Use of relevant economical indicators for the evaluation of farming systems in terms of resilience, vulnerability and sustainability: the case of the Lake Alaotra region in Madagascar

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Résumé

Le projet Observatoire des Agricultures du Monde (OAM) vise à construire un observatoire mondial permettant de donner des informations sur les agricultures des différents pays ainsi que sur leurs évolutions. Madagascar est un des 5 pays pilots choisis. La zone d'étude qui a été retenue est le lac Alaotra. L'étude des notions de vulnérabilité, résilience, durabilité et viabilité a guidé le choix, le calcul et l'analyse des indicateurs nécessaires à la construction de l'observatoire. Trois bases de données différentes ont été retenues dans le cadre de cette étude : i) les bases de données du Réseau des Observatoires Ruraux (ROR), ii) La base de données du diagnostic agraire BV-Lac de 2007 avec 100 fermes (Durand, Nave & Penot) et iii) la base de données du Réseau de Ferme de Référence (RFR) avec 48 fermes. Cette communication présente une partie des résultats issus de la modélisation sur les deux dernières bases de données du projet BVlac en montrant les indicateurs utilisés pour l'exemple d'un changement technique avec l'adoption de l'agriculture de conservation.

Mots clé : observatoire mondial, informations, Madagascar, vulnérabilité, résilience, durabilité, viabilité , indicateurs

Summary

The project Observatory for World Agricultures wants to elaborate a worldwide observatory collecting information on agriculture in different countries and its evolution. At the moment five countries have been chosen as countries of reference, Madagascar is one of them. The geographical area of the study which has been chosen is the lake Alaotra. The study of the notions of vulnerability, resilience, durability and viability has been the main point concerning the choice, the calculation and the analysis of the necessary indicators leading to the elaboration of the observatory. Three different data lines have been chosen : i) The database from the ROR, ii) The database from RFR and iii) The database from the agricultural diagnosis Bv-Lac (Durand, Nave & Penot). This paper presents some results with farming systems modeling using the two databases from the BVlac development project showing the indicators used through the example of a technical change with adoption of conservation agriculture.

Key words : world observatory, information, Madagascar, vulnerability, resilience, durability, viability, indicators

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Introduction

Recent food crises, persistent pressure on agricultural commodity markets and concerns about land appropriation in southern countries place agriculture at the heart of public policy concerns. In Madagascar, as in many developing countries, agriculture remains the foundation of rural society. Agriculture is undergoing profound changes and has to face many challenges. Reducing rural poverty necessarily involves agricultural productivity improvement, crop diversification and activities, a better market access, while preserving natural resources. The main issues relate to the vulnerability and resilience of “activity systems” (a livelihood+ a farm): what will be farmers‘ strategies to prevent or to respond to a shock? Which households are most vulnerable? What are the strategies that increase farm’s resilience? What are the characteristics of different types of agriculture, their dynamics and their impacts in terms of sustainable development? This study focuses on an example using socio-economic indicators of sustainability, vulnerability, resilience and sustainability to implement the calculation of these indicators on 2 farms databases from the “Bvlac” development project (2007 farming system diagnosis and 2010 Farming System Reference Monitoring Network, FSRMN).

Lake Alaotra is located in the province of Toamasina, northeast of the capital Antananarivo at 750 m above sea level It is a vast flatland surrounded by hills (*tanety)* between 750 and 1500m above sea level, characterized by a quite aggressive erosion process (*lavaka ..)* It is now a major rice-growing area with over 110,000 hectares of rice fields from which 30 000 ha are irrigated with the rest in traditional perimeter without complete water control. It can be considered as a " slow pioneer front” (Garin and Penot, 2011) with a high population pressure on *tanety* and upland soils leading to erosion and silting of irrigation schemes. Since the disengagement of the State in 1991, maintenance of irrigation networks becomes more difficult. The 2000’s are characterized by the revival of local development projects along them the project BV-Lake is the most important. It focuses since 2003 on watershed protection, land certification, diffusion of conservation agriculture, livestock improvement and farmers capacity building.

1 A focus on risks with upland agriculture and farming systems’ résilience

In agriculture, the scientific community search for methods and tools to assess farm sustainability and resilience in a context of global uncertainty. Sustainable agriculture is composed of productive and commercial functions but as well environmental and social which are not “merchant”. Rural societies are deeply affected by changes in agricultural policies, trade globalization, privatization of services and sectors and demographic pressure. Farmers make their choices in this changing environment, without complete knowledge on further consequences. They try to improve their livelihoods and escape poverty through production intensification (when inputs prices do allow it), diversifying products, or looking for off-farm activities. The Lake Alaotra region is rich in information and results of various

