

Full Length Research Paper

Reinventing new systems of crop production in time of agro-ecological change in Burkina Faso

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Received 29 February, 2012; Accepted 25 March, 2015

During the last decade, great floods, destructive winds, desertification and grain shortages in Burkina Faso have spotlighted agro-ecological change as a crucial challenge for achieving sustainable development in eastern part of the country especially in the Gourma region. In fact, the new agro-ecological order has reshaped and transformed geographical representations, land tenure and norms and techniques of crops production in this auto-subsistence agrarian society of Gourmantche. In response to the current agro-ecological and social framework, local farmers have invented methods of crop production: the *zai* techniques which enable the maintenance or restoration of the soil fertility, rotational practice (combining or mixing food and cash crops in the same field), shifting cultivation as well as the fragmentation of households in order to optimize the productivity of manpower in nuclear families. These technological innovations allow local farmers to manage sustainably their landscape.

Key words: Agro-ecological change, auto-subsistence, innovations, farming strategies, Burkina Faso, West Africa.

INTRODUCTION

Climate change is a critical issue for humanity and a great challenge to social and biological life reproduction. On the global scale, the tropical deforestation had already been dealt with by the 1850s as a “problem” and as a “phenomenon demanding urgent and concerted state intervention” (Grove, 2006). The late nineteenth century was the opening era of the colonization¹ (of many

West African countries) of which the main objective consisted in providing for raw materials and manpower to Western industrialization. Hence, this imperialist project and its inherent commoditization drawing of local natural resources leading to a revolution of ecological paradigms. This ideological revolution in Man-Nature interface was characterized by the move from bio-centric paradigm – in which human being and nature are interconnected by symbiotic relations (Haudricourt, 1962; Fairhead and Leach, 1996; Rival, 1997; Descola, 2000; Ouédraogo, 2006) – to the anthropocentric paradigm in which the

¹The colonization of the Gourma kingdom has been formalized by a protectorate agreement, signed in 1895 by the French colonizers and chief Bantchande.

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former must dominate and exploit nature for capital accumulation (Marx, 1972; Guha, 1989; Ashcroft et al., 2006). Based on the author empirical research, the bio-centric relationship between human and nature appears in the founding myths of Gourmantche. One of the mythological versions, taught in circumcision camps through songs, revealed that the Gourmantche's ancestor, created by God, lived harmoniously in the bush with such meat-eating animals as lion, leopard, hyena, etc. The other version, the best known by the natives, states that Jaba Lompo came down from God's home, domesticated the hostile environment and created the local dynasty (Swanson, 1989; Korbéogo, 2013). Also, their farming systems and processes of natural resources domestication are carried by mystical narratives and rituals (like *dilembu*, the greatest agrarian rite of Gourmantche) (Korbéogo, 2009). The imperial incursion led to a new form of governance and 'commodification' of nature (Escobar, 1999; Beck, 2003; Foucault, 2004) which has triumphed over indigenous arenas. Thus, a new political economy of nature, inspired by the capitalistic spirit, emerged in the colonized societies (Greenberg and Park, 1994; Comaroff and Comaroff, 1997; Escobar, 1999; Crosby, 2006). The capitalist exploitation of indigenous landscape led a lot of ecological upheavals like the rapid degradation of soil fertility. According to Rodney (2010), some of the new cash crops like groundnuts and cotton were very demanding of the soil. In countries like Senegal, Niger and Chad – as well as Burkina Faso – which were already on the edge of desert, the steady cultivation provoked the soil impoverishment and encroachment of the desert.

In Sub-Saharan West Africa, an "ecological crisis" has emerged during the 1960s, after the formal independence of countries like Burkina Faso. The "Sahelian crisis" has been marked by the devastating drought of the early 1970s (1974 in Burkina Faso), desertification, and the collapse of pastoral and agrarian systems. Since that time, 'the investigation of spatial and temporal rainfall anomalies in West Africa has become the focus of global attention, especially, with regard to the projected climate change' (Falk and Szarzynski, 2010). In Burkina Faso, agro-ecological change is among others manifest by the fact that 63% of the soil resources are affected by major soil constraints for agriculture, due to the shallowness and the sandy structure of the topsoil leading to a low water holding capacity and high infiltration rate (Anne et al., 2010). In the research conducted in the Gourma region, the authors pointed out different factors that are interacting in the soil erosion processes: climate, properties of soil types, vegetation cover, and human activities through farming systems. The main markers of climate change in Burkina Faso are the 'irregularity of rainfall amounts, a bad spatial and temporal distribution, the rapid degradation² of the structure of surface soil, an

elevated thermal regime (25 to 30°C); the high temperatures acting on microbial activity and favouring the decay of organic material as they reduced the soils fertility' (Kagambega et al., 2010).

Bio-physical findings provide insights into the processes and parameters underlying current and projected dynamics of African ecosystems. Nonetheless, they cannot explain the changing interplays between ecology and society. In this sense, Fairhead and Leach (1996) criticized the fact that ecological science tends to overlook human influences on nature degradation (society and nature are then considered as separated; human beings are 'acting' to dominate and subordinate nature) and leads to misread African landscapes. In the context of 'climate change', one of the common disadvantage for rural African coping strategies is that they are often not documented, but rather handed down through oral history and local expertise' (Mary and Majule, 2009).

To work out agro-ecological disturbances, farmers use different cognitive and pragmatic schemes: use of traditional knowledge, domestication or appropriation of exogenous technologies or invention of new farming technologies. In a context of unequal distribution of economic resources and political power, as Agarwal (1983) asserted, the making and diffusion of innovations³ are related to the 'personality characteristics' and 'the efficiency with which the network channels' are functioning. Based on this theoretical framework, local-based innovations' producers are considered as 'peasant intellectuals'⁴ acting within elaborated discursive or practical schemes – whether or not they are dissenting from or fitting into preceding hegemonic schemes – in order to overcome or to reduce successfully agro-ecological disturbances. This paper aims to show how agro-ecological change has led to the invention of new strategies of 'farm tenure' (Bohannon, 1963), crop production and to the reconstruction of the socio-political

² The concept of degradation is extremely elastic. It refers to change of state or types of natural vegetation formation (vegetation cover) as loss or lowering of productivity of the land or lowering of productivity (agriculture) (Kagambega et al., 2010). In sociological or anthropological point of view, the degradation and the fertility of the soils are socially constructed (social products); they reveal the socio-cultural, economic and political status of the farmers (Fairhead and Leach, 1996; Reboul, 1989; Sebillotte, 1989).

³ This concept is used here in a broad sense. It refers to immaterial and material knowledge viewed as new by the farmers even if these knowledge or practises have existed or used elsewhere (Agarwal, 1983).

⁴ Intellectuals should not be simply defined by their engagement in intellectual activities (artists, bureaucrats, teachers...) because in any 'physical work' there is 'a minimum of creative intellectual activity' (Feierman, 1990). Partly influenced by Gramsci's work, Feierman defined 'peasant intellectuals' as 'men and women who earned their daily livelihood by farming'. They can create discourses dissenting from colonial order, or dissenting from local traditional hierarchies. The abilities of peasant intellectuals to create are not mainly or exclusively shaped by their 'class consciousness', as defended by Gramsci; they can also be induced by 'lived condition' and individual agency (Feierman, 1990).

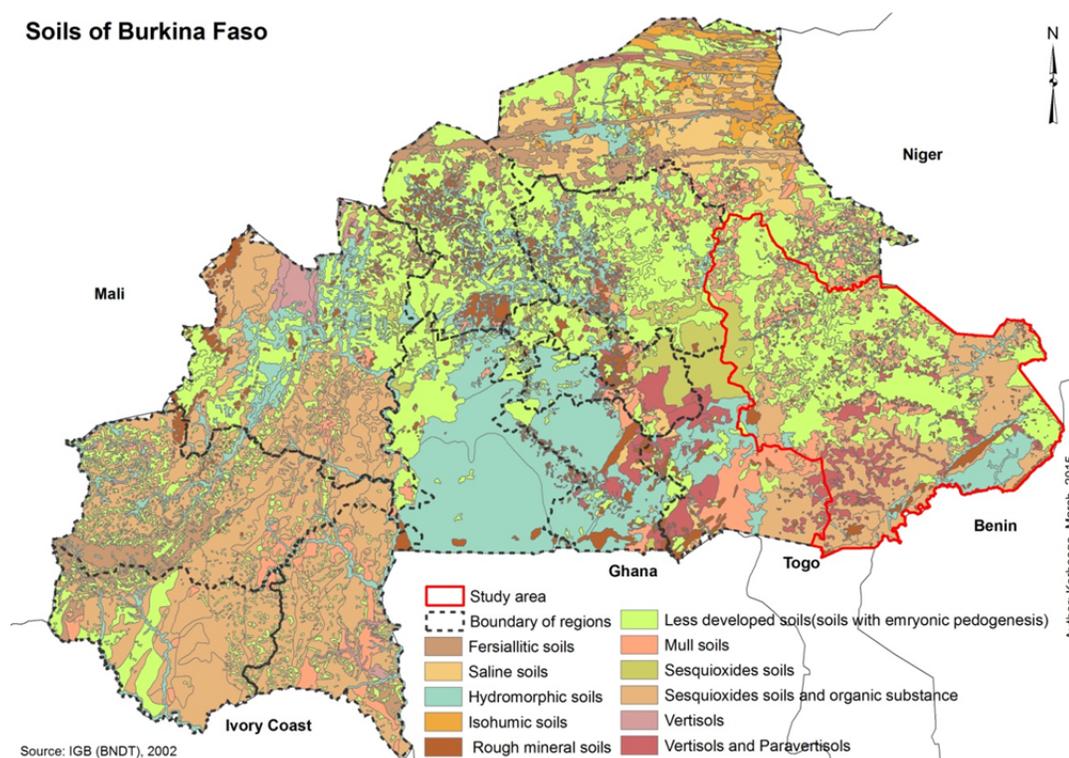


Figure 1. Soils of Burkina Faso.

networks in the Gourma region. It explores the way in which Gourma farmers *read* and *manage* their landscapes in time of agro-ecological variations.

MATERIALS AND METHODS

The methodological design of this study is mixed method. Mixing quantitative and qualitative is more fruitful for exploring landscapes' *reading* and *management* in the Gourma region because such an approach allowed making better use of the epistemological impetus of the two methods. The quantitative survey was dealt with questionnaire that has been submitted to 150 peasants who were chosen randomly. The survey was focused on household's economy, farmers' representations and knowledge on agro-ecological changes (soil fertility, rainfall, temperature, declining or abundance of species, decline or growth of farmlands' productivity, etc.), technological apparatus in regard with landscape's changes. Quantitative data were codified and modelled in the tables that are interpreted following bi-varied analysis. Qualitative survey was conducted through direct observation, secondary document analysis, semi-structured and informal interviews – conducted individually in the three local languages – within different strategic groups (farmers, herders, politico-legal leaders and political authorities). The empirical data were interpreted for understanding the ideology and politics of local agrarian systems.

Research area

This research was conducted during the years 2005, 2006 and 2007 in the Gourma region, in east Burkina Faso; bordering Benin and Niger (Map of soils of Burkina Faso). This region is located in

the North Sudanian phytogeographical zone between parallels 13° North and 11° 30' North (Fontes and Guinko, 1995) (Figure 1). It is a most cultivated area, with rainfall varying between 700 to 1000 mm over 5 to 6 months (Thiombiano, 1996; Ouédraogo, 2006). The average annual temperature is mid-range, between 20 and 30°C (Dipama, 2010). The dominant type of soil is classified in the Regosols group; "soils with very limited soil development, unconsolidated windblown materials; low moisture holding capacity, often used for extensive grazing (Anne et al., 2010: 63)". The savannas look like rustic landscapes dominated by protected species (e.g. *Adansonia digitata*, *Faidherbia albida*, *Lannea microcarpa*, *Parkia biglobosa*, *Tamarindus indica*, *Vitellaria paradoxa*, etc.) (Boussim, 2010). The population is mainly composed by three main ethnic groups: Gulmanceba (autochthonous), Moose and Fulani.

RESULTS AND DISCUSSION

Soil degradation in farmers' perspective

Following the dramatic drought of the 1970s, the issue of ecosystem change in Sahelian societies is included on the international political agenda (Harrison, 1993). From this stage, the question is appropriated by bio-physical and social scientists that are looking for the causes and sustainable solutions to the ecological crisis (Raynaud, 1997). The ecological disturbance is characterized by the decrease of rainfall, grain deficits, violent floods and winds, climate warming, and transformation of plant

Table 1. Indicators of soil infertility in farmers' perceptions.

| Indicators | Frequency (%) |
|---------------------------------|---------------|
| Emergency of weeds | 23.7 |
| Decrease of productivity | 46.5 |
| Whitening / flushing of soil | 14.3 |
| Rapid drying of soil after rain | 8.5 |
| No response | 7 |
| Total | 100 |

Source: Korbéogo, G. quantitative survey, 2005.

diversity (Koechlin, 1997; Crate and Nuttall, 2009). Even if the issue of agro-ecological change is basically a bio-physical phenomenon, socio-anthropology can explore its sociocultural indicators in local arenas and the adaptation strategies of social actors.

In the Gourma region, to make better use of available lands and select appropriate cultures, farmers use their cultural, economic, and historical patterns as well as the local 'plants signalling' (*signalisation végétale*) (Le Roy Ladurie, 1982), constituted by herbs, flowers, soil's color and texture, termites and amphibians. To corroborate this statement, the Table 1 shows basic criteria of soil degradation in Gourma farmers' perspective. The distribution of percentages highlights the decline of crop productivity as the first criterion of farmland degradation. A fifty years old peasant, an inhabitant of Momba village, testifies to that:

'Ah! When you are used to growing and then you suffer during one year, two years and you cannot feed your family, you know that the land is exhausted and must seek another solution. Thus, the area that the father cultivated to feed his family, the son is obliged to triple this area today, because the soil degradation, in order to expect to make both ends meet'⁵

Therefore, the decrease of productivity – locally evaluated within the quantity of the harvest – appears to be one of the indicators most frequently used by farmers to determine the quality of a soil. However, the diversity of plants also guides farmers in determining the agronomic qualities of their field. According to Gourmantche farming experience, *Striga hermontheca*, *Corchorus olitorius*, and *Eragrostis tremula* are 'weeds' that announce the landscape aridification.

Nevertheless, these species are useful in local economy: *S. hermontheca* is exclusively used as grass for livestock while *C. olitorius* and *E. tremula* are used for human diet and for sweep of houses. In contrast, great trees like *V. paradoxa*, *Acacia gourmaensis*, and *Ficus*

sycomorus as well as grasses like *Andropogon gayanus*, *Pennisetum pedicellatum* and *Eulesine india* reflect the agronomic qualities of the farms. Farmers' agronomic skills are generated by individual and collective experiences. A young farmer (30 years old) witnesses:

'To recognize the fertility of the soils I look at the color of their, and especially the type and the size of the plants that grow there. If the plants are high such as *V. paradoxa* or *A. gayanus*, I know that if I sow on the land I will get good harvest. I have learned it from my father, but I have also done my own experience by watching the vegetation condition'⁶.

Then, the transformation of the 'color of the soil' can also help determine farm productivity. Thus, the turn of the soil color from 'black' to 'red' or 'white' is a sign of its exhaustion. The elder of the blacksmith community of Natiaboani, 25 miles from Fada N'Gourma city, attests:

'When you cultivate a 'dark' fertile farm and years after the soil turns as 'red' as a forge, you know that you must find another plot if you do not want to get poor-harvest. A good farmer must be careful to all the signs of the surrounding environment; this awareness has been taught by our fathers through the daily agricultural practices. The forge as well as the field is like our soul'⁷

The connection between the necessity of preserving the 'cultural soul of tradition', embodied in the forge, and agricultural fertility reflects the cultural dimension of fertility. This means that many components of peasants' life inform their perceptions and practices of farming. For example, the soil ability to absorb water after a rain – measured by their ability to move easily on the landscape during rainy season – allows farmers of Sietugu or Balere homelands to know if their fields are deteriorated or not. The soils of the two localities are sandy-clay soils and impracticable after great rains. The elders of Gourma homelands told that in the late 1960s they could not move by bicycle or go out of their village during seven or 10 days.

Although, since late 1980s, they can move on their landscape just three or five days after rains. So, during the author investigations, when clouds started gathering, he was told to leave the village if ever he had meetings in other villages. Otherwise, he should be compelled to extend his stay for five more days. According to his informants, the length of their isolation demonstrates the degradation of their farmlands.

In addition, the assessments on the fertility of farms vary according to the agricultural systems of production. In accordance with the two types of cropping systems we

⁵ Namoano, B: Personal Interview held in Fada N'Gourma on 1/04/05.

⁶ Tankoano A, Personal Interview held in Namungu on 24/11/07.

⁷ Ouoba Y: Personal Interview held in Momba on 20/11/07.

Table 2. Techniques of farmland degradation control.

| Technique | Frequency (%) |
|----------------------|---------------|
| <i>Zai</i> | 26.5 |
| Stone banks | 5.1 |
| Rotation | 10.3 |
| Fallow | 34.7 |
| Chemical fertilizers | 17.6 |
| Plough/tractor | 2.8 |
| No response | 3 |
| Total | 100 |

Source: Korbéogo, G. quantitative survey, 2005.

have 'autonomous farming' that is 'separated' from the livestock and the 'combined farming' in which farmers use their grazing lands as farmland. In the first case, fertility is seen like direct effect of ecological crisis, mainly the rainfall fluctuations, but in the second case, the field needs to be fed as a human being, then fertility is socially built. 'No responses', about farming inexperience and unexpressed opinions, have been collected specially among women and young farmers.

Finally, farmland degradation should not be approached by criticizing only shifting cultivation, archaism of indigenous techniques of production or demographic growth issue. The socio-economic, cultural and political status of peasants should be considered too:

"Blame for environmental mismanagement is largely directed at villagers' land-use practices [...] Opinion expressed during the Environment Days suggests that farmer-led degradation is worsening as result of social, economic and political change, as well as demographic pressure" (Fairhead and Leach, 1996: 29-30).

Thus, the processes of farmlands' appropriation in the Gourma region is a complex pattern combining social life of landscapes and agency of the farmers who are dealing with different ecosystem contingencies.

Agro-ecological dynamic and technological innovations

The struggle against aridification of farmlands is an evidence of technical knowledge progress of farmers and a strategy of their politics of subsistence (Feierman, 1990). In Burkina Faso, smallholders – with the support of scientists, national and international agencies⁸ – developed mechanical and biological strategies to

⁸ Danish International Development Agency, DANIDA; German Society for International Cooperation, GIZ; Food and Agriculture Organization of the United Nations, FAO; etc.) are supporting sustainable farming techniques.

confront the challenges of battle against desertification and soil degradation (Kagambega et al., 2010). The advent of techniques of restoration farmlands fertility by peasants is a response to the effects of climate change. In the Gourma region, three main techniques are used: crop rotation, shifting cultivation, and *Zai* (Table 2). Fallow technique is the preferred fertility recovery technique in rural Gourma. This option of natural self-regeneration of farms is an ancient technique that proves successful when the ecological reserves allow its practice. Indeed, up to date there is still more than 30 years old fallows in the villages. But since the last decade, the effects of migration and relative insecurity of land ownership created by land and agrarian reform (RAF) have threatened the practices of fallow.

The quantitative data show how access to farm induces social differentiation in the local arenas. Should it be stressed that long term fallow are practiced exclusively by the first-comers Gourmantche. So, the oldest fallows – more than 10 years – which cover 29.9% of local farmlands are held by the first-comers Gourmantche while the recent fallow, 70.1%, – less than ten years – are cultivated by young natives or borrowed by the migrants Moose and Fulani. Old fallows can regenerate and appear like virgin bush. Thus, peasants use these plots as grazing lands or as sites for cutting firewood and building woods. Lending new fallows– less fertile than the old ones – to young natives or migrants allow the elders to legitimate their property rights and to escape the uncertainties of the RAF. The effects of physical changes in local landscape pushed the actors to invent new forms of resistance:

"This process occurs when poor grassroots such as farmers or shifting cultivators are pushed onto lands that are economically marginal as a result of their marginal political and economic status. Desperate to extract a living from such lands, these actors intensify production, but in the process often only increase the land's ecological marginality (that is, reduced capability)" (Bryant and Bailey, 1997: 32).

Erosion of soil affects agricultural production by decreasing the soil fertility content, the fine gained of soil content, the water holding capacity as well as the depth of the top soils. It has an important effect on land fertility in the West African Sahel where it is mainly caused by winds and water flows (Mahamane, 2015). *Zai* (moore⁹ word) is a local method of erosion control, which appeared in Yatenga region (Northern Burkina Faso) in the 1950s following recurrent droughts (Kagambega et

⁹ It is the language of the Moose, the most dominant ethnic group in Burkina Faso.

al., 2010; Lenhardt et al., 2014). This traditional technique was improved by a local farmer who participated to a study visit organised in Mali by Oxfam international (Kaboré and Reij, 2004). 'Zaï is drawn from "zaïegre" which means in moore language 'to get up early and hurry to prepare one's land' (Kaiser et al., 2010). This agricultural¹⁰ technique is mainly promoted by a Non-government organization, called "6S" (*savoir se servir de la saison sèche au Sahel*) and Naam networks (Harrison, 1991). In Burkina Faso, zaï is one the best 'achievements of smallholder farmers in the Central Plateau that stand out as one of the best examples of how to achieve progress in land reclamation in the Sahel' (Lenhardt et al., 2014). How does this method work? In fact, farmers dig small holes— with right distance between them – in their fields that they fulfill with well-rotted manure or compost before closing with earth taken from the holes. Then, they sow immediately just before or soon after the first good rain. *Zaï* technique has overcome contingencies of large arid farms in Yatenga region. It enhances the capture of rainfall and runoff water, the protection of seeds and organic matter, concentration of fertility and increase of agricultural productivity (Hien et al., 2010; Lenhardt et al., 2014; Kagambega et al., 2010). Studies carried out by Environment and Agricultural Research Institute (INERA) of Burkina Faso revealed that *Zaï* improves the productivity of 86% in Central Burkina Faso. However, this technique needs much manpower¹¹ (it requires between 300 and 400 h of work to treat one hectare) and material resources in order to dig the holes and to gather straw, organic waste and water. Throughout Yadse (Moose from Yatenga) migration and agricultural public institutions – the local committee for land management (*Commission villageoise de gestion des terroirs*), created by the National program for land management (Programme National de Gestion des Terroirs) –this technique has been promoted in rural Gourma during the late 1980. Nowadays, the *zaï* has a relative success among the erosion control techniques of mainly in Moose communities.

'We had to teach farmers how to cultivate, how to make furrows to retain water, how to apply zaï technique, and

¹⁰ Kaiser et al. (2010) have identified 2 types of Zaï: agricultural zaï and forestry zaï. The former consists in digging pits (water microsheds) in parallel or alternate rows and putting seeds with organic material into the holes. The latter refers to the process in which the farmlands 'lie in fallow after 4-5 years of continuous zaï cultivation'. So, 'within 10-20 years, rich woody and herbaceous vegetation emerges, forming a matrix for the production of economically valuable species'. This paper refers to agricultural zaï which is the well-known and the more applied technique in the Gourma region.

¹¹ The technique is essentially manual. According to Kaiser et al. (2010), 60 working days are necessary to prepare 1 hectare land with the improved zaï technique.

how to plough the field instead of burning the grass. Grasses must be buried in the soil when ploughing or we must bury it in the ground. Many people practice the traditional technique but they think it is a modern one. This is not true! Local fertilizers are better than the modern ones'¹².

