

From Structuring Cotton Fields to Restructuring Farming Families: Social and Environmental Transformation in Northern Benin

Gnon Clotilde Bio N'goye ^{a*}, Janvier Egah ^a and Mohamed Nasser Baco ^a

^a Society and Environnement Laboratory (LaSEn), University of Parakou, (U.P.), Benin.

Authors' contributions

This work was carried out in collaboration among all authors. Author GCBN designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author MNB performed the statistical analysis and the structure of the manuscript. Author JE managed the methodological approach. All authors read and approved the final manuscript.

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ABSTRACT

Farms in cotton production areas in West Africa have been undergoing environmental, economic, and social transformation, which is contributing to a restructuring of families. Drawing on sociological theories on family models and the functioning of agricultural families, this study collected data through formal and informal interviews with 349 randomly selected cotton producers in Northern Benin. Focus group interviews were also conducted. Data analysis was done through speech analysis and quantitative methods. Results revealed the crucial role of cotton production in the transformation of agrarian systems and land use. Cotton production has become the mainstay of farm development in cotton-growing regions. The economic and technical transformation of farms in the region resulted in significant changes in the allocation of production factors within households as well as in the structure of families. Furthermore, new economic and social challenges led to a decentralization of farm manager responsibilities, and the redistribution of roles and resources. Overall, new forms of farm management emerged within families, which are gradually becoming restructured. Families agricultural models are increasingly fragmenting towards nuclear models. The multiplication of decision-making units coupled with the fragmentation of farm assets calls into question farm sustainability. This study sheds light on the ongoing process in Benin's cotton zones and the issue of their sustainability.

*Corresponding author: E-mail: cbiogoye@yahoo.fr;

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1. INTRODUCTION

Small-scale family farming is the most widespread social model of agricultural organization in the world [1]. Small-scale farmers that is generally used to describe family farmers, represent at least 80% of all farmers in Africa [2]. Despite rapid economic transformations in many African countries, agriculture is still the main source of income, livelihoods, and food supply for African populations [3,4]. African agriculture, long considered as traditional, is now more dynamic and integrated with the global trends, which offer new opportunities while also imposing new constraints.

Cotton cultivation, for example, was introduced into farming systems as early as 1895 by French industrialists to diversify their source of supply in French colonies in West Africa [5]. In recent decades, cotton farms have drastically changed due to their production success, not only through the organization of the value chain, but also by improving performance of agricultural systems, as well as producers income and welfare [6,7]. Many research studies conducted in cotton-growing areas highlighted the driving role played by cotton in the economic and social development of farmers [7,8]. The cotton production has triggered local development and technical strengthening of farms [6]. Farmers involved in cotton production also have found relatively easy access to needed means of production and agricultural extension services [7]. This phenomenon is not new and is also observed with other commercial crops in other countries. These include potatoes which production is primarily based on small scale farming with low yields and economic revenues in Central Europe [9]. The potato became a pivotal element of the Agrarian Revolution by permitting the development of crop rotation and intensification of land, livestock farming and fertilization [10].

Food and Agriculture Organization of the United Nations (FAO) highlights the transformations that take place in the farms due to cotton cultivation, especially the ecological impact that affects their sustainability [11]. Factors related to globalization and commercialization are at the origin of these changes [12], which affect also the functioning of social and economic entities on which agricultural development depends. What is the

effect of these changes on the sustainability of farming systems constituted by traditional extended families? This paper examines this question. Specially, it investigates the effects of cotton cultivation on both cropping choices and the structuring of families on farms, and conducts in-depth analysis of the sustainability of these new organizing forms of cotton-based farms. Understanding the scope of these changes will be fundamental for future farming model development, and for developing appropriate agricultural policies to ensure the sustainability of agriculture in the cotton producing areas.

2. MATERIALS AND METHODS

2.1 Theoretical Framework: Family Models of Farming

Family is a universal institution, the contours and functions of which greatly differ between societies and evolve over time. There are various forms of family, ranging from the conjugal group to the whole kinship [13]. Dandurand [14], based on Bourdieu's work, suggested to consider research related to family as a structured space of positions defined by the stakes and interests that specifically mobilize a set of agents, individuals, groups and institutions, often with divergent logics [14]. The organization of families is based on a few simple but fundamental questions to ensure the renewal of the human patrimony, namely the number of children to be procreated, the responsibilities in the education of children and the management of adults who have passed the age of contributing to household production.

More particularly in agriculture, families are difficult to dissociate from their activities. By trying to assimilate it to models of European farms, researchers have been confronted with the complexity of the African farm and the organization of rural families [15]. Thus, the definition of the family is derived from that of the farm, recognizing its dual function as a unit of production and a unit of residence. Such direct interference between family organization and professional activity undoubtedly constitutes the originality of farm families. The characteristics of farm families provide information on the conditions of implementing agricultural activities and elements for understanding the development and perpetuation of the enterprise [16].

The thesis of convergence of family systems towards the nuclear model derived from Talcott Parsons' work on the American family in the 1950s. According to this theory, the process of modernization, through industrialization and urbanization, inevitably leads to a shift from the traditional extended family to the modern nuclear family, embodied by the category "couple with children" [13]. For years, this theory has been the central paradigm of work on households and families in developing countries, particularly in Africa. Some of the factors that lead to the nuclearization of families are as follows: empowerment from socially valued work, the market, and self-control of productive assets [14]. Gautier and Pilon [17] have observed a process of renegotiation of inter-individual relation within and outside families, accompanied by new family forms, new residential and domestic arrangements, and new relations between generations and between gender. However, they conclude that the different strategies developed do not presage nuclearization or individualism in families [17]. So, that Parson's theory has been superceded or proved incorrect for African context.

What are the characteristics of the new family forms on cotton farms and what are their implications for the sustainability of agricultural activity?

2.2 Description of the Study Area

The study was conducted in northern Benin the zone where cotton is mostly produced. The municipality of Banikoara was chosen as the study area because of the preponderance of cotton cultivation on farms there. In this

municipality, more than 60% (131064.23 hectares) of the available agricultural land has been allocated for cotton production during the agricultural season (2018-2019). Nearly a quarter (1/4) of the national cotton production is grown in this municipality, which is popularly described as the "capital of white gold". Over the last twenty years, cotton production has increased by 400% with the constant support of national agricultural policies despite the numerous economic controversies on the profitability of its production as well as its environmental impacts.

Two (02) villages in each of five (5) of the ten (10) districts in the municipality were selected for data collection. These districts and villages represent those with the highest levels of cotton production in the municipality. A classification of villages based on the households exploitation size allowed for selection of households with high level of agricultural activity. The criteria of size and accessibility related to the degradation of rural tracks were used to select villages for data collection.

2.3 Data Collection and Analysis

Data collection was conducted during a time of intensive agricultural activity in the municipality of Banikoara. This timing was chosen to enable better understanding of the organization and functioning of farms and the challenges of agricultural production. The initial sample of 300 farms was distributed proportionally to the size of the agricultural population in each village, with a safety margin of at least 5%. A total of 349 farms were randomly sampled. The distribution of the sample is presented in Table 1.

Table 1. Distribution of the sample

Districts	Villages	Number of agricultural households	Sample per village	Sample per district
Founougo	Iggrigou	3449	55	116
	Founougo centre		61	
Goumori	Goumori centre	2435	37	66
	Gbassa		29	
Banikoara	Dèrou Garo	2187	34	60
	Arbonga		26	
Somperekou	Simpèrou	1979	16	55
	Poto		39	
Ounet	Ounet centre	1909	26	52
	Sonnou		26	
Total		11 959	349	349

The data collected related to cropping systems, farm structure and farm functioning. Specifically, the data of farm structure were the types of crops, the crops areas and agricultural practices such as rotations, chemical inputs using, chemical pesticides, agricultural mechanism, agricultural materials and tools. About the farm structure, there were the farm size, types and quantity of labors, sex and age of household's head, household composition in term of generations for appreciating if the household is extended or nuclear family. The farm functioning was described by labor organization, access and control of production factors, decision-making processes. These data were collected during the semi-structured individual interviews using a questionnaire. Testimonies and life stories were also recorded to better understand ongoing processes. Focus groups were conducted in each district including the elderly, young people, and women to understand the dynamics of change in agricultural activities and farms. On average, 10 to 15 people participated in the focus groups, which were conducted based on an interview guide.