studies or surveys. (Farming System References Monitoring Network/FSRMN, plots and farms databases, livelihood Monitoring Network ...).
The selected indicators identified as relevant should reflect the issue centered on the various forms of farming, on viability, sustainability, vulnerability and resilience of agricultural activity. The central hypothesis is that the way agricultural activities are organized affects renewable resources, environment with social and economic dimensions. The selected indicators will be used to understand the strategies of households and their contribution to sustainability. These indicators concern the 'system activity "(Chia, 2005) defines as a farm + an household as, indeed, in many situations, off-farm incomes directly contribute to the sustainability. This approach is consistent with the conventions adopted by the FAO which defines several farm categories according to the share of agricultural income in total income.
Once the concepts of vulnerability / resilience have been defined, selected indicators should reflect the evolution of agriculture in time and structure. Indicators are tools for monitoring, evaluation, forecasting and decision support (both at farmers and project level). The main quality of an indicator is its ability to report concisely complex phenomena. They are defined with reference to goals or issues previously determined by actors. These indicators should be consistent with those defined at international level for comparability, but also in order to potentially extrapolate results to larger groups. They should be selected to identify relevant sustainable development issues at regional or local scale. Monitoring indicators are used to describe the links between the nature of farms (family, entrepreneurial ...) and their characteristics in terms of vulnerability and sustainability.

2 Méthodology

Data are provides from two databases (BV-Lake project). The first farm database concerns the diagnostic 2007 survey (Durand, Nave & Penot, 2007) on 110 farms, used as a basic tool for the creation of a farm typology and the FSRMN. It serves as a reference for project operators to measure the impacts of current actions and innovation processes. The second database is the FSRMN (Penot 2008) which is a set of representative farms of different farming situations, monitored each year to measure the impact of innovations and farm trajectories. The results also allow prospective analysis to test new scenarios. The comparison between the potential scenarios and reality at the end of each year improve project decisions on extension.
The FSRMN provides relevant information on the following points: i) gross or net margins / ha, labor productivity, income distribution between activities and different strategies, ii) adjust project recommendations to real trends and farmers possibilities (technical advise, credit, annual work planning….), iii) provide basic information such as cost for different level of intensification for members of farmers' organizations (FOs) to improve ability to negotiate commercially with traders, iv) also allows a better understanding of global impact on farms' trajectories, v) anticipate problems (marketing, access to inputs ....) and vi) better estimate the possible degrees of empowerment of actors (producers and OP) based on economic performance actually observed.

3 The relevant concepts

Viability is the main concept used to structure the development of indicators (Loyat, 2008). It is used to measure the performance of different forms of agriculture. Viability in its raw definition is the ability of territories or any entity to survive. It can be completed as the character to survive, last and grow. (Little Robert, 2001). Farm viability implies to survive in the long run. There are different ways to measure viability: i) the ability of a system to experience some disruptions while maintaining vital functions and control capabilities through the concept of resilience, ii) a measure of the potential for viability sustainability trough the economic, environmental, social and institutional sustainability. We favor the study of "vulnerability" (possibly permanent state) and the farm resilience (capacity, and therefore a non-permanent). "We will use the term "sustainability" to describe the trade-off between viability and resilience.

The term sustainability is used since the 1990s to describe the configuration of a human society that is perennial. Such human organization is based on maintaining a sustainable environment and both an economic development through an equitable social organization. It takes into account the social aspect through the challenge against poverty, against inequality and social exclusion. In 1987 the Brundtland Report defined sustainable development as the goal of development compatible with the needs of future generations: it is then defined as "a development that meets present needs without compromising the ability of future generations of meet their own needs. For Landais 1997 agriculture is sustainable if it is environmentally sound: it must preserve the quality of natural resources and improve the dynamics of the entire agro-system.

There are many definitions to define vulnerability. It can be described as a function of reduced risk and threat of adaptive farmers' responses to issues. In a pragmatic perspective, vulnerability and sustainability can be seen as two sides of the same coin (Winograd 2006). The notion of resilience is often associated with vulnerability yet these two concepts are quite different: i) the resilience has its origins in the theory of psychological and human development (Lallau, 2011). This word generally describes the ability of the individual to face a difficulty or a major stress There are two relevant definitions of resilience according to Guderson & Holing (2002) (Gunderson 2002): i) The first is a "traditional" resilience that determines the level of vulnerability of a system subjected to random disturbances (ie not - expected) that exceed the control capacity of the system to failure. It is based on the options of stability, resistance to disturbance and speed of return to equilibrium. These authors define it as "engineering resilience"; and ii) the second definition considers resilience as the ability of a system to experience some disruptions while maintaining vital functions and control capabilities. The ability to resist a system maintaining the bulk of its structure and its operation prevails while including the possibility of change, both in structure and in terms of the functioning of when it works. This vision seems more practical for living systems or humans when determinism is much less predictable. Conway (1987), finally, defines sustainability as the ability of an agro-eco-system to maintain productivity when subject to major disruptive events, of any kind. It introduces the concept of resilience.

