Assessing the impacts of a transition to agroecology-based agricultural systems on smallholder farmers' livelihoods in Burkina Faso: The contribution of a methodological framework combining the Anglo-Saxon Sustainable Livelihoods and the francophone "*Agriculture Comparée*" approaches

Diane KAPGEN (diane.kapgen@ulb.ac.be)
PhD Candidate at the *Centre d'Etudes de la Coopération Internationale et du Développement* (CECID), *Université Libre de Bruxelles* (ULB)
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Laurence ROUDART (laurence.roudart@ulc.ac.be)
Centre d'Etudes de la Coopération Internationale et du Développement (CECID)
Institut de Sociologie (ULB)
Professor of Agricultural Development at the *Université Libre de Bruxelles* (ULB)

1. Introduction

During recent years, more and more studies have emphasized the importance of a transition to alternative agricultural systems through "*an agroecological development paradigm based on the revitalization of small farms which emphasizes diversity, synergy, recycling and integration, and social processes that value community participation and empowerment*" (ALTIERI et al. 2011). While this debate is embedded in a context of global food systems, it is especially important in regard of the situation of African smallholders where "*sustainable agriculture offers new opportunities, by emphasising the productive values of natural, social and human capital, all assets that Africa either has in abundance or that can be regenerated at low financial cost*" (PRETTY et al. 2011). Agroecology and its field applied practices have the potential to meet the double challenge of high productivity and high sustainability, and thus to improve livelihoods of smallholder farmers in developing countries (DE SCHUTTER 2011).

Regarding the sustainability and feasibility of a transition to agroecologically-based agricultural systems, further questions arise. Is it ethically just to promote agroecology (and consequently "withhold" the industrial way of farming) in the context of poor smallholder farmers in developing countries? How do more local production-consumption cycles make sense in West African rural areas where local cycles are the norm, not the exception, and where government policies tend to promote a more industrial agriculture? Is it possible for smallholder farmers to "move up the social ladder" without becoming a "big farmer" and how can the agroecological pathway empower smallholders and give a perspective to young rural people?

The essential question in the light of analyzing the impacts of a transition in the portrayed context is of methodological nature. Which concepts can provide a holistic, hybrid, transdisciplinary and dynamic methodological framework that goes beyond the agronomic viewpoint and embraces the different dimensions of the rather woolly sustainability term with more depth and precision? The following contribution tries to answer this question by presenting a conceptual framework elaborated for our PhD study on the impact of agroecology on smallholder farmers' livelihoods in Eastern Burkina Faso, and the preliminary results obtained with this framework. The framework combines the Anglo-Saxon Sustainable Livelihoods Framework (SLF) and the francophone "*agriculture comparée*" related concepts.

2. Diagnosis: Agroecology and development

Following ALTIERI's flagship publication "*Agroecology, the scientific basis of alternative agriculture*" of 1987, the agroecological development paradigm has spread among development actors, above all non-governmental organizations and farmers' associations

(WEZEL et al. 2009). In today's era of the renaissance of the sustainability debate, agroecology has become an integral part of the discussion on agricultural and rural development approaches, supported by the *International assessment of agricultural knowledge, science and technology for development (IAASTD)*; report that not least allowed for an appearance of the agroecological concept on the political stage. As stated by MÉNDEZ et al. (2013), the report identifies agroecology as a promising approach to "*resolve the interrelated global problems of hunger, rural poverty, and sustainable development*".

However, up to now, some controversy about the definition of agroecology remains. According to STASSART et al. (2012), agroecology is a concept that provides an orientation but is of "*polysemous*" meaning. Following the same logic, WEZEL et al. (2009) define three major uses of the term agroecology: as a science, as a movement and as a practice. The basis of agroecological practices was developed during the 1980s in Latin America, where local farmers were supported in improving their indigenous farming practices in order to provide an alternative way of agriculture to the highly external input dependant approach (WEZEL et al. 2009). During the 1990s, agroecology as a practice became ever more popular. Today, there is still some dispute on when a farming practice or technique can be defined as agroecological. Most scientists differentiate between concepts of agroecology and other forms of alternative agriculture, but there is some overlapping. The essential idea of agroecological practices is to enhance beneficial interactions and synergies among the components of the agroecosystem and thus reduce external inputs to a minimum (ALTIERI and TOLEDO 2011). Key principles of sustainable agriculture are relevant for agroecology, including practices like integrated nutrient management, conservation tillage, agroforestry and livestock integration (PRETTY 2007). Some practices used under the definition of sustainable agriculture cannot be qualified as agroecological if they do not rely on recycling, enhancing, diversifying and integrating actions in the system as an entity but only focus on changing single components of the system in order to overcome a limiting factor (ALTIERI and NICHOLLS 2005). For example, this is the case of organic agriculture if managed as monocultures and dependent on commodified biological inputs (ALTIERI and TOLEDO 2011). According to GRIFFON (2013), it is not desirable to create a competition between different alternative agricultures. He summarizes that agroecological practices are rooted in integrated farming and conservation agriculture. We adopt the viewpoint that agroecological practices should lead to an ecologically-based enhancement of the interaction of the different agroecosystem components, while avoiding external inputs, which distinguishes them from conventional agriculture as well as from some other alternative agricultures (ROSSET and ALTIERI 1997).[1] As agroecology claims to be locally-specific, it seems evident to us that very different practices and techniques can be classified as being agroecological. Flexibility is intrinsic to the concept.

Out of the growing popularity of agroecological practices and the conventional agriculture's growing negative externalities, agroecology as a social movement appeared in the 1990s, foremost in the USA and in Latin America, and wanted to promote "*a new way to consider agriculture and its relationships with society"* (WEZEL et al. 2009). Agroecology as a social movement is spreading today, a prominent example being the international farmers' movement *Via Campesina* that supports agroecological practices worldwide and is an essential actor of the food sovereignty debate (ROSSET and MARTÍNEZ-TORRES 2012).

Agroecology as a science can be divided into two main perspectives (MÉNDEZ et al. 2013). The first and predominant perspective is grounded in the natural sciences, concentrating research on ecological and agronomic processes, as well as biophysical and environmental aspects of agricultural production (DALGAARD et al. 2003 and MÉNDEZ et al. 2013). In the context of developing countries, these studies reveal the potential of agroecological practices for crop yield increases, soil recovery and fertility, larger biodiversity, and other positive externalities on natural capital[2], as well as resilience of agroecology-based production systems in a context of extreme weather events (HOLT-GIMÉNEZ 2002). But while certainly

[1] For a general overview of conventional vs. alternative agriculture, see BEUS and DUNLAP (1990)
[2] For the African context, a review is provided by PRETTY Jules et al. (2011)

being crucial dimensions, sustainable and ecological production and productivity increase do not automatically result in more sustainable livelihoods for smallholders: access to social, human, natural, financial and physical assets, as well as locally varying vulnerability conditions on different levels, contribute equally to smallholder farmers' life conditions. The large perspective of agroecology sets in here and aims at the participatory development of agroecology-based agricultural systems. Agroecological farming practices on a field-, farm- or village level are then part of a broader transition to changing social, economic and political conditions.