Besides, the *zaï*, peasants used the method of 'stone banks' to fight against erosion. It consists in laying stones in rows on the surface of the field in order to retain the rainy water. These anti-erosion techniques, which were promoted by external actors or migrants, are less practiced by the Gourmantche because of its demand in material means and manpower. Subsequently, such techniques are mainly used by the peasants, can have the help of his association or cooperation.

The last agricultural technique for soil erosion control is the utilization of plough or tractor. In the context of soil degradation, the plough and the tractor – with their toothed actions – are means of working which enable to scrape or break up of the upper of the soils in order to improve their capacity of water penetration and permit a 'good soil-water-plant balance' (Kagambega et al., 2010). The farmlands' scarification or subsoiling (depth of 10 cm to more than 30 cm) cannot be carried out with the flimsy traditional hoes. These two mechanical tools (plough and tractor) were introduced in rural Gourma during the colonial era. According to the archives of the local prefecture ploughs have been introduced in the Gourma region in 1949 by colonial agricultural centres in order to facilitate farming activities and to increase the production of raw materials for Western industries. After the colonial regime, the plough is still used by small number households. It is the case of mister Segda, one of the first rice producers and plough's users of the Gourma region (Korbéogo, 2009; Korbéogo 2013). Accumulation of social, cultural and economic capital – through his prosperous trade and livestock – allowed him to access the technological innovations in local farming systems in the colonial context. But since late 1990s, with the promotion of cotton production, this technique has been relatively popularized in rural Gourma. Thus, 70% of the households surveyed have a plough, bought in most cases with the cotton revenues. But, we can note that natives and migrants Moose are the largest users of the plough unlike the former who have a negative opinion of this instrument. A septuagenarian Gourmantche peasant notices:

'The Moose who have borrowed land to produce cotton and using a plough have degraded the land within a period of five years and still wanted more land. Under

¹² Koidima, J: Personal interview held in Nienduga on 01/9/05.

these conditions it is difficult to continue to give people who do not take good care of the land! And if you continue giving them more lands, they or their children may one day claim ownership over their old fields left fallow. And this will create problems between us'¹³.

Such a correlation between plough use and land degradation – contrary to Brunhes Delamarre and Haudricourt observations (2000) – coincides with the results of scientific experiments conducted in West Africa (Harrison, 1991). Indeed, the extension of plough use has induced rapid degradation of cotton fields and an expansion of land use. This social competition for land use is characterized by a correlative affirmation of indigenous land rights and discursive or physical conflicts between the hosts Gourmantche and their clients Moose. It is the reason why technological innovations in local agriculture can lead to significant social changes in terms of land management and social differentiation (Blaikie and Brookfield, 1987; Chambers, 1983; Kirk, 1999; Lenhardt et al., 2014). Then, if the processes of innovation implementation are misconceived and mislead they can increase the technological and social exclusion of poor farmers in developing countries. So, without 'forms of assistance' (to access labor, tools and inputs) (Lenhardt et al., 2014) as well as without political and social network precarious households cannot adopt sustainable farming techniques.

Small-scale response to degraded and politicised environment

Access to domestic labor force is becoming more and more a tough issue due to the process of social individuation in rural Gourma. Although, the generalization of polygamy within peasants, whatever their religion, allows them to cope with the effects of family fragmentation and manpower scarcity. As Boserup has mentioned: "(...) the institution of polygamy is a significant element in the process of economic development in regions where additional land is available for cultivation under the long fallow system (Boserup, 2010:390)". This social process is linked to the development of cash crops and to the strategies of land accumulation by the Gourmantche first-settlers.

'We have to break up the units of production per household because if all the members of our family work in the same field people can feel less concerned. I experienced farm labor in a large group with my family. We were at least four married men, but sometimes some

people dealt with personal matters while others cultivated for family; and ultimately this result into frustrations. But if you are with your wife and children, if you do not work hard your family will not get food. So I gave plots to each married son and they worked very well. It is also a duty for a father to give farmland to his children in order to prevent land appropriation by the government or migrants'¹⁴.