A historical and qualitative analysis of the data were carried out using the analysis of the recorded speeches. Descriptive statistics were also used to analyze the quantitative data.

3. RESULTS

Cotton has become the mainstay of agricultural development in the farming systems of the municipality of Banikoara. As the main cash crop for traditional subsistence farms, its cultivation has paved the way for the development of a market economy on the farms. Having very early benefited from a good organization of actors, cotton has become a central crop in production systems. In the study area, it is favored in crop rotation systems and plays a central role in defining cropping systems at the farm level. In addition, cotton cultivation has provided farms with better access to the main factors of production, particularly technology, credit, and agricultural information, through the system of producers organization that has been set up. However, it has also led to a change in social relations in the social organization of agricultural work, in intergenerational relations and in the management of natural resources (environment and forms of access to land, etc.). The cultivation of cotton has thus become the structuring component in the fields and at the root of the emergence of new models of family farming. These dynamics are inevitably leading to a real transformation of agrarian systems in the cotton production zone. The process of this transformation is presented in Fig 1.

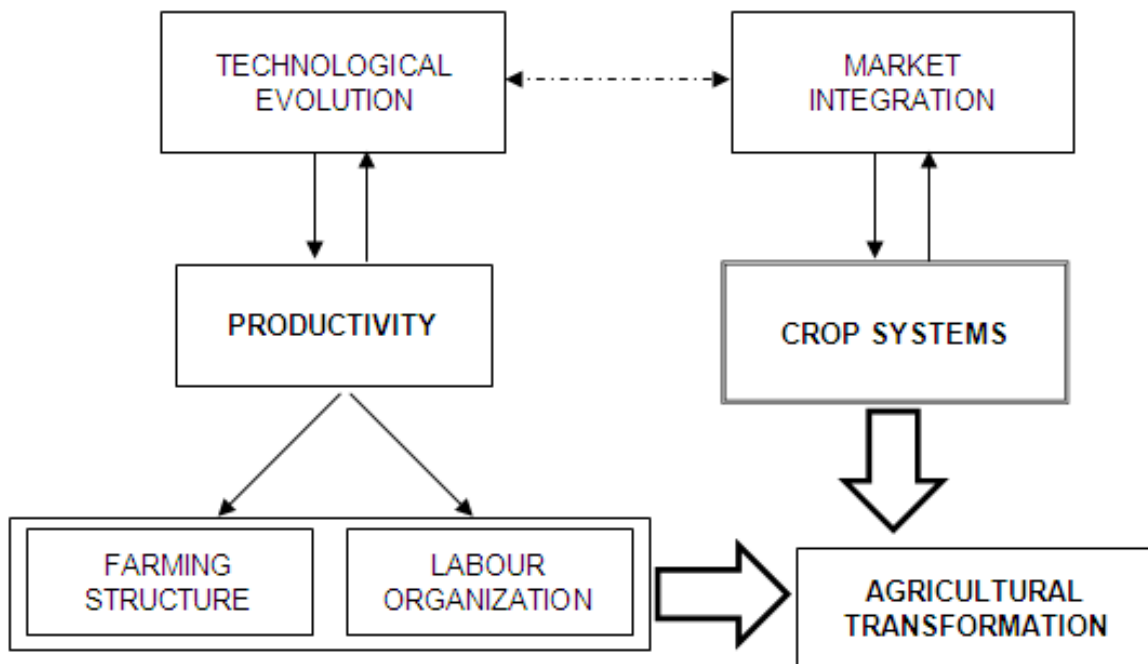


Fig. 1. Agricultural transformation process in the cotton area

Source: Field data, July 2020

3.1 Cotton, a Central Part of the Farm

3.1.1 Evolution of cropping systems: Between adaptation and substitution

In the cotton production areas in Benin, farms have gradually moved from the specialization of their production to some diversified systems. Although cotton is the main cash crop grown by nearly 99 % of farmers and occupied 61% of cultivated land in the study, other crops are cultivated, which are also essential for household economy and food security.

