Global diagnosis and set of specifications for the conception of adapted cropping systems in Middle West of Madagascar

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Introduction

In Madagascar, rural development projects based on Conservation Agriculture (CA) principles started in the years 2000. Conservation Agriculture (CA) practices (Lal, 2008) including direct seeding mulch-based cropping (DMC or SCV) systems (Séguy*et al.*, 2006) are recognized as efficient strategies to enhance soil fertility, biological activity and to sequester atmospheric CO2 into soil organic carbon (SOC) pools (Bernoux*et al.*, 2006; Lienhard*et al.*, 2013). The mulch based cropping systems put in place in the Middle-West of Madagascar follow CA principles (No soil tillage, permanent plant soil coverage, rotations et crops associations) and insure several benefits : fertility restoration, weeds control and more over *Strigaasiatica* control (Michellon*et al.*, 2011), a parasite plant particularly harmful to cereals, soil protection and erosion control (Douzet*et al.*, 2012), crops diversification, crop yields and soil water status improvement, income improvement and adaptation to climate hazards. Despite the main advantages of these CA techniques identified in Madagascar, CA diffusion seems to be limited.

The work presented allowed an analysis of the decisive factors and the constraints regarding the AC techniques adoption and then to order them according to different levels of intervention.

Methods

The study has been based on previous works, reports from BVPI-SE/HP project (Bassins versants etpérimètresirrigués du Sud-Est et Hautsplateaux) funded by AFD from 2006 to 2013, complementary surveys, farmers and key persons interviews.

The analysis of difficulties in diffusion encountered by these innovative techniques focused on Middle West (MW) area of Madagascar.

This initiative which guides the conception of innovative cropping systems in MWof Madagascar is part of the DATE approach (Diagnosis, Design, Assessment, Training& Extension) which was developed and applied to co-design CA based cropping systems adapted to different situations. DATE is a multi-scale, multi-stakeholder participatory approach, integrating scientific and local knowledge.

This operation can be completed through the elaboration of a bill of specifications which considers the different determining factors identified, farmers' motivations and general agricultural production conditions.

Results

The studies carried out among the adopting farmers and extension staff show that the conservation agriculture (CA) practices adoption leads to several constraints at different levels, namely the cropping systems tier, the CA diffusion tier linked to specific conditions and the rural development tier.

The constraints felt and expressed by farmers and extension agents at the field level are various. Their understanding and interpretation reveals some bottlenecks, often not perceived, at the root of felt and shared issues. Those blockages reveal a multitude of decisive factors which determine the adopting conditions on the agricultural innovations in the long term. Four essential difficulties have appeared along the CA diffusion operations in the MW of Vakinankaratra: i) The control of Stylosanthes cover crop which stays difficult, ii) weeds pressure which increase with recovered fertility, iii) the pressure on the biomass (mainly crops residues and cover crops) with the theft, the shifting and bush land fires and iv) difficult monitoring of Stylosanthes based cropping systems for small farmers. So these constraints can involveCAtechniques in themselves but more often general dysfunctions, prior to the implementation of the techniques, are revealed or intensified by the change of practices.

The brakes to the DMC diffusion result from the constraints located at different levels and raise from different local situations.

The improvements to be brought to the diffusion methods need to focus on the determining factors and farmers motivations identified, so that constraints can be managed beforehand in order to offer adapted and sustainable solutions. An holistic approach, principle of CA cropping system conception, leads to a set of specifications established under a participative manner, which design adapted solutions.This process of specifications development highlighted the fact that numerous determining factors are more often linked to the production environment than the only CA practices implementation. It is now obvious that rural development project and R&D actions have to make the difference between what could be resolved by CA based cropping systems, what is dependent from project implementation and what is conditioned by global infrastructures (Figure 1).

The analysis of encountered issues highlights the implication of a range of determining factors at different levels interacting between them.The compatibility between the technical and organizational offers and the farmers concerns and objectives is vital.

Three interdependent levels have been identified:

Level 1: Determining factors or conditions fromlocal rural development. The principal obstacles to rural development are linked to the infrastructures weakness and rural society functioning, including relationships between different groups of population and field workers.

Level 2: Determining factors or conditions to the implementation of CA practises. The understanding of socio-cultural particularities in the countries and areas of intervention is justified especially when the proposed techniques are innovative. Their acceptance will be facilitated if i) they respect the local customs and local institution, ii) they are supplemented with trainings and guidance with a progressive evolution of the traditional practices.

Level 3: Determining factors of the adoption and diffusion conditions of the innovating, efficient and adapted SCV cropping systems.

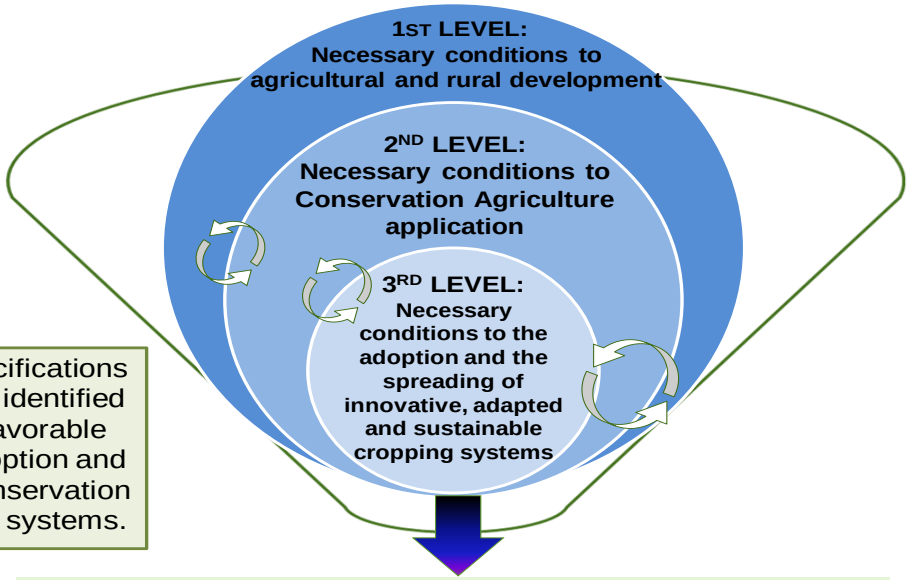

Figure 1: Set of specifications through the 3 levels identified allows to identify favorable situations to the adoption and the spreading of Conservation Agriculture cropping systems.

ADOPTER FARMERS AUTONOMISATION:

- Understanding and technical control of systems,
- Complete appropriation of system conception,
- Decision and initiative taking,
- Innovation by spontaneous diversification of cropping systems.

Discussion

The farmers who adopted the CA techniques in the Middle-West of Vakinankaratrain Madagascar took benefit from the CArecognized advantages, especially the fertility restoration of their plots, the *Strigaasiatica* control, crops diversification, incomes enhancement. They will, however, have to face, during the first years of technical transition, different constraints which threaten the upkeep of the adopted innovations in the long run. Those constraints are sometimes linked to incompatibility between offered systems and the means that can be mobilized, but definitively more often linked to the global environment of the farming production.

The studies carried out in the MW area to identify the principal constraints, highlight, on one hand the management difficulties of the offered systems regarding the means that can be mobilized by the farmers and, on the other hand various contextual blockings (institutional concern, land tenure, access to credit, awareness, convