Land Conflicts and Land Tenure Effects on Agriculture Productivity in Chad

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Authors' contributions

This work was carried out in collaboration among all authors. Authors DD and TTG designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Authors DD, TTG and SDGH managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this article is to measure the extent of land conflicts on agricultural productivity and yields in the most conflict-prone regions of Chad. We obtained the results that, the interaction of land conflicts in agricultural activity is a barrier to productivity and the improvement of agricultural yields. The effects of climate change on yields and productivity are dwindled by government reforms and subventions in the agriculture' sector. Hence, we recommend the government to promote customary land tenure to reduce conflict and in another hand to trace transhumance corridors to support the State's agricultural reform efforts.

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1. INTRODUCTION

For mostly conflict related to land found their origin in the disproportional distribution or repartition of land area [1]. The problems relating to farmer conflicts remain a real concern in sub-Saharan Africa, and more particularly in Chad. The various conflicts opposing the Chadian peasant or farmer's populations do not date from today and show different natures. Some relate to lack of water, theft of animals and the destruction of growing areas [2]. Indeed, the case of Chad as for other countries of sub-Saharan Africa, troubles between the layer of agricultural peasant populations and herders, constitute a real obstacle to the motivations of agricultural production considering the consequences that they reveal.

According to the study report of Marty [3], 15 Chadian prefectures and 26 Chadian townships surveyed have revealed that 78.5% of the conflicts are due to the straying of animals while water problems cause 15% of the conflicts [4]. Climate change leading to water scarcity is another cause. Indeed, for Marty's report, at least 91% of these conflicts are of serious intensity, as a result of the low involvement (7%) of justices of the peace of the country or the country in the management of said conflicts. Local authorities, including village chiefs, despite the limited resources and because of the tribal nature of their judgments, account for 90% of the resorption of pastoral conflicts. The lack of mastery of property rights issues leaves the traditional and administrative authorities lax to deal with the crises that plague farmers [5].

In another dimension from the facts listed above, the climatic changes observed today significantly influence the cultivable spaces creating a dilemma between the different producers and households [6,7]. Nowadays, the increase of population and land management standards (property laws) either constitute land management variables and their exploitation [8] (Mooya and Cloete, 2007). Land distributions despite these established laws are made in a traditional way to each crop; in other words, they are customary, while climate is changing and creating a scarcity of land. Arable land is decreasing due to climate change, at the same time, land distribution in Chad is distributed through the peoples belong to a community or group. For the reasons which are announced land using in Chad depend on a "third dimension", means like a mystic or occult strengths [7]. Climate change and rational strategies of land using linked with green revolution have been demonstrated that they impact productivity and urbanization [6].

In general, the laws relating to the ownership of private property and land, justify to a certain extent an annexation of the cultivable area of a third person by another (in our case of a farmer by a breeder). Indeed, in Chad, Law No. 24 of July 1967, states that the possession of private property requires before as any land system, a registration of the field exploited. A non-registration reveals the vacant (public) and non-owner status of the land (Article 13 of Law No. 24). The land distributions despite these established laws are made in a traditional manner specific to each crop. Land management and conflicts in recent years are of more concern in urban than rural areas with an increase in death rates due to land-related conflict. In 2014, Chad government proposed an informatics system called Informatics Management and Secure Requests of Land Acquisition (IMSRA) in the objective to create a database on property rights thus to promote the good land repartition in the urban sector. Article 340 of the same Penal code of 1967, states on different conflicts happened in the region of Hadjer Lamis (Massaguet and Gama) where farmers make a "guet-apens" to breeders. Falling outlaws on land and land tenure, farmers grow their crops around expressly creating conflicts that lead to murder. Contrary to the strategies for resolving farmer-farmer conflicts in Niger, those in Chad remain less advantageous, since they are based on futile interventions by the authorities responsible to establish order. About the rural code of Niger for security and land conflicts prevention, conflict management is transferred from customary authorities to judicial, under some conditions or facts. Indeed, can be considered as the annexation of a property when the field damage source of the conflict is committed in a space of hydro-agricultural development or protected field during a season of culture. The salient or important facts, as well as the conflicts identified in Chad for the framework of this article, are delimited around four regions. These are areas with considerable capacity and arable land accompanied by a population with a low literacy rate. These are mainly the region of Mayo Kebbi, Logone Orientale, Salamat and Moyen Chari. The vast majority of the population of these regions is primarily engaged in agriculture. While the cultivable in Chad area covers only 499,350 km², for an estimated population of 14 million [9],

the agricultural sector represents only 23% of GDP. This does not ensure food self-sufficiency, despite the other side of the estimated number of livestock meanwhile has at least 94 million head. Even though the causes of land conflicts in Chad are returning to the conception of land acquisition based on ancestral reasons as in Cameroon (Socpa 2010), the management of these conflicts, on the other hand, remains nuanced. Conflict resolution remains an arbitration depending on whether one is in the region of Moyen Chari, Mayo Kebbi and Salamat. In the first two regions conflict resolution is ensured respectively by peacekeepers (Gendarmes) on the one hand and traditional authorities on the other. Whereas in Salamat conflict prevention is a matter for the development of national institutions such as CELIAF, CLDR[1] and others [7].

For the majority of studies on the causes of these conflicts [3], the search for grazing, the migration (of pastoralists) because of the attacks of certain rebel groups or lack of water, drought are the main ones. The most relative proposals aimed at eliminating or even restricting the negatives impact of these conflicts, do not resolve today the conflicting trend between the layers concerned. Despite the pastoral hydraulics project (DHP-AFD) and the prevention of conflicts adopted by the government since 1993, for resolving farmer-farmer conflicts, results are inconclusive. Climate change, capitalist behaviour, population growth has improved this situation. Most articles on land issues in Chad are treated from a sociological perspective without empirical or econometric analysis.

The objective of this study is to measure the extent of land conflicts on agricultural productivity and yields in the most conflict-prone regions of Chad. As a first step, it seeks to explain the margin of loss in food self-sufficiency and productivity policy of Chadian farmers and herders in land conflict and climate change situations. Indeed, it tries to restore the resilience between farmers and herders and to emit new strategies of protection of the lands exposed to the conflicts. Apart from the low level of research and studies in Chad on this field, conflicts around land continue to remain topical and make victims thus binding migrations from the labour (workforce) to less advantageous activities for

Food self-sufficiency and well-being. Then this paper aims to set the stage for empirical studies of the implications of agricultural conflicts on agricultural productivity and the contribution of property rights in Chad.

2. LITERATURE REVIEW

Land conflicts can to some extent concern farmers (farmer-farmer conflict) or breeders only and in another dimension both. Diversity in the design of property rights (private, communal or customary) can amplify conflicts [10] if there is no real understanding between authorities (urban and/or rural). The diversity of activities and householders remain the principal explanation of the conflict. For Koler[2], the land must be shared between a community whose activities are similar, that he qualify of "ethonogeographic communities", one of the best way to prevent conflicts. Howard [11], By examines land conflicts around natural resources in Nicaragua, also notes the negative impact of institutions quality on land tenure. Indeed, in the absence of coordination between authorities responsible for sharing and management of the land and lack of funding, the land that used becomes less optimal. Also, analysing the difference between land tenure in Northen Sudan and Ghana, Yasin & Obeng-Odoom [12], aligns with the fact that customary lands rights, cause of marginalization, land conflicts and decreasing of productivity in these countries, and mostly in Sundan. Indeed, for many countries like Chad, with traditional laws based on customary land tenure, property rights on land must be correlated with government objectives.

According to Socpa [13], land conflicts in Africa and in particular in Cameroon, are the consequence of conceptual facts on the one hand and the other from distributive policies [14]. Most of the population refer themselves to ancestral legacy land or the national character of land ("Free Land and Land without Masters"). While Simmons [1] treating of the forces interacting in land conflicts at the local level in Brazilia, concludes relationships between population concentration and conflicts. Therefore, the author infers a direct and indirect link of concentration on rancher employment and farmers conflict due to a bad land repartition. The more land inequality or repartition related to the growth of population and scarcity of land rentable, is higher, land conflicts become

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superfluous [16]. Questions on property rights and the implications of capitalist behaviours in a scarcity economy have been a treat in many contexts. In fact, on each domain, the capacity to make use of the land or goods give a sense to the property rights notion [17].

The first approach which has taken the in consideration property rights and the quality of institutions in economic analysis were born from the questioning of neo-classical theory by the New Institutional Economy (NIE). The neo-classical economic hypothesis is focused on economies with a higher endowment of factors of productions and the absence of asymmetric information's, the NIE School brought a conclusion based on how resources are sharing [18]. Institutions and their structure [8,19] through property rights, are the best way to minimize economic constraints in scarcity situation to promoted economic development [20], despite the influence of transactions cost [21].

The identification of different types of property rights by Eggertsson, (1990) gives many conceptions [18]. Considering his position, the legal land exploitation in the objective, to obtain productivity, incomes and to deals, it (land using transfer) corresponding to the rights detention. Property rights can also refer to the owner selling rights or a land tenure when land belong to a community, a collectivity [22]. In general, property rights notion focuses on the significant part of investment induced in the secure land [23,24].

For the world Bank (2005), secure land by property rights improved land investment, consumption [25] in the sense of financial development promotion in other terms. However, the property rights based on a traditional condition or manage by traditional authorities do not lead to an increase in financial credit [12]. In this case, it is important to make a difference between financial institutions which can accept promoted the increasing householder's or farmer's incomes, among those with classical financial conditions. By measuring factors which influence farm and productivity in rich and poor countries, Adamopoulos & Restuccia [26], found that apart the known factors of productions (Labor, Land, capital), policies adopted or all two types above institutional can affect productivity through land distribution. Therefore, from the moment wherein each considered countries land secures policies lead to investment increasing.

Land secure promote farmer productivity and increase their income when farmer belongs to a social, institutional or political group [20]. Stating on three formal characters of institutions, which focus firstly on the society rules, on law and how it is organized; then on some constitutional decisions and finally on "culture values", Gershon Feder & Feeny [8], noted a possible transfer of land property endowment based on clanic behaviour or cultural decision. Institutional quality becomes a fact. According to Fenske [27], the weak quality of institutions in African countries mostly comes from their classical land tenure, market structure. In other terms institutions are based on "precolonial strategies" without any restructurations discouraging in major part productivity.

3. METHODOLOGY

3.1 Model

Cobb-Douglas function using to achieve simplified production functions (high elasticity of substitution) such as translog function and CES permitted to make it easier to understand interactions between variables in a specification [28]. Following the example of Kislev & Peterson (1982), who used biotechnology variable as a substitute variable of technology in the production function (Sato, 1967) apart from usual factors variable as labour and Capital. We consider as well as Adamopoulos & Restuccia [26], CES function of production in an agricultural production economy (unlike the production of non-agriculture goods) or not, defined as follow:

$$y_a = A_⊐[\theta k^\rho + (1-\theta)(sl)^\rho]^{\frac{ℵ}{\rho}} \qquad (1)$$

$$y_n = AK_n{}^\alpha N_n{}^\beta \qquad (2)$$

With y_a and y_n the output of farmer *s, l* and *k* irrespectively the amount of the input of labour and capital. N and K are aggregated level of the above inputs. The translog function of production will measure conflicts implication on farmer's productivity in considers region. Then:

$$lny_n = logA + \alpha logK_n + \beta logN_n \qquad (3)$$

By considering the relaxing of constraints on some parameters and by taking consideration of homogeneity of production, the estimated model can be introduced by the equation given by:

$$lny_{it} = \pi_0 + logA + \alpha logK_{it} + \beta logN_{it} + \\ \alpha_1 log^2 K_{it} + \beta_1 log^2 N_{it} + \delta_{KN} logK_{it} * logN_{it} + \\ \mu_{it} logK_{it} * X_t + \vartheta_{it} logN_n * X_t + \theta_i X_t + \varepsilon_{it} \qquad (4)$$

X_t is the matrix of the *conflict* interest variable. Indeed, the use of the variables dummies will allow estimating the effects of the conflicts on the farmer's production, this through labour factors, implicitly on the capital (K) and other factors. Thus we will estimate productivity and the production yield in a situation where $X_t = 1$ (conflict case) and $X_t = 0$ otherwise. The estimated model establish as following:

$$y^*_{it} = \rho_0 + \rho_1 Conflict_{it} + \rho_2 logDec_{it} + \rho_3 logDep_{it} + \rho_4 ConflictRes_{it} + \rho_5 logAreaC_{it} * LandT_{it} + \rho_6 logDimR_{it} + \rho_7 LandT_{it} + \rho_8 logAreaC_{it} * Clim_t + \rho_9 ModAgri_{it} * Conflict_{it} + \rho11 logPopSurf_{it} * Conflict_{it} + \varepsilon it \quad (5)$$

y^*_{it} is the variable of production given by the logarithm of the production and agriculture yield in the region *i* at the consider period. This variable includes the production of millet, sorghum, rice and maize. Due to the traditional understanding of land tenure in Chad, we will take in our observation some transitions which exist on the character of land tenure when conflict resolution is share between others jurisdiction and customary tenure (or mixed tenure). Alongside the *(Conflict)* variable, we will integrate like Simmons [1], Eck, [5] and Rudianto & Andi [29], Death related to conflict *(Dec)*, population density *(DeP)*, cultivable area *(AreaC)* (Carter & Olinto, 2003) and Region dimension *(DimR)*. About the control variables, we will include variables as land tenure *(LandT),* conflict resolved by authorities (mixed or customary) *(ConflictRes),* agriculture employment *(ModAgri)* and the proxy variable of climate change *(Clim)* apprehend by the level of temperature. *PopSurf* captures the cultivable share of the population in each region.

In the context of different or variable technology used to improve agriculture productivity, none parametric method according to Ozcan et al. (2001) is although useful. The model will be estimated by OLS (Ordinary Least Square) in our case and because our endogenous variables are not binaries.

3.2 Data Sources

Samples of our paperwork will come from the regions of Mayo Kebbi, Logone orientale, Salamat and Moyen Chari. The choice of regions is justified by the frequency of conflicts observed and the importance of their contribution to the production and marketing of agricultural products in Chad. Given these areas and the dynamic nature of conflict impacts, the panel data that will be used will be spread over 5 years. Thus, we will take a period of study, from 2000 to 2017.

Table 1. Definition of variables

Variables	Definitions
Conflict	Considered the variable for the different periods of conflict observed in the regions studied. The values taken by this variable are binary depending on whether, over a given period, a conflict has arisen either overland or relating to the delimitation of cultivable and transhumance areas.
DeP	This variable is given by the number of inhabitants per km^2. It is a question of apprehending the density of the population in the conflict zones and other zones which will be regarded as a group of comparison or control.
AreaC	Cultivable area per km². To avoid any confusion with the variable area, the cultivable area will be the total property exploitable by the farmer. So, it will be cultivated and unused plots
ConflictRes	Type of land tenure applied. It will take a value equal to 1 when the land tenure is customary and 0 otherwise. The codification of this variable, however, will depend on the type of regime that prevails.
ModAgri	Frequency of land use by season
Clim	The periods of climatic variations known from one period to another. For the framework of this thesis, we will consider as a variant of climatic conditions by facts such as rainfall variations and to a certain extent the reduction of cultivable areas.
DimR	Village limit measured by Google Map. This measurement is effective because measurements made from a visual angle may be overestimated, while the geographic delimitation is more exact.
Popsurf	Area exploited for cultivation per km². Here we will take into account the global space used whatever the agricultural activity.

Source: Authors

Our data are collected from the database of the Ministry of Agriculture in Chad, Stat World data on climate change and the World Bank. Conflicts variables are obtained thanks to documentary reports of Newspapers (Lavoix, Tchadactuels etc.).

4. RESULTS AND DISCUSSION

The result in Table 2 shows the most normal and plausible effects expected concerning climate change and land tenure. Moreover, the resolution of land conflicts does not show any significant results. Thus, it follows that when cultivable areas increase (AreaC) by 1 ha in cultivable areas negatively affects agricultural yields in the regions concerned by at least 0,76% and at the 1% threshold. Indeed, this situation can be explained by climatic degradation and land impoverishment. For Mooya and Cloete, [18], the demographic population can lead to a driving effect to reduce and/or distribute yields in the regions. This result remains plausible on the one hand by the significant negative effects on production and yields at the 1% threshold of the region's size (DimR). On the other hand, the PopSurf variable also shows at the 1% threshold that strong demographic growth of 1% in the regions leads to a scarcity of cultivable land exploitation reducing agricultural yields and productivity.