With the various crises experienced by cotton production, crops that were once intended for family subsistence are increasingly oriented to the market. Cereals, tubers, and legumes are seasonal crops in Banikoara; some farms have cashew plantations and fodder reserves for feeding their livestock. However, because of the extent of cotton cultivation causing land pressure, fodder reserves are being less and less cultivated, endangering the livestock.

The cultivation of maize has overtaken sorghum for climatic and economic reasons, and because of its complementary roles in the production system. The long production cycle required for sorghum can no longer guarantee households' food security due to the climatic disturbances to which farms are exposed. Sorghum, a crop long identified like an identity crop in the municipality of Banikoara, is gradually being replaced by maize with a short production cycle, which has seen high demand in the market and helped reduce food insecurity. There is a positive relationship between maize and cotton production due to a favorable effect observed in the management of inputs and soil fertility. Rotation between cotton and maize is a common practice observed on almost all farms, due to the beneficial effects of inputs used for cotton production on maize yields.

Similarly, soybean, a fertilizing vegetable, has seen its production increase in the last few years, not only for commercial reasons but also for feeding purposes. Soybean represents a substitute crop to locust bean (*Parkia biglobosa*) production in the municipality. The cotton cultivation has not allowed the regeneration of locust beans, a tree with seeds used for the production of an essential spice (mustard) in the culinary tradition of this community. The systematic destruction of young plants during tilling operations and by the use of weed killers is

causing their gradual disappearance. Only trees that have reached an advanced stage of growth have been able to survive the deforestation and the improper use of pesticides but they are already old enough to produce the quantity of locust bean necessary for household consumption. These trees have also been pruned to reduce their shade and reduce the competition for light with cotton. Soybeans are currently being introduced as a partial substitute for locust beans to produce a popular local mustard. Soybeans also represents a source of protein for families, consumed in the form of cheese, as a substitute for cheese made from cow's milk. The production of cow's milk is decreasing as a result of land pressure for agriculture in general and cotton production in particular and human habitat.

3.1.2 Access to agricultural technology and information

As the main export crop in Benin, cotton is strongly supported by the government. Cotton producers can easily access to extension services, which help them enhance their efficiency. In addition to agricultural equipment, technical support (improved seeds, improved technical itineraries, fertilizers, etc.) has accelerated the increase in cotton production. Access to this support is exclusively reserved for cotton production and for other crops, provided that the farmer s producing cotton the ongoing season. Cotton producers have also easy access to credit from microfinance institutions. For instance, a producer from Ounet village declares the following:

"Our parents were not as fortunate as we are today in agriculture. Farming was very hard, they had to do all the operations using the manual hoe, and the farm labor was painful for them. Today, with money, you don't even have to bother, technologies exist to do everything and this simplify agriculture".

This testimony illustrates the progress made in the agricultural sector just in few decades. These technologies are developed to provide solutions to the requirements of the agricultural activity from seeding, tillage, and marketing of products. Cotton production facilitated acces to new technologies such improved varieties, mineral fertilizers, and advanced production equipment to increase their production. Today, 98% of cotton production farms have at least one animal-drawn plow. The rare farms without equipment

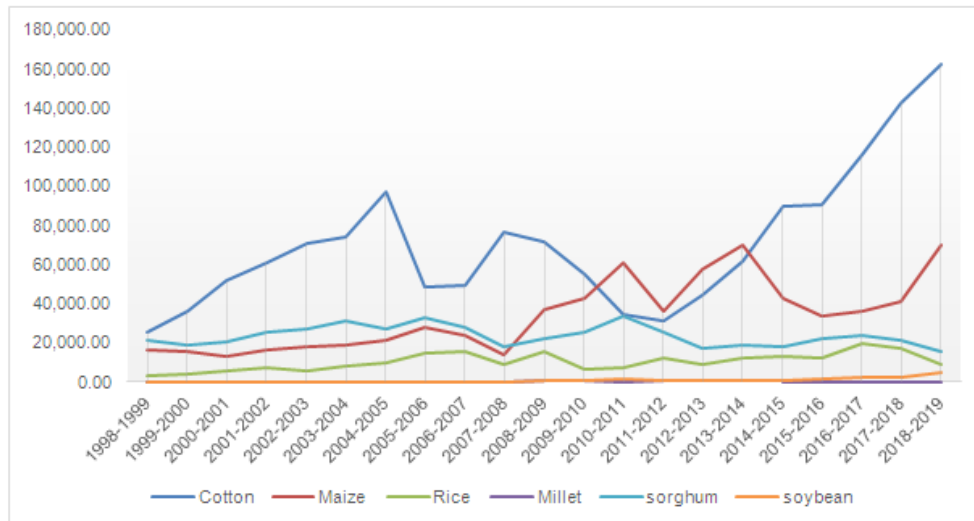


Fig. 1. Evolution of the production of key crops in Banikoara

Source: Agricultural production statistics DDAEP, 2020



Picture 1. Motorized plow with a trike used for tilling

Source: Author photo, 2020

are owned by migrants or women with limited financial resources. Farmers with large cultivation area who can afford it acquire tractors to facilitate soil cultivation. A good deal of small-scale equipment is also being adapted to move from mechanization to agricultural motorization. For example, with the use of power tillers, bikes are even adapted to the plow to replace animal traction for more efficacy and efficiency (Picture 1).

3.2 An Agricultural Revolution with Multiple Social Effects

3.2.1 Smaller families

The farms were under the authority of the head of the household. He represents the head of the

land, who concentrated all the decision-making powers for the allocation of production factors for land use and the management of food supplies for the survival of the entire extended family. These family structures are also composed of brothers from the same family, with their wives and children, over several generations. The constraints of farming were indeed favorable to the maintenance of these large family groups, which offered security through high availability of labor during activities. Gradually, technologies evolved in response to the political and economic environment that favored the development of the agricultural sector (improved seeds, fertilizers, weed killers, plows, tractors, etc.). These technologies have been an important factor in the changes observed in the structure and internal organization of work on family farms.

Labor shortage related to agricultural and cotton production led farmers to increase the size of their household by marrying several wives. Women represents not only labor but increase the number of children as laborers. Nowadays, with technologies advancement, there is a change in mindset and concomitant practices. Many families are having less children compared to previous generations. Agricultural research and farmers have developed useful solutions to facilitate agricultural work. The weeding operation, was an essential agricultural operation for crop development and which requires high amount of labor, has been progressively reduced by harrowing with animal-drawn plow, a process that allows farmers to bypass the second tillage and strengthen the plants against bad weather. Nowadays, farmers with financial capacity do no longer weed manually but instead, use herbicides, which considerably reduce the need for labor to cultivate crops. In addition to "zero weeding", which is now the new trend, technical itineraries have been simplified with work tools that are no longer rudimentary, allowing for a real change of scale in agricultural activity. The adoption of animal-drawn plows and small-motorized equipment has further facilitated plowing and crop maintenance operations. These technologies have made optional the need to maintain very large families. Large families require provision of more food and, critically, partition of farm assets over time given inheritance. There is a decreasing trend in the size of household in general and in the number of wife of the household head in particular. Since

labor is no longer a crucial problem, families become more and more restricted in size as nuclear families in other contexts.

Currently, in Banikoara, more than 75% of cotton production households have at most 20 members. In these households, two generations of relatives usually coexist, including the farm manager, his wife and their children, and sometimes brothers/sisters, nephews/nieces and laborers. Three-generation farms have a dependent elderly parent or uncle or grandchildren of the farm manager. The same is observed for four-generation farms where the farm manager, usually in third place, has a dependent parent. Although family ties may come from the farm manager's side for brothers or nephews, it is rare for dependent relatives on the farm to be related to the wife. One-generation farms are those run by young married couples with no offspring and are rare (Fig. 3).