In the West African context, few studies analyze the impact of agroecological practices on smallholder farmers' livelihoods by adopting a large perspective of agroecology. Despite the claim for interdisciplinary research, many studies on the transition to agroecology in developing countries don't bridge what AMEKAWA (2010) calls "*the conventional chasm between ecological research and social realities in agroecology-based development*". The author criticized the absence of studies providing a holistic impact evaluation of agroecological transitions in developing countries and provided new insight on agroecology's strong conceptual links to sustainable livelihood approaches and sustainable agriculture.

Analyzing agroecology in Burkina Faso is also an assessment of a development intervention. In theory, agroecology is conceptualized as a transdisciplinary, participatory, bottom-up and action-oriented approach, designed with smallholder farmers, based on improvement of traditional techniques, reinforcing locally available natural and social resources and ideally integrating political-economic empowerment. However, many rural and agricultural development projects and programs in Burkina Faso remain grounded in the definitions and categories of outside development technicians (HAGBERG 2008). There are examples of poorly adopted, externally developed practices in the domain of sustainable agriculture in Eastern Burkina Faso; local non-specificity and ignorance of the role of social capital (and to some extent financial and human capital) being key reasons (MAZZUCATO and NIEMEIJER 2000). Hence, there is a potential danger of a decay of agroecology into "just another top-down technical package". Furthermore, as SAUL (1991) already stated some time ago, "*newly inspired production practices, even though locally developed, are not always within the reach of everyone in the village, because they depend on the control of resources (...)*".

3. Discussion of the theoretical concepts

We use the Sustainable Livelihoods Framework (SLF) as a basis for an enlarged conceptual framework. Rather than adopting the SLF lock, stock and barrel, we developed a novel framework by incorporating the concepts of the francophone *Agriculture Comparée* approach (MAZOYER and ROUDART 2002, COCHET 2011). By adding an agronomic dimension, the transdisciplinarity of the original SLF is further enhanced. Three main concepts of the *Agriculture Comparée* approach are integrated into our framework.

At the field level, the concept of *système de culture* is used to identify the cultivated crops and their succession on the different plots, as well as the crop management techniques used. It is important to not only rigorously identify the individual operations on the plots, but to also understand the reasons why specific techniques are employed and why specific plants or varieties are favored. (SÉBILLOTTE 1976). At the farm level, the concept of *système de production* is used to understand in which way land, labor and capital are combined for vegetal and animal production (REBOUL 1976), and to characterize the differences between the existing systems in the study region. The concept of *système agraire* is used to understand what types of agriculture, each composed of a characteristic cultivated ecosystem and a defined social productive system, have succeeded historically in the study region (MAZOYER and ROUDART 2002).

The framework based on both elements of the Sustainable Livelihoods approach and elements of the *Agriculture Comparée* approach benefits from the latter's concrete and practical concepts which provide a rigorous guideline on how to assess "what happens on the field and farm levels", which is necessary when evaluating agroecology, as explained earlier. It further has the function of "*a research tool helping us to organize the information*

collected in a territory" (GASTELLU 1987). A challenge of assessing impacts of agroecology is related to the nature of agroecological practices. As they are based (or should be, in theory) on indigenous practices, the context in which impact of agroecology is to be analyzed, was an agroecological context to some extent already before the development intervention took place. As a consequence, it is not always possible to make a neat difference between traditional (old) and improved (new) practices. It requires a close and careful analysis of farm management techniques in order to understand exactly what farmers do on their fields and what possible differences exist, as well as the evolution of production systems in time.

However, a larger perspective going beyond the agronomic and natural sciences viewpoint is needed to understand the impacts of an agroecological development intervention on peasants' livelihoods. Here, the elements of the SLF are useful; not least to understand the underlying factors that condition diversity in adoption.

While there are some interesting reflections on the use of the SLF for scientific research (DE HAAN and ZOOMERS 2005, SCOONES 2009, VAN DIJK 2011, BOND and MUKHERJEE 2002, JAGGER et al. 2012) the framework remains more commonly used as a planning tool for development projects. Examples for impact assessment or for evaluating a change in livelihoods more generally are provided by ADATO and MEINZEN-DICK 2002, ASHLEY and HUSSEIN 2000, BENNETT and FRANZEL 2013, CAMPBELL et al. 2000, DAS 2014. This may also be related to the amount of data that has to be collected if all capitals are considered equally to analyze rural livelihoods, which led ELLIS and BAHIGWA (2003) to state that researchers have to set priorities. By choosing a qualitative data collection methodology, such obstacles can be handled because dimensions and indicators can be developed based on theory but then specified according to field reality (which means peasant families priorities). As JAGGER states in a paper from 2012, "*(...) Interest in livelihood portfolios (...) is motivated by the desire to understand the lives of the poor (...)*."

We use the SLF as a core structure. The framework incorporates the main factors that affect people's livelihoods and the essential relationships between these (CHAMBERS and CONWAY 1991, SCOONES 1998, ELLIS 2000). The building blocks of sustainable livelihoods are a range of livelihood assets which people have access to and control over. They are of tangible or intangible nature and can be split in five so-called "capitals": natural, financial, physical, human and social capital. People combine these capitals in order to create livelihood outcomes through pursuit of activities. A stronger capital base is associated with richer livelihood outcomes and a more sustainable livelihood. A weaker capital base is associated with poorer livelihood outcomes and a more vulnerable livelihood. A basic principle of sustainable agricultural systems is that they accumulate stocks of the five livelihood assets and increase the asset base over time. Unsustainable systems deplete or run down assets, decreasing and liquidating the asset base over time (PRETTY 1999).

Natural capital refers to all components of the natural resource base and produces ecosystem goods and services (COSTANZA et al. 1997). Social capital "*refers to the social networks and associations in which people participate, and from which they can derive support that contributes to their livelihoods*" (ELLIS 2000). Also, social capital is seen as an essential imperative for the adoption of sustainable behaviors and technologies (PRETTY 2011) and plays a particularly important role in the context of emancipatory action (defined as "*challenging the structures under which one makes a living"* by BEBBINGTON 1999). Human capital is the basic asset required to make use of the social, natural, physical and financial capitals at one's disposal (CARPENTER and MCGILLIVRAY 2012). Physical capital comprises public and private infrastructure as well as production equipment and technologies, and market infrastructure (PRETTY 2011). Financial capital refers to the private capital base that can be accessed in order to purchase production and consumption goods (ELLIS 2000).

The different capitals are influenced by building and destroying effects of the vulnerability context (trends, shocks and seasonality), which people have limited or no control over on an

individual and small group basis. Trends can be of economic, natural, political and social nature. Shocks are majorly economic and natural, but can also consist of local conflict sources. Seasonality is characterized by specific local conditions.

Overall transforming structures and processes (policies on different levels, institutions, organizations, legislation, local culture and power structures) also have an influence on the access to assets. Vice versa, people, both on an individual and group basis, can have profound influence on structures and processes. In general, the stronger their asset base, the more influence people are able to exert. In theory, a strengthened livelihood base acquired through the transition to an agroecological system should thus enable peasants to change the overall transforming structures and processes on the longer term.

4. Data and indicators

The field research takes place in Gnagna province (Eastern Burkina Faso). Several projects led by the local NGO ARFA (*Association de Recherche et de Formation Agro-écologique*) in Gnagna and Gourma provinces since 1995 have aimed at the promotion of agroecology and have resulted in the adoption of new agricultural practices by smallholder farmers in the region.

The research project tries to answer the following overall research question: Does the transition to agroecologically-based agricultural systems sustainably improve livelihoods of smallholder farmers in Eastern Burkina Faso? While this question has evolved according to the research stadium and is refined through sub-questions, we focus on the presentation of intermediate results in the present contribution. These include the identification of the farming production systems (*systèmes de production*); the identification and discussion of the meaning of agroecology in the study region; and the impact of agroecology on social and human capital, as well as, vice versa, the role of social and human capital for engaging in agroecology.

Note on the sampling

We try to evaluate the impact of the adoption of agroecology on smallholder farmers' livelihoods through a comparison of households that participated in the projects and those that didn't, using purposive samples for each household type, their size depending on saturation. The influence of surrounding social and economic (as well as political, natural and cultural) changes on farmers and the potential bias arising therefrom is addressed by the adoption of the double difference method, which consists in comparing a participating and non-participating group (first difference) for both before and after project scenarios (second difference). The second difference complies with the requirement of impact assessment to take into account the dynamics of livelihood portfolios. Samples for both groups are drawn from the same villages to avoid potential biases occurring from the influence of external factors. We conduct semi-structured interviews with smallholder farmers and with their family members using adaptable, open interview guides addressing all dimensions of the enlarged livelihood framework, for the examination of before and after project scenarios (assessed at the same point in time). So far, 32 households have been interviewed.

Dimensions of the capitals

Dimensions and descriptors of each of the capitals were more precisely developed from literature on sustainable livelihoods, agroecology and sustainability impact assessment (e.g. IZAC and SWIFT 1994, FERNANDES and WOODHOUSE 2008), and combined with findings of the field research first phase. The five capitals are used as overall dimensions, further split into operational dimensions. Hereinafter, the dimensions are listed. It should be noted that they overlap in practice.

Natural capital: Land (access, quality), Soil (types and related problems for farmers), Water (rain catchment in the fields, access to humid soils and irrigation) and Biodiversity (crops, natural vegetation, interactions)

Human capital: Education (including knowledge, know-how, training, general education), Spirit of innovation and initiative, Ideas for one's life, Health (evolution of family health and reasons, access to sanitary facilities)

Social capital: Social organization (including networks and groups), Access to information, Institutional support (NGOs, government, traditional authorities, other organizations), Political action, Empowerment, Life perceptions

Physical capital: Farm (and home) infrastructure and equipment, Community infrastructure (roads, electricity, drinking water facilities), Market infrastructure

Financial capital: Household income (*Revenu agricole* + potential other income sources), Access to credit, Savings, *Seuil de reproduction sociale*

Moreover, in accordance with our conceptual framework and the field reality, the following framing or interpretative context data are being collected on the field:

Data on trends: (a) economic: real prices of agricultural commodities at regional and national scales; (b) natural: soil degradation, climate change, biodiversity loss; (c) political: national agricultural policies; (d) social: status of family farmers

Data on shocks: weather hazards; household tragedies; conflicts between farmers and pastoralists

Data on seasonality: local agricultural commodity prices, agricultural production fluctuation and food availability

Data on transforming structures and processes: agricultural policies and support at the different decision-making scales; NGO intervention at the local scale; markets at different scales; power relations, traditional rules and societal norms at the local levels.

5. Experience from the field (intermediate, preliminary results)

Note on the peasant term

In the following, if referring to peasants, we employ the definition of AKRAM-LODHI and KAY (2011): "*A peasant is an agricultural worker whose livelihood is based primarily on having access to land that is either owned or rented, and who uses principally their own labour and the labour of other family members to work that land. Peasants rely to a significant, if not exclusive, degree on cultivating arable land. (...) Peasants are rarely self-sufficient. (...)"*. We use the term "farmer" as equivalent to "peasant".

5.1. Preliminary analysis of agriculture in Bilanga in terms of "*systèmes de production*"

Bilanga is a rural municipality of seventy villages, occupying an area of 2,100 km² in the rural province of Gnagna in the Eastern region of Burkina Faso. The field research concentrates around the village of Bilanga-Yanga and the included surrounding hamlets, situated in the southernmost Gnagna province, with a population of 5.000 inhabitants approximately. Gurma people constitute the predominant ethnic group, followed by Mossi and Peulh people. The sudano-sahelian climate includes a dry season (October to May) and a rainy season (June to September) with annual rainfall of 600 to 700 mm on average. Climate change is highly tangible in the region, resulting in lower and more erratic rainfall. The hydrographical network is composed of temporary streams with small ponds and pools during the rainy season. During the dry season water scarcity is common across the region.

Three soil types predominate: Gravelly and sandy-gravelly soils on granitic plateaus, showing signs of impoverishment; sandy-clayey and clayey soils with higher agricultural potential; and lowland soils where temporary flooding is possible. The region around Bilanga-Yanga suffers from an increase of eroded and degraded land. The vegetation is dominated by sparse wooded or shrub savanna, and steppe with savannah grassland in places. Dominant native tree species are Acacia, Nere, Shea, Baobab and Tamarind.

5.1.1. Farming production systems in the Bilanga-Yanga region

From the 32 production units (being equal to family households) in the sample, 19 cultivate an area between 1.5 and 5 hectares, whereas 13 cultivate an area between 6 and 10 hectares. In sum, 163.5 hectares of land are cultivated by the sampled households, leading to an average of slightly over 5 hectares per household.

All farms are managed through family workforce almost exclusively. For time-consuming work, neighbors or friends may help each other out on a mutual assistance basis.

Access to farmland is organized trough traditional inheritance. Most descent groups of the village possess permanent land rights. Landlessness has remained rare up to the present. Tenant farming is not common in the region.

Farmers have plots next to the homestead (granitic plateau) and plots at 1 to 5 kilometers distance (more humid soils). The shares of land owned in the different areas have an impact on the proportions of the cultivated crops.

The main combination of crops adopted by farmers includes white sorghum, pearl millet, maize, cowpea, peanut and sesame. Some peasants add red sorghum or rice to this combination; others do not plant sesame or peanut, the latter being more common if red sorghum was added.