In a certain dimension, land tenure has a negative and significant impact on yields and production. Significant relationship to the 1% threshold. Indeed, outside the Mayo Kebbi region, which exercises customary land tenure in conflict resorption, the other regions resolve conflicts in a mixed manner with the military authorities (police forces). The results show that mixed conflict management affects negatively agricultural productivity and yields in the regions that use it by more than 10% and 7.4% respectively. Indeed, conflicts in most cases are managed by law enforcement agencies engaging in arbitrary judgments. In a way, this shows the incoherence and mismanagement of conflicts and land tenure systems. A system of land acquisition through customary conditions seems to be a good outcome. For Marty, et al. [3], the Mayo Kebbi region can reduce and resolve conflicts through traditional land tenure or management regimes.

The idea of this study is to highlight the impact of land conflicts and climate change in a context of non-conventional land tenure and/or management on agricultural productivity and yields in Chad. The following Table 3 shows the results of the interactions between the different subsequent interest variables. Thus, we can easily see that the significant and positive effect of climate change on yield at the 10% threshold (at least 0.27 points for 1 point of ºC) can be explained by the agricultural reforms undertaken since 2002 (the era of oil exploitation). However, when compared to arable land (Area C), climate change (average temperature variation of 30ºC from 2000) negatively and significantly affects agricultural yields at the 1% threshold (INSEED, 2009) [6].

Table 2. Effects of climate change and land tenure on the productivity and yields

Variables	Production	Yield
Ldec	-0,0681389	0 ,0320226
	(0,151)	(0,248)
Lconflictres	-0,0547434	0,0595448
	(0,579)	(0,322)
Lareac	-0,1174005	-0,7677554***
	(0,555)	(0,000)
Ldimr	-0,6763918***	-0,2052931*
	(0,006)	(0,099)
landT (M)	-1,09883***	-0,746303***
	(0,000)	(0,000)
ModAgri	0,0223811	0,0600282*
	(0,655)	(0,068)
lpopSurf	-1,255247***	-0,7355328***
	(0,000)	(0,000)
Cte	20.896***	16.105***
	(0,006)	(0,001)
R²	0,997	0,964

Source: authors

Table 3. Interaction with land tenure and conflicts variables

Variables	Production	Yield
Ldec	-0,03719	0,04719
	(0,562)	(0,262)
Lconflictres	-0,004894	0,0886814
	(0,972)	(0,331)
Climat	-0,14821	0,276068 *
	(0,465)	(0,061)
lareac*LandT(M)	036294	0,1504543
	(0,342)	(0,523)
lareac*climat	0,001149	-0,0268329***
	(0,915)	(0,006)
Ldimr	-0,642120**	-0,1843097
	(0,028)	(0,237)
LandT(M)	-5,28698*	-2,506892*
	(0,050)	(0,075)
ModAgri*conflict	0,01364	0,0556769
	(0,805)	(0,147)
lpopsurf*conflict	-0,96135**	-0,6288933**
	(0,022)	(0,019)
Cte	23.132***	8.17444*
	(0,0060)	(0,060)
R^2	0,9919	0,9653

Source: authors

Several researchers have reported theoretically on the effects of land conflicts on productivity in Chad. Our empirical results show that the interaction of conflicts with the shares of cultivable land by population harms agricultural yields (for a conflicting aspect) at 0.96% and 0.62%. The upsurge in conflicts and their mixed management between traditional and military authorities perpetuates in some respects the harmful effects. For the Niger Rural Code, beyond mixed management, it is imperative to set up competent judicial bodies. The effects of land tenure systems remain negative and significant at the 1% threshold despite integrated interactions.

5. CONCLUSION

This study aims to measure the extent of land conflicts on agricultural productivity and yields in the most conflict-prone regions of Chad between 2000-2017 period. The results show that land tenure negatively and significantly affects productivity and yield. However, climate change has a positive and significant effect on yield. Harmonization of land tenure and conflict management systems alone cannot mitigate conflicts to improve agricultural productivity and yields. While the initiated transhumance corridors have not reduced land conflicts, the framework of the Mayo Kebbi region in its

management through traditional or customary conflict regimes may be the subject of particular attention.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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