What are the connections between concepts and indicators? Vulnerability reflects the external pressures to which individuals are subjected. However, they are not deprived of any ability to respond, as outlined in the concept of resilience. To analyze the vulnerability is not only identify the overall risk for each individual household or in a place and at a given time, but also their responsiveness and resilience, that is to say the overall capacity reaction to implement all the options available to them to resist the negative effects of shock and recover. Indeed, although constrained by a wide variety of risks, individuals act on their environment and their living conditions through preventive and offensive strategies. The three factors used to study the vulnerability and resilience: i) The risk exposure / risk description, ii) the ability to withstand shocks and coping strategies and iii) the dynamic effect of shocks

The risk is linked with action that leads to a specific set of possible outcomes whose value is known, each result being paired with a specific probability. The risk at the macro level, according to orthodox economic theory, is that of expected utility, strongly challenged in the 1990s. The risk at the micro and meso economic level appears to be a major factor to consider and resilience of production systems will be dependent on the ability to identify and manage risks of all kinds, especially the risk of crops, climate risks, economic risks (related to price volatility) and ecological risk long neglected in favor of an immediate return .The risk is as much important as prices in agricultural activity. If it seems clear that price volatility has only a very small influence on the overall level of production in a country, the impact on the farm can be much larger and jeopardize the reproduction of system when prices are too low or too volatil. The two most important identified risks remain i) the risk that climate plays on cultural practices linked with the level of intensification and ii) the economic risk (price volatility, speculation strategy ...).

4 Identification and use of indicators

The FSRMN is a network of 13 reference farms in 2010 (48 in 2009). The objective of prospective analysis with scenarios is to understand, by all extension operators, the ins and outs of CA technologies proposed by the project (CA crop performance, intensification, credit etc..). The scenarios assess the impact of any technical choices on the production system (labor, economic performance, capital required etc..) and resilience of the new system. (Cottet, 2010). The building of these scenarios involves two steps: i) the first step is to adopt a new technology and compare with and without the selected technology and ii) The second step is to generate hazards in order to test the consequences of any technical choices on farm structure and resilience (Penot and Deheuvels, 2007). The risk of adoption can be therefore assessed (Cauvy & Penot, 2009).

There are indicators in Olympe that are already existing according to classical economic convention, also present in the list of indicators used by OAM, Bosc and Le Cotty, 2009):

- Gross, Gross Margin and Operating Expenses
- Net margin for agricultural activities (equivalent to net farm income)
- Return to labour
- ratio of intensification and retun to capital
- Total Net Income (net farm income + off-farm income)
- Cash Balance (after all expenses including that of family)
- Debt ratio and proportion of off-farm income in total

We can therefore estimate the impact of any hazard (climatic, economic, social, familial, etc ..) and predict the effects of any shock on a given new situation with technologu adoption.

5 Hypotheses and results

Some hypotheses are tested: i) the different forms of organization for farming do explain their level of viability? ii) Diversification strategy can be multiple, iii) households available capital might condition their vulnerability and resilience; iv) households that cannot subscribe to formal insurance mechanisms use other forms of insurance to limit risks, v) households do not all have the ability to turn an income increase into rising living standards in the long run, vi) the degree of risk determines the investment farmers are willing to do in a given cropping system. Farmers' strategies depends on real risk assessment, vii) there is less interest in investing in a plot in sharecropping, viii) some factors may reduce the poverty and vulnerability of households, ix) a good nutritional status of family workers can increase the resilience and x) according to their level of risk aversion, some farmers prefer to make extensive agriculture rather than intensive ones with a potential better income.

An exemple to illustrate the approach

We take the example of a given farm codified M901: a traditional farming system of Lake Alaotra. Rotation is based on peanut/cassava/fallow. Land is rented for three years. Therfore, there is no investment on this land in this area, no or few weeding and seeks to maximize its returns. The farmer is interested in CA. Several possible farm trajectories according to CA technology adoption will be tested in order to identify the "best bet" alternative and le lower risk for change.

- **1st trajectory: 1** hectare of traditional crops is replaced by a classical mais/dolic-rice CA system ("classic" in red on the figure)
- **2nd trajectory : 1** hectare of traditional crops is replaced by a mais associated with cowpeas/dolic-rice CA system ("optimal" in green on the figure)

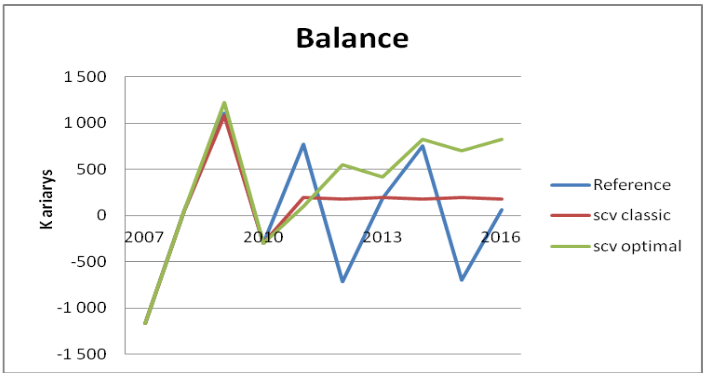

Figure 1 : Farm balance before the shock

The first trajectory create stability with far more stable cash balances. The increasinf cumulated cash banalnce inrove its investment capabilities. The second trajectory increases the global effect and the net income and was considered by farmers as optimal before 2008.