White sorghum is the main staple food and the basis for Tô, the traditional meal consisting of a boiled flour paste served with different sauces. **Red sorghum** is used for Tô only in the absence of white sorghum. Red sorghum grows better on heavier soils, which can be a selection criterion, but it is not grown in large quantities traditionally; its main usage being the traditional alcoholic beverage called "*Dolo*". **Pearl millet** grows well on dry, nutrient-poor gravelly-sandy soils, is drought-tolerant and less sensitive to *Striga hermonthica*. Even though its nutritional qualities are less appreciated, peasants value it as an important anchor in years with insufficient rainfall and in conditions where soils become more and more degraded. **Maize** is grown on gravelly plots around the homestead. It is ready for harvest more than a month before sorghum and millet and assures the function of staple food during the lean season if sorghum and millet stocks are used up. **Rice** cultivation is an “extra” for farmers owning a plot on temporary-flooded lowland and plays a dual role: economizing for rice-based holiday dishes and as a small income source. **Legumes** are cultivated for grain and less for forage, with cowpea and peanut being an essential protein source, whereas sesame is a cash crop mainly.

Most farmers rotate their crops, but few have adopted a fixed rotation system. If, at the time of the harvest, the farmer estimates that weed pressure (foremost *Striga hermonthica*) is too strong or that soil fertility has declined too much to be sufficiently restored through the use of fertilizers, he will plant the crop on a different plot next season. Land is very rarely left fallow because of farmland scarcity. Random intercropping of a cereal and a legume is common.

Both rotation and intercropping patterns are not systematic and cannot be chosen as further differentiation criterions between cropping systems (*système de culture*).

Apart from exceptional cases, all farmers own livestock composed of caprine, ovine and bovine species in varying proportions and numbers. Goats and sheep are held in outdoor enclosures, mostly near the homestead. Zebus graze in the bush during the whole year and are only led to the farm plots after the harvest for pasture. Families, who own bigger cattle herds, have enclosures in the bush, where zebus are left for the night. If their number is limited, they will spend the night in the bush or are brought home and attached to a wooden pole rammed into the ground. Donkeys are the main work animals.

The decisive element for differentiating between farming production systems (*système de production*) is the presence, or not, of drought-animals for soil tillage, and the type of animal if applicable. Hence three categories:

1. Animal tillage with donkeys only (At_d)
2. Animal tillage with donkeys and zebus (At_d+z)
3. Manual tillage with hoes (Mt_h)

The cross table shows the farming production systems with their respective number of cases.

Table 1: farming production systems	**At_d**	**At_d+z**	**Mt_h**
A (white sorghum + pearl millet + maize + cowpea + peanut + sesame)	7	5	1
B (A *plus* red sorghum or rice)	3	2	1
C (A *minus* peanut or sesame)	3	3	0
D (A *plus* red sorghum *minus* peanut or sesame)	5	2	1

5.1.2. The farming calendar

The farming calendar can be divided in several periods: Land preparation, tillage of the plots, seeding, weeding, harvest, and post-harvest. The farming year starts with a ritual in March for honoring the ancestors and asking for their blessing for the coming season.

In general and contrary to the ancient times, plots are not cleared during land preparation, which is a result of training for peasants. Nonetheless, some famers continue to slash and burn on lowland plots, if it was left fallow or if grasses grew back intensively between the harvest and the new season. On plots without slope (and little water and mulch run-off) and limited flooding, farmers gave up the burning part and moved on to assembling the slashed vegetal material on small piles on the plot for mulching purpose. Axes are used to cut bigger branches or harder woods, whereas machetes suffice for slashing small shrubs and grasses. Where necessary, pickaxes or hoes are used to dislodge roots. Rakes are the most efficient tool to gather slashed material on heaps.

When land is not cleared, the first operation on the field consists of assembling previously collected dead leaves on small piles on the plots, choosing areas where soil fertility is particularly low. Peasants who possess larger herds, allowing them to produce more animal manure or compost, apply vegetal refuse less systematically.

With the first rains in April, compost ditches or manure heaps are emptied with shovels or forks, and the animal manure or compost is transported to the field in donkey carts, wheelbarrows or wicker baskets on the head. In the fields, it is piled in small heaps in regular intervals, then either spread with rakes and the front side of pickaxes, or simply left in heaps. Most farmers rotate the plots where compost or manure is spread: they spread compost on one portion of the field in the first year, on the second portion in the second year and, eventually on a third portion in the third year (or come back to the first portion in the third year), depending on soil type and fertility, as well as on the amount of compost produced. Farmers, who can afford to buy mineral fertilizer, may use NPK next to organic manure.

After these fertilization steps, peasants will till parcels with animal-drawn plows (or manual hoes more rarely), starting on heavier soils first and then move on to gravelly soils. Peasants who use hoes either haven't been trained to use animal-drawn plows or cannot afford the necessary equipment. Peasants who use a bull for tillage often alternate with a donkey or another bull, for not overworking the generally rather poorly fed animals. A donkey needs the double amount of time for finishing a plot compared to a bull. However, many households do not own draught cattle. The differences in access to draught animals and plows are essential for the work speed and ease. Some peasants spread a total herbicide while tilling, which prevents weeds for about 40 days.

All tilling is done no later than the months of April and May. Seeding should start in mid-May, immediately after tillage. A part of the previous harvest is saved for seeding purpose. Seeding in rows is very common and allows a higher density of pockets and thus, ideally, a higher yield per plot. The furrows opened by the plough are used as parallel seed beds and the distance of the pockets is hand metered during the seeding. Every person is equipped with a calabash containing the seeds and a small pickaxe for digging seeding holes. The pre-treatment of seeds with an insecticide is quite common for planting on soils with high presence of termites. Most peasants have plots on which each crop is planted in pure stands as well as plots where lines of white sorghum or pearl millet are alternated with cowpea or peanut and sometimes sesame. Cereals are then planted in hand-measured intervals on the lines, whereas legumes are thrown on the lines freely from the wrist. Finding the optimal time for seeding is becoming a growing problem in the region because of the changing rainfall pattern: if the rains start late, the tilling can only begin late and families will fall behind schedule for seeding. Improved early-maturing varieties allow stretching the seed period until early July.

The traditional weeding season starts in late June or early July, when seedlings have achieved 15 to 20 centimeters height. Plots are weeded twice or even three to four times, depending on the soil type and the rainfall pattern. Peasants who plant in rows will perform a weeding with a draught-animal, using a “goose-foot” share, followed by a hand weeding using hoes to pull out remaining weeds. Spraying of herbicides is very uncommon, even though many peasants express the wish to have access to herbicides for facilitating the time- and labor-intensive weeding process.

After the weeding period, peasants will harvest maize plots, take care of their livestock, and repair the granaries. Cowpeas are ready for harvest soon after the last weeding and families will start reaping them and leave them to dry on the field for some days before podding. The main harvest starts from end-October and men and adult boys will sleep in the fields or in small huts near de fields. Children will eventually miss school during harvest period because their workforce is needed on the fields. Crops are harvested using hoes, machetes, pickaxes, small knifes, and baskets and carts for transport. Women usually cut the cobs with small knives from the felled stems and deal with charging the baskets.

Legumes are stored in polypropylene woven bags for later selling and for the next seeding period, or in clay pots for immediate household consumption. As the immediate post-harvest period coincides with the due date of annual school fees, many peasant families immediately sell a part of the peanut harvest. Cereals are always stored in granaries. Many households proceed to selling small parts of the cereal harvest during the year if cash is needed and legumes were already sold.

After the harvest, the stems and twigs are left on the plots, except for smaller stems. These are collected and put on hangars or in trees to dry and serve as fodder for livestock during the upcoming season. Livestock is released to graze on the plots for an extended period. The valuable livestock can eat the fresh crop residues and the soil is fertilized with animal feces directly as well as indirectly through the trampling of livestock on the stems, which allows a faster decomposition of the mulch. The soil is left covered until the new season. Cereal straw residues are often added in the compost ditch. Peanut plants are used as fodder for goats and sheep.

5.2. Different visions of agroecology in Bilanga and the role of social and human capitals

For our study, we adopt elements from a definition by ALTIERI (2011) as a conceptual orientation, saying that agroecology is “*based on the revitalization of small farms which emphasizes diversity, synergy, recycling and integration, and social processes that value community participation and empowerment*” and enlarge it with a further element from ALTIERI and TOLEDO (2011), namely that it should be “*socially just”*.

5.2.1. ARFA's perception of agroecology

ARFA implements agroecology through technical packages including: stone bunds for improving soil fertility and limiting erosion; compost ditches based on livestock feces and vegetal residues for prolonged topsoil fertilization; reforestation on the cultivated plots for improving soil fertility; improved early-maturing varieties for adapting to changing rainfall patterns; livestock breeding for developing compost production; deep planting pits (*Zaï* in the local languages) for land rehabilitation or cultivation on very dry lands; biological control of plant pathogens and biological soil stimulation; irrigated vegetable cultivation for local markets. Since several years, ARFA has also tried to promote organic agriculture, with the aim of introducing a certification seal and creating an income generating activity for farmers, based on cash crops for export.[3]

Some of the techniques, like stone bunds, have already been used by the ancestors in the region. Others, like planting pits, have been used since the ancient times in other regions of Burkina Faso. These traditional techniques are promoted in an improved version by ARFA. Stone bunds are laid along precise intervallic lines, according to previous measurements of the degree of slope in the plot and the direction of water runoff. Bunds are planted with herbaceous plants (*Andropogon gayanaus*) and shrubs. Bigger stones are used for plot contours and smaller stones for the repetitive bunds in the plots, the latter also differing in height according to the slope and intervals chosen. The traditional version of stone bunds doesn't include precise measurements nor planting grasses on the bunds. In the case of the planting pitches, the technique is improved by filling the deep pits with compost and a biological soil stimulation product. This is not the place to discuss the techniques in further detail, but the examples provided should give an idea of the meaning of an improved traditional technique.

Next to new or improved techniques, ARFA also encourages the adoption of field management strategies that should lead to more sustainable farms, able to cope with changing rainfall patterns, growing soil degradation, loss of biodiversity and natural vegetation throughout the region. For example, animal tilling and seeding in rows should allow farmers to have a better margin for timing the seeding in the context of a shifting onset of the rains. Rotation of crops and intercropping should enhance soil fertility strategies as well as help controlling *Striga hermonthica*. Permanent soil cover using the crop residues after harvest should control soil degradation and contribute to the development of soil organic matter.

ARFA uses farmer groups, a classic tool for implementing new technological packages (DELVILLE, 1992). Farmer Field Schools, that are a more participative tool in theory, are also organized to use real-life demonstrations of new techniques and enhance the joint learning process through discussions on experimental comparison plots. These measures should allow peasants to take part actively in experimentations, and enhance farmer-to-farmer knowledge transfer and scaling-up of agroecological practices by "*social processes valuing community involvement*" (ALTIERI and TOLEDO, 2011).

Along with these more cognitive support actions, ARFA also equips farmers with tools at subsidized prices and provides material like cement for stabilizing compost pits. Bigger infrastructure like impluviums (closed rain water tank) for households or small biogas plants for electricity generation on the household compound are part of the program but need important financial self-investment from the household.

5.2.2. Peasant's perception of agroecology

When asked, most peasants know the term agroecology, either only by hear-say or with a specific idea of the meaning. Some have never heard of agroecology, which implies that they do not know what hides behind this term. However, there is no clear difference in the adoption degree of agroecological practices between these two groups, meaning that

[3] For the moment, only sesame is marketed as an organic cash crop by ARFA. ARFA plays an intermediary role between sesame producers and potential buyers (one being for example the drugstore chain *Yves Rocher*)

farmers who do not know the term of agroecology may also have adopted practices promoted by ARFA.

The expression of farmers that agroecology is "*everything that protects the farmer's fields*", or "*everything that reinforces a farm*", summarizes quite well the prevailing perception of agroecology as a set of practices, techniques and (external) inputs. This set, seen through the farmers' eyes, can be summarized as follows: Improved version of stone bunds; compost ditches based on livestock feces and vegetal residues; planting trees in the fields; using planting pits (Zaï); mixing traditional (late-maturing) varieties with so-called "biological" varieties (local expression for the improved early-maturing varieties promoted by ARFA); animal tilling; seeding in rows; using mineral fertilizers and chemical pesticides; being able to enlarge livestock breeding (for "*producing much compost*" and generating an income in times of need); participating in irrigated vegetable cultivation (income generating activity), and, on a more aggregate level, "*gaining big(ger) yields*".[4] Generally, many farmers associate agroecology with practices that the ancestors didn't know.

Conventional wisdom among peasants is that "*big farmers*" or "*prosperous farmers*"[5] are the ones that adopted "*much*" agroecology. At the same time, there is a consensus that "*almost every farmer in the region has adopted agroecological practices*", at least to some extent, because soil degradation makes the practices a precondition for gaining yields that permit a certain degree of food security. Without these techniques, first of all stone bounds and compost ditches, peasant families would "*end up begging for food*".

Peasants do not establish a link between agroecology and more sustainable agriculture in the sense of reducing or avoiding the use of mineral fertilizer or chemical pesticides. While some peasants are aware of potential adverse affects of chemical inputs, the choice for a management technique or an external input follows a different rationality, sometimes long-sighted (as it is the case for the preference of compost over mineral fertilizers, the latter allowing for improved soil fertility for one season at most, whereas compost allows improving soil fertility for 2 or more seasons, depending on the soil type and condition), sometimes short-sighted (as it is the case if a farmer can afford bigger quantities of mineral fertilizer or chemical pesticides and then uses these products to ease farm operations that would otherwise need longer and physically harder labor). Farmers' perceptions on agroecology illustrate the different directions of a transition to agroecology if started from "conventional agriculture" in the "North" or "conventional agriculture" in the "South", to put it plainly. For farmers in Bilanga, agroecology means a "*modernization*" and "*mechanization*" of their farms, no matter by what means, whereas in regions where agriculture is highly input-dependent, it rather means a "step-back" to less (or different) modernization and mechanization.

While these perceptions are related to agricultural practices, a second aspect in the peasant's point of view is of equal importance. The listed practices are strongly associated with training. According to the dominant opinion, "*agroecology doesn't help*" if the know-how on how to implement a technique hasn't been acquired first-hand in farmer groups or farmer field schools. This link to social and human capital appears very strongly in peasants' statements. Farmers, who adopt practices by imitating what they see on other farmers' fields without following specific training, are not regarded as having really improved their farm management by those who were able to participate in training workshops. For example, the technique of stone bounds is only labeled as being "agroecological" if the technique is adopted in the improved version. Farmers who haven't been able to participate in training sessions wouldn't know with what intervals to lay the stones or even lay out stone rows parallel to the direction of the water run-off. These alleged differences between trained and untrained peasants generally withstand objective field observations, with the limitation that there are also different degrees of efficient or correct adoption among farmers who did get training.

[4] According to the statements, farmers who "*adopted agroecology a lot*" gain bigger yields.
[5] The terms should translate the idea of "*gros paysan*" in French, word often used across West Africa to designate more prosperous farmers (relative to others in the region!)

As a consequence of their perception of agroecology, farmers associate the adoption very strongly with the assistance by development organizations (foremost ARFA and, to a far lesser extent, governmental agricultural extension workers).

5.2.3. The adoption of new practices and the role of social and human capital

The association of agroecology with assistance of development practitioners is also reflected by the fact that the vast majority of the farmers in the study region, who adopted agroecological practices as defined by ARFA and themselves are members of ARFA farmer groups, where they receive training on new practices.

The lack of human capital in the form of knowledge and know-how but also in the form of general education and alphabetization is a major barrier for adopting new agricultural practices. Most peasants try to find ways to improve their farm and fields but they are dependent on external guidance because they haven't been "*educated*" or "*instructed*"; they are not "*intelligent on their own*". The wish to receive (more) training and improve field work is omnipresent and really tangible among the interviewed, as is the acknowledgement of already acquired skills. Discussions reveal that the adoption of agroecological practices strongly impact on human capital in the form of knowledge and know-how, with human and social capitals reinforcing each other. As agroecology is "*highly knowledge-intensive*" (ALTIERI and TOLEDO 2011), a trained peasant enhanced his know-how considerably and will further develop it by sharing his experience of field adoption with other peasants in the farmer group. A farmer who adopts practices rigorously can become an example for other farmers of the region and beyond. His farm and fields can serve as a best practice example for ARFA workshops. He will enlarge his network through getting in contact with many other farmers who may recurrently ask for his advice. He can also tie relations to non-governmental organizations' leaders and workers, as well as political authorities if these are open to agroecological innovation. ARFA agricultural technicians will choose this farmer for in-depth training. In this sense, the adoption of agroecology strongly impacts on empowerment (capacity to decide and act) and networks of farmers who are chosen as mediators and leaders. Farmers who are not in this privileged situation surely benefit from weaker impacts on their social capital stock.

Without belonging to a farmer group, it is also difficult for peasants to access information on ongoing projects or workshops. Access to the farmer groups is organized and defined by social norms. Farmers who do not belong to a group indicate access obstacles as the major hindrance, followed by the general ignorance of the existence of groups, due to non-information ("*Nobody informs us*"). Access obstacles are threefold. First, traditionally, farms are rather dispersed in the region, leading to strong family bonds and little contact with other farmer households during everyday life. This is a hindrance to group formation and information access, but also a situation that hinders farmers to approach others on their own initiative, particularly if those "others" are already organized in a formal structure, emitting a certain closeness or exclusivity. Second, during initial group creations, meetings are organized where everyone in the village can attend and express his interest for joining. Extension workers from ARFA headquarters along with local leader farmers choose initial members on the grounds of their competence. Farmers that are regarded as "*competent*" are thus chosen over others, even if the latter compose the majority. "*Competen*t" farmers are willing to invest themselves in group work even if they have no immediate benefits. "*Incompetent*" farmers are more skeptical and adopt a wait-and-see strategy. They are reluctant to invest themselves if they do not **understand** how it will benefit them. Competent farmers are often the ones with better education and better networks, their nomination potentially leading to social exclusion. Third, nepotistic structures are common. Group access is easier for peasants who have a family member in the group already: "*He will choose his brother, that's normal, isn't it*?" In a similar manner, it should also be noted that groups are often gender divided, with male groups dominating. Some mixed groups exist though as well as some women groups. To some degree, these obstacles also apply for inner hierarchy formation, with seniority being a key factor.

Some peasants add a further element for group engagement. They explain that they won't engage in a group if they do not see a clear advantage for their own farm management. This aspect is also mentioned by farmers who are already members of a group. They say that those farmers who are not yet member of a group are not willing to invest their energy, time and means without seeing a concrete advantage in the short term, or even prior to joining. However, many farmers who do not belong to a group are very well aware of the advantages, expressing that "*they are offered ploughs and carts and other tools also, like pickaxes or manure forks, everything, even wheelbarrows"* and "*they receive much training and then they can do this in their fields too and that will help them a lot*". They simply are not able to access a group, for one of the reasons pre-exposed.

Besides ARFA groups, there were no others mentioned by farmers, even when explicitly asked. As a matter of fact, farmers do not organize without an NGO or other donor actor acting as driving force, for the same reasons that block the adoption of innovation, as well as lack of financial means ("*We, we do not have the monies*"). The development actor that guides the agroecological transition thus provides social capital in the form of groups and social organization.

5.2.4. Critical discussion of agroecology in Bilanga

As explained in chapter 2, scientists differentiate between the concepts of agroecology and different forms of alternative agriculture. However, on a practical level, it seems that development technicians mix up concepts to "design agroecology". This situation is enhanced by the lack of a clear definition of agroecology which widely opens doors for subjective definitions and possibly even abuse to attract funding possibilities in a context where agroecology has become synonym with sustainable, "ethically sourced" agriculture, favoring the situation of smallholders.

As most techniques promoted by ARFA are either traditionally-based or low in external inputs while favoring on-farm recycling processes and locally available resources, they could be defined as agroecological. However, some components seem to be less in accordance with the agroecological philosophy.

Contrary to vegetable cultivation for the local markets, organic cash crops as promoted by ARFA create dependency on foreign markets with the underlying volatility (ROSSET and ALTIERI, 1997). A similar constraint can be noted in the promotion of biological soil stimulation and biological control of plant pathogens based on products from *Trichoderma* spp. and different other natural components like Neem seed oil or powder, and plant extracts (pepper, mustard, garlic and onion). While these products are developed in an ARFA laboratory[6], they have to be purchased by peasants after being actively promoted in farmer field schools. This surely is a top-down propagation of external inputs, whose utilization is restricted to farmers who can afford to buy the products. To some extent, this also applies to reforestation because farmers are dependent on nurseries; ARFA or leader peasants acting as intermediary for providing plants to farmers. There is also a difference between native species and the species used for reforestation. For example, the Nimtree (*Azadirachta Indica*) is widely promoted for reforestation because of its fertilizing properties. Peasants appreciate local varieties and biodiversity for replanting their fields, not least because the fruits of the native trees are important elements in households' nutrition.

Access to seeds for improved early-maturing varieties of the predominant crops is limited to farmers in ARFA groups. Other peasants state that they would need an informant on where to purchase these seeds; they are not sold on the local market.

The promoted agroecological practices require a certain stock of equipment (thus physical capital), like plows for tillage or carts and wheelbarrows for transporting stones or compost, just to name a few. While a farmer's tool inventory may be enlarged through access to equipment at a subsidized prize, access is limited to peasants who can afford the self-

[6] in corporation with the firm Biophytech in Montpellier (France) leading to an Economic Interest Grouping called Bioprotect

investment (financial capital). In consequence, the adoption of an agroecological practice (or efficiency of the adoption) is dependent on a peasant's ability to afford already subsidized material, this ability in turn being restricted to group belonging (social capital). This latter aspect is essential: if access to transfer of knowledge and material is restricted to farmers who are members of an ARFA farmer group to a large extent, is it then socially just?

There is also a legitimate question regarding the durability of a transition to agroecology if it is limited to the transfer of practical knowledge and material and doesn't include a larger perspective of agroecology. At this point one can see a loop back to the question if agroecology is just another paradigm for attracting donor funding. Even if it is well designed, as we think is the case for ARFA's agroecological practices, agroecology cannot always be the same "on the ground" than in theory. If it is implemented through development practitioners who are dependent on funding and face obligations towards both donors and the beneficiary population, realities of the different actors may not "match".

Today, the farming production systems identified in Bilanga-Yanga are largely based on agroecological practices. However, there are differences in the level of adoption of the practices promoted by ARFA, which are only partially related to differences in production systems, meaning that different levels of adoption can be found in every farming production system. Financial means and farm equipment are deciding factors for the adoption of agroecological practices. These deciding factors in turn depend on social and human capital.

There remains some controversy about the meeting of agroecological standards of some of the practices promoted by ARFA. In addition, the transfer of practices doesn't go hand in hand with the introduction of broader food sovereignty and empowerment structures.

In sum, agroecology in the region could be defined as a compendium of skills and land management techniques on which every peasant draws upon more or less intensively, foremost blocked by his know-how and access to social organization. Social and human capitals are a precondition for engaging in the adoption of improved agroecological practices, and, vice versa, the adoption enhances social and human capital, creating a "*vital feedback loop*" (PRETTY 1999).

6. General conclusion

The combined framework including concepts of the francophone *Agriculture Comparée* approach and the anglo-saxon Sustainable Livelihoods approach, allowed us to see that the adoption of agroecological practices is not majorly a question of differences between production systems but differs in different degrees depending mainly on social and human capital across all production systems in Bilanga. The combined framework thus allowed for first the identification of the different production systems and second, understanding that the adoption relies on factors both outside (group belonging and access to knowledge) and inside (financial means and equipment stock) the production system, the latter being however strongly dependent on the former. The analysis of social and human capitals revealed an enhancement for peasants already belonging to farmer groups. Based on the field discussions, we realized that agroecology has not always the same meaning for a peasant than for an agricultural development practitioner or a scientist.

We found that ARFA successfully uses farmer groups and farmer field schools for transferring knowledge, know-how and material as well as external inputs to some extent, but doesn't fully exploit this form of social organization for making the implementation more participatory and bottom-up for community empowerment. On the other hand, it seems that it is not always evident to use farmers' knowledge as a basis. Many peasants express their "inability" to improve their farm and fields without strong external guidance. While human capital in the form of knowledge can be generated at low financial cost, it is not available in abundance prior to training; a clear indicator that agroecological practices, even if they are based on traditional knowledge, introduce new, innovative techniques, and can be understood as a transfer of innovation. A major obstacle to the dissemination of agroecological practices is that peasants who are not members of an ARFA farmer group

have poor access to training whilst farmer-to-farmer diffusion outside farmer groups remains low. In addition, some of the ARFA project components fail to meet agroecological criteria in terms of empowerment and resilience to the vulnerability context. Consequently, we cannot speak of a transition to agroecology in its larger sense.

We should also bear in mind the dependency of peasants on external development actors: the adoption of new agricultural practices enhances the productivity on the farm but it is mainly generated through externally provided social and human capitals, meaning a dependency from transforming structures and processes. However, it remains to be seen how the acquired social and human capital base will enable peasants to challenge these same structures.

On a more global level, agricultural systems based on agroecology have long since found their way into the development discourse. And perhaps the global development context, putting sustainability in the focus of attention[7] has never been more favorable to agroecology. But there is a danger that agroecology is abused as a flagship and doesn't lead to a transition to an agroecological system on the long-term, but only enhances the livelihoods of part of the peasant population, based on the transfer of innovative agricultural practices.

[7] Expressed trough the Sustainable Development Goals for example

Bibliography

ADATO Michelle and MEINZEN-DICK Ruth Suseela (2002): Assessing the impact of agricultural research on poverty using the sustainable livelihoods framework. *EPTD discussion papers 89*, International Food Policy Research Institute (IFPRI)

ALTIERI Miguel A. et al. (2011): Agroecologically efficient agricultural systems for smallholder farmers: contributions to food security. *Agronomy For Sustainable Development* 32:1-13

ALTIERI Miguel A. and NICHOLLS Clara I. (2005): Agroecology and the Search for a Truly Sustainable Agriculture. United Nations Environment Programme, *Basic Textbooks for Environmental Training*

ALTIERI Miguel A. and TOLEDO Victor Manuel (2011): The agroecological revolution in Latin America: rescuing nature, ensuring food sovereignty and empowering peasants. *Journal of Peasant Studies* 38(3): 587-612

AMEKAWA Yuichiro (2010): Delineating the Multifunctional Role of Agroecological Practices: Toward Sustainable Livelihoods for Smallholder Farmers in Developing Countries. *Journal of Sustainable Agriculture* 34:202-228

ASHLEY Caroline and HUSSEIN Karim (2000): Developing Methodologies for Livelihood Impact Assessment: Experience of the African Wildlife Foundation in East Africa. *Working Paper 129*, Overseas Development Institute, Chameleon Press, London

BEBBINGTON, Anthony (1999): Capitals and Capabilities: A Framework for Analyzing Peasant Viability, Rural livelihoods and Poverty. *World Development*, 27(12):2021-2044

BENNETT Mica and FRANZEL Steven (2013): Can organic and resource-conserving agriculture improve livelihoods? A synthesis *International Journal of Agricultural Sustainability*, 11(3):193-215

BEUS, Curtis E. And DUNLAP Riley E. (1990): Conventional versus Alternative Agriculture: The Paradigmatic Roots of the Debate*. Rural Sociology*, 55(4):590-616

BOND and MUKHERJEE (2002) Livelihood asset status tracking: an impact monitoring tool? *Journal of International Development* 14(6):805-815

CAMPBELL, B., J. A. SAYER, P. FROST, S. VERMEULEN, M. RUIZ PÉREZ, A. CUNNINGHAM, and R. PRABHU (2001): Assessing the performance of natural resource systems. *Conservation Ecology* 5(2):22