In this perspective, Gourmantche peasants shorten the time of land use in order to conquest the virgin bush or their lineage oldest fallows. So, the signs of recent agricultural settlement (plow furrows or trees regeneration) legitimate their property rights over the land and prevent new-comers access to lands. This form of land rights appropriation based on labor (that is, cutting down the bush, fighting wild animals, planting trees, cultivation of the land, etc), in the sense John Locke theory of property, is frequent in rural West Africa (Lentz, 2006). In this case, the fallow is not a response to the deterioration of soil fertility but a strategy to reinforce autochthonous land tenure. Therefore, the recent fallows—between five and ten years - are transferred to new applicants so as to allow the first-comers to clear new farms. This strategy of farmlands management that is in force in Gourma frontier societies, also observed by Doevenspeck (2004), prevents the political clients (Moose and Fulani) to expand illicitly their farms beyond the boundaries of the borrowed fields. This strategy is also an institutional arrangement (Ostrom, 1990) that enable the first-comers Gourmantche to maintain their socio-political supremacy on the new-comers and create the bases of local socio-political institutions.

Moreover, the individuation of land rights devolution in rural Gourma is characterized by the affirmation of heritage within the patrilineal (in a nuclear scale: from father to his sons) and the decline of the traditional adelphic system of heritage (in a lineage scale) (Korbéogo, 2010).

Conclusion

Ecological change is an old problem induced by the pervasive use of natural resources that has threatened the equilibrium of ecosystems in the world. In West Africa, and mainly in Burkina Faso, this bio-physical fragility has been intensified by colonization which challenged the *green social security* (Cunningham, 2001) that occurred in rural landscapes. Thereby, peasants have to produce adaptive strategies in order to deal with the constraints of the new ecological order. In the dynamic

¹³ Thiombiano, H: Personal interview held in Namungu on 04/5/05.

¹⁴ Thiombiano, T., Interview held in Natiaboani on 23/4/05.

of a continuing scientific enterprise initiated by contemporary scholars (Chambers, 1983; Comaroff and Comaroff, 1987; Feierman, 1990), this article is an attempt to explore the 'history' and 'consciousness of intellectuals' in a West African farming society. It pulls out the genius of Gourmantche peasants to interpret and manage the current ecological contingencies of their society.

In response to the current agro-ecological and social framework, local farmers have invented pragmatic and sustainable processes of crop production: the rotation of crops (rotating food and cash crops in the same field), the *zaï* technique which reinforces the soils fertility, shifting cultivation as well as the fragmentation of households in order to increase the productivity of manpower in small units of production. Nevertheless, these different technical and social strategies of desertification control are implemented in accordance with local structural principles as well as with peasants' beliefs and practical sense. Thus, local farmers should not be considered like subjects dealing passively with external ideologies and technical protocols; instead, they should be regarded as inventive citizens dealing with external ideologies and ecological patterns. Therefore, the ongoing climate change has led to the invention of new strategies of land tenure, crop production and is contributing to the reconstruction of the socio-political links in local arenas. The capacity of action and resistance of peasants – through the making of 'practical knowledge' or local 'know-how' to mitigate ecological variability – legitimates their attribute of 'intellectuals' defended by Feierman (1987).

In conclusion, he state that sustainable responses to agro-ecological change in Sahelian West Africa should take into account the stakes of local agrarian systems, markets' forces, as well as collective experience and actors' agency. So, 'history' or long term experience and everyday active innovations are ingeniously woven by 'peasant intellectuals' to enlighten their farming systems. The dynamic and conscious negotiation of these driving forces strengthens farmers' abilities to *read* and *manage* sustainably rural landscapes.

Conflict of interest

The authors did not declare any conflict of interest.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the reviewers, Aderemi Ajala, Natewindé Sawadogo and Moussa Kambiré for their relevant comments as well as Issa Sory for his generous help for the drawing of the map of soils of Burkina Faso.

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