3.2.2 Erosion of the principles of family solidarity

Farming families are increasingly falling apart because of conflicts of interest linked to the allocation of resources that arise in the management of farms. The cultivation of cotton on the one hand, and technological developments on the other, are presented as the leading factors of these changes in the structure of families. Young people, motivated by a strong desire for autonomy, are rebelling against

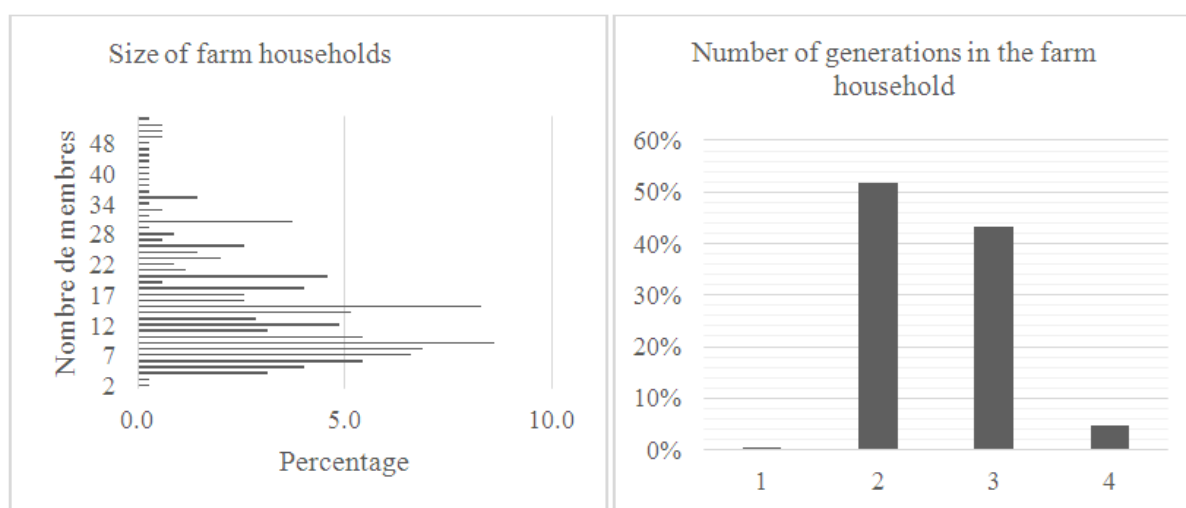


Fig. 3. Composition of agricultural households in the study area

Source: Data collection, 2020



Picture 2. Cotton harvest mutual aid group

Source: Author photo, 2020

the authority of their elders and seek to become independent early. The following declaration of a cotton producer from Simp erou village elucidates that phenomenon:

"In the past, a young person could not leave his family to farm his own field. Only by thinking to the workforce required he will be discouraged. Whatever his capacity is, a young man could not maintain a field of more than two hectares alone. Nowadays, agriculture is easier, only one person can cultivate dozens of hectares without needing the help of his brothers. That is why farms are getting more nuclear with fewer children; everyone wants to get rich by their own. With cotton production, young people get money to buy different inputs that make their work easier; they can even get them with credit."

However, technological progress in Benin's cotton areas has not provided an appropriate

solution to the harvesting of agricultural products. Cotton harvesting is manual and still requires the use of a significant amount of labor. The only agricultural operation involves a high proportion of specialized temporary labor and still mobilizes communitarian labor through self-help groups organized by young people from different farms to accelerate the mobilization of cotton harvests for marketing at the right time. The use of communitarian forms of labor has thus declined in favor of salaried labor.

3.2.3 Land tenure changes

The various structural transformation observed in the cotton farms in Northern Benin have been accompanied by very strong land constraints. In addition to the increase of the rural population, the multiplication of farms has resulted in strong pressure on agricultural land (Fig. 4).