CARPENTER D. and MCGILLIVRAY M. (2012): A methodology for assessing the poverty-reducing impacts of Australia's international agricultural research. *ACIAR Impact Assessment Series Report No. 78*. Australian Centre for International Agricultural Research, Canberra

CHAMBERS Robert and CONWAY Gordon (1991): Sustainable rural livelihoods: practical concepts for the 21st century. *IDS Working Paper 296*

COCHET Hubert (2011) : *L'agriculture comparée*. Éditions Quae, Versailles Cedex, France

COSTANZA, Robert et al. (1997): The value of the world's ecosystem services and natural capital. *Nature* 387:253-260

DALGAARD, T., HUTCHINGS, N.J., PORTER, J.R. (2003): Agroecology, Scaling-up and Interdisciplinarity. *Agriculture, Ecosystems and Environment* 100:39-51

DAS, Nimai (2012): Impact of Participatory Forest Program on Sustainable Rural Livelihoods: Lessons from an Indian Province *Applied Economic Perspectives and Policy* 34(3):428-453

DE HAAN Leo J. and ZOOMERS Annelies (2005): Exploring the Frontier of Livelihood Research. *Development and Change* 36(1):27- 47

DE SCHUTTER, Oliver (2011): Agroecology and the Right to Food. Report presented at the 16th Session of the United Nations Human Rights Council [A/HRC/16/49], 8 March 2011

DELVILLE LAVIGNE; Philippe (1992): Groupements villageois et processus de transition. *Cahiers des Sciences Humaines* 28(2) :327-343

ELLIS Frank (2000): *Rural Livelihoods and Diversity in Developing Countries*. Oxford University Press, pp.292

ELLIS, Frank and BAHIIGWA, Godfrey (2003): Livelihoods and Rural Poverty Reduction in Uganda. *World Development* 31(6):997-1013

FERNANDES Lúcio André and WOODHOUSE Philip J. (2008): Family farm sustainability in southern Brazil: An application of agri-environmental indicators. *Ecological Economics* 66:243-257

GASTELLU, J-M (1987): Présentation. *Cahiers ORSTOM de Science Humaines* 23(3-4):343-351 In: SAUL, Mahir (1991): Farm production in Baré, Burkina Faso: The technical and cultural framework for diversity. In: DUPRÉ, Georges et al. (1991): *Savoirs paysans et développement (Farming knowledge and development)*, Éditions KARTHALA et ORSTOM, Paris, pp.524

GLIESSMAN Stephen (2005): *Agroecology: The Ecology of Sustainable Food Systems*, second edition, CRC Press, Florida, pp.408

GRIFFON, Michel (2013): *Qu'est-ce que l'agriculture écologiquement intensive ?* Éditions Quae, Versailles Cedex, France

HAGBERG, Sten (2008): *Poverty in Burkina Faso. Representations and Realities*. Uppsala-Leuven Research in Cultural Anthropology (ULRiCA)

HOLT-GIMÉNEZ, Eric (2002): Measuring farmers' agroecological resistance after Hurricane Mitch in Nicaragua: a case study in participatory, sustainable land management impact monitoring. *Agriculture, Ecosystems & Environment* 93(1-3):87-105

IIZAC A-M.N. and SWIFT M.J. (1994): On agricultural sustainability and its measurement in small-scale farming in sub-Saharan Africa. *Ecological Economics* 11:105-125

JAGGER, Pamela et al. (2012): Asking questions to understand rural livelihoods: Comparing disaggregated vs. aggregated approaches to household livelihood questionnaires. *World Development*, 40(9):1810-1823

MAZOYER and ROUDART (2002): *Histoire des Agricultures du Monde. Du néolithique à la crise contemporaine.* Éditions du Seuil, Paris

MAZZUCATO Valentina and NIEMEIJER David (2000): The Cultural Economy of Soil and Water Conservation: Market Principles and Social Networks in Eastern Burkina Faso. *Development and Change* 31:831-855

MÉNDEZ, Ernesto V. et al. (2013): Agroecology as a Transdisciplinary, Participatory, and Action-Oriented Approach. *Agroecology and Sustainable Food Systems* 37(1):3-18

PRETTY, Jules (1999): Can Sustainable Agriculture Feed Africa? New Evidence on Progress, Processes and Impacts*. Environment, Development and Sustainability* 1:253-274

PRETTY, Jules (2007): Sustainable Agriculture and Food Systems. In: PRETTY Jules et al. (eds.): *The SAGE Handbook of Environment and Society* (2007:457-470), SAGE Publications, Los Angeles, London, New Delhi, Singapore

PRETTY, Jules et al. (2011): Sustainable Intensification in African Agriculture. *International Journal of Agricultural Sustainability* 9(1):5-24

REBOUL Claude (1976) : Mode de production et système de culture et d'élevage. *Économie Rurale* 112:55-65

ROSSET, P. M., and MARTÍNEZ-TORRES M. E. (2012): Rural social movements and agroecology: context, theory, and process. *Ecology and Society* 17(3):17

ROSSET, P.M. and ALTIERI, M.A. (1997): Agroecology versus input substitution: a fundamental contradiction of sustainable agriculture. *Society and Natural Resources* 10(3):283-295

SAUL, Mahir (1991): Farm production in Baré, Burkina Faso: The technical and cultural framework for diversity. In: DUPRÉ, Georges et al. (1991): Savoirs paysans et développement (Farming knowledge and development), Éditions KARTHALA et ORSTOM, Paris, pp. 524, p. 301-329

SCOONES Ian (1998): Sustainable Rural Livelihoods: A Framework for Analysis. *IDS Working Paper 72*, IDS Brighton

SCOONES Ian (2009): Livelihoods perspectives and rural development. *Journal of Peasant Studies* 36:171-196

SÉBILLOTTE Michel (1976): Jachère, système de culture, système de production: méthodologie d'étude*. Actes des Journées d'études Agronomie-Sciences Humaines*

STASSART Pierre M., BARET Philippe V., GRÉGOIRE Jean-Claude, HANCE Thierry, MORMONT Marc, REHEUL Dirk, STILMANT Didier, VANLOQUEREN Gaëtan, VISSER Marjolein : L'agroécologie : trajectoire et potentiel. Pour une transition vers des systèmes alimentaires durables, In : VAN DAM Denise, STREITH Michel, NIZET Jean, STASSART Pierre M. (2012) : *Agroécologie. Entre pratiques et sciences sociales*. Educagri éditions, Dijon, France

VAN DER PLOEG Jan Douwe (2009): *The New Peasantries: Struggles for Autonomy and Sustainability in an Era of Empire and Globalization*, Routledge

VAN DIJK Tara (2011): Livelihoods, capitals and livelihood trajectories: a more sociological conceptualisation. *Progress in Development Studies* 11(2):101-117

WEZEL, Alexander et al. (2009): Agroecology as a science, a movement and a practice. A review. *Agronomy for Sustainable Development*, INRA, EDP Sciences