1er shock : increase of fertiliser price

The majority of operators adopted from 2003 to 2008 the second pattern (in green). However from 2008, following the doubling of fertilizer prices, farmers moves to a low input CA system and eliminated fertilizers. We may question if such choice is justified and whether the return to the initial situation is the best choice for operators.

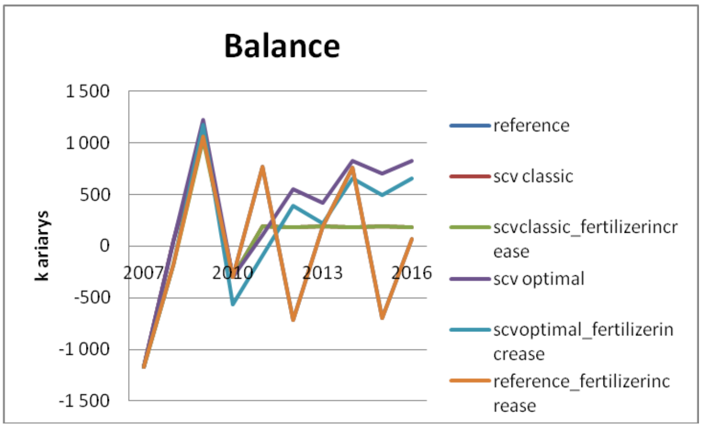

Figure 2 : Farm balance after the shock: fertilizer price increase of 50 %

This chart displays the impact of the shock due to an increase in fertilizer prices of 50%. Despite that, the "intensification" trajectory remains the most interesting. The optimal CA system is in fact more resilient than the classical CA one. These scenarios results are challenging the "extensive" strategies effectively chosen by farmers since 2008 as risk ins considered as far more increased with fertilizers (in particular if credit is required). Farmers 'choices, however, can be justified by fear of credit failure and interruption of fertilizers availability (a realty in 2001).

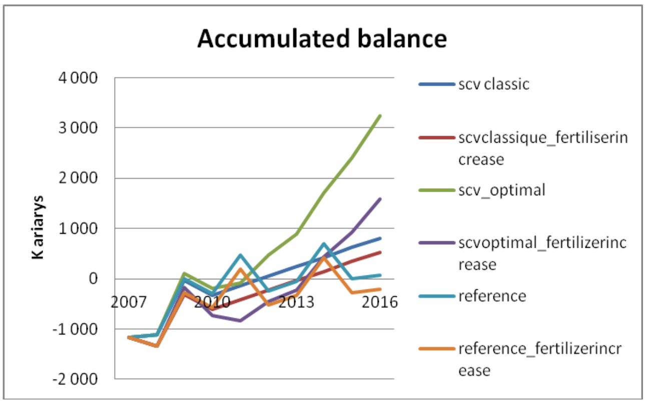

Figure 3 : Impact of 50 % fertilizer price increase on cumulated farm balance

- **Second shock: a decline in rice prices by 40%**: The second CA system gives the best results.
- **Third shock: combination of fertilizer prices increase and lower rice prices**: this is again the second CA system that obtains the best results.

The choice of the CA maize/cowpea – rice system allows a higher cash balance and provide more resiliency to the farm. However it is considered as more risky by most farms which is theorically antinomic. In fact the risk is considered socially as not acceptable whatever economic performance. It emphasize that risk on farmers' point of view can be understood as "not rationale" and probably over emphasized as long as the technology has not proven its efficiency which takes a minimum of 5 years with CA.

6 Conclusion

Many agricultural projects have been implemented in the Lake Alaotra area since the 1960's. With the BV-lac project, it seems important to integrate farms that are not supervised by the project in order to assess real impact of any changes and to take into account the typology as farm types and associated strategies are quite different in term of risk and technology adoption. The basic data of the FSRMN, built from the initial 2007 agrarian farming systems diagnosis should be seen as a tool to obtain information on vulnerability and resilience through the establishment of different scenarios, to understand the effects of different types of shocks. This is complementary to the analysis of other available databases, especially the ROR (Rural Observatories Network, Benz et al, 2010) which focus more on livelihood.

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