweconomie, Katholieke Universiteit Leuven, januari 1994, 35 p.

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