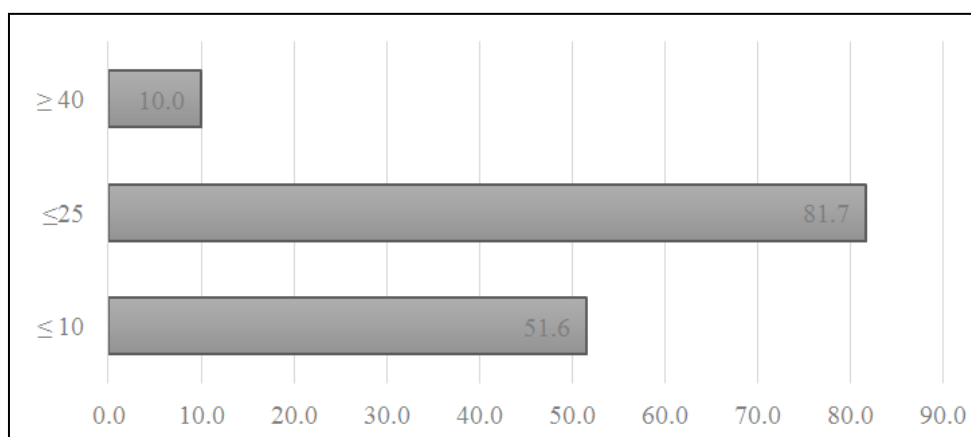


Fig. 4. Farm land holdings

Source: Field data, July 2020

Farms in the cotton area show significant disparities in their land accessibility for agricultural activities. More than 50 % of farms currently have less than 10 hectares of land to cultivate. Land, which represents the first factor of agricultural production, continues to become scarcer on farms. Farmers who still had the possibility of using new farmland and becoming its owner have less and less possibility. Farmers have thus moved dozens or even hundreds of kilometers from their village in search of new farmland, exacerbating the phenomenon of agricultural migration. The landholdings of agricultural families are becoming insufficient for allocation among members, due to extensive farming and the increase in the population of farmers.

4. DISCUSSION

4.1 Multiplication of Decision-making Units

One of the characteristics of traditional african farms is the presence of several generations (children, parents, grandparents and great grandparents) around the same farm. The high labor requirement imposed by agricultural activities, and specifically cotton cultivation, which is very labor demanding for its maintenance and development, has reinforced the maintenance of these large family groups around agricultural activities. Almost all cultivation operations were carried out by manual labor, and the size of the household is a factor for increasing production. These family models are increasingly fragmenting towards nuclear models. Dandurand [14] highlighted the autonomy of socially valued work, that of the market, and the liberation from a good part of the material obligation towards non-productive adults as factors that lead to the nuclearization of families. This phenomenon of intergenerational conflict at the origin of the break-up of cotton farms is not new; it was already presented as a premise for the transformation of West African agriculture more than two decades ago [18]. The cultivation of cotton, which has become the mainstay of economic development for family farms previously based on subsistence, is at the heart of a technical revolution [6]. It began with the adoption of animal traction [19] and quickly expanded to include innovations of all kinds. The effects of this revolution are perceptible at the farm level in the diversity of crops, but also within the social structure of work organization that the family unit represents. Inspired by the principles

of the green revolution, mobilizing chemical inputs, equipment, and selected varieties [6] production models have undergone significant changes. Among other things, the reduction of the drudgery of work has been an important factor in the segmentation of farms.

Jeanneaux et al. [20] attributed the fragmentation of family farm models to new economic and social issues related to changes in agricultural activity [20]. Conflicts of interest arise on farms due to the redistribution of production factors, notably land and cotton sales income. In Central Africa, Mbétid-Bessane [21] has highlighted that, in rural areas, a social organization based on a family segmentation mode that is also increasingly common in the Sudano-Sahelian zone of West Africa. Young farmers create their farms at the time of marriage. The farm is thus reduced to a single unit in which the unit of production, consumption, accumulation and residence are combined [15]. One of the reasons for this observed segmentation is the search for economic independence of young farmers from their elders [22]. In Cameroon, the difficulties experienced by some farm managers in ensuring sufficient monetary income for their families have led many women and adolescents to cultivate their cotton plots [15]. This is particularly linked to economic issues that develop around agricultural production. Beyond food production, which is the basis of physiological needs, agriculture is called upon to meet other important needs. Only the empowerment and the ownership of the farms by the young people allows them to assert themselves in society and move toward self-realization.

This has led to a fragmentation of farm assets, which has progressively led to a nuclearization of farms and poses the problem of the transmission of the family farm from various perspectives [20], with the multiplication of decision-making centers within agricultural families. These mutations are considered a failure in a farming world historically sensitive to the transmission of heritage between generations to perpetuate the family. The current developments are part of the dynamic of changes known in French agricultural families [16], marked by a significant decrease in the number of families composed of three or more generations. However, in contrast to agriculture in developing countries, where a reduction in the farm population has been recorded in favor of an increase in the size of farms, there has been an increase in the farm population followed by a considerable reduction in the size of farms. This

fragmentation of farms (size reduction) raises the question of the viability of farms not only for the profitability of production factors but also to guarantee the food security of farm households.

This assumption of responsibility for farm advisory services by public intervention structures has reduced the dependence of the youngest farmers on the elders, who kept the knowledge of farm operations. This transfer of skills has weakened the power of the traditional authorities and accelerated the dislocation of farms and families. The knowledge of agricultural techniques is now accessible to all and demystified due to technologies advancement. Access to agricultural advice, inputs, and agricultural credit depends on membership in a village cotton production group. Globalization in agriculture, aided by Information and Communication Technologies (ICT), has resulted in economic opportunities, particularly in developing countries. While less than two decades ago, family farms had limited or difficult access to the market [23]; today, this situation has improved significantly. For cotton farms, not only because it is essentially a commercial crop, but also because of better access to production inputs and technologies that allowed to generate unconsumed surplus of production.

4.2 From Mechanical Solidarity to Organic Solidarity

The collective consciousness of belonging to the same social group is at the origin of the development of a form of mechanical solidarity between individuals. It manifests at the scale of a village or a community through the duty of mutual aid and solidarity towards each other. The practice of solidarity is considered as one of the basic principles of social cohesion within kinship systems, sharing common values and norms [13]. Agriculture remains a place for the expression of family solidarity, a breeding ground for social relations, the exchange of know-how and a way of life [24]. Producer organizations are set up to build on these solidarity systems. For instance, cooperatives were set up at the village level to facilitate the management of input credits and the organization of the cotton sector. Conflicts arising from this management led to the break-up of the producers' cooperatives. No cotton farmers wanted to be responsible for the mistakes of others. Beyond the producer organizations, relations between members of the same family regarding the management of the farms are becoming more distant. Young people

aspire to take their autonomy from the elders very quickly. However, children are considered the first form of wealth [25], and their support is, therefore, a primary form of intergenerational solidarity. The aspiration to professional autonomy is also expressed with the legacy of fathers and grandfathers, whose presence sometimes weighs on young farmers who would like to do things their own way [24]. It has been noticed the decline of mechanical solidarity in favor of organic solidarity based on individualistic and reciprocity logics. Without the constraints imposed by the management of the cotton sector, each individual would like to manage his or her farm autonomously. This autonomous depends also religion factors such as islamization, tradition, ritual belief, etc [12].

Concerning the type of labor used for agricultural work, there has been a decline in community work in favor of salaried work or new forms of mutual aid groups working in reciprocity to each other. For authors [24] the family can be an asset for sustainability, transmission, and solidarity just as it can be akin to a heavy inheritance, a place of oppression and its openness allows a strengthen links with other sectors of society. The disassociation has an impact on the weakest, who no longer benefit from the support and security that belonging to this family group provides. However, it favors the emergence of those whose efforts were drowned out in this group, considered as a weight pulling down the most active. The decline of such traditional systems of solidarity reflects the transition from spontaneous forms of relationship to new forms, motivated by interest.

5. CONCLUSION

Agriculture in cotton area in Benin has undergone a real revolution. In less than thirty (30) years, driven by favorable agricultural policies, the cotton area has taken a significant technological step forward compared to other areas of the country. Better equipped and market-oriented family farms have been at the origin of environmental, economic and social changes. Cotton cultivation has played a fundamental role in this transformation of farms. It has offered new opportunities that have changed the logic and social processes of organizing agricultural activity with new environmental and social constraints. The changes underway in family cotton farms highlight organizational and structural transformation the viability of which deserves to

be questioned to ensure the sustainability of the agricultural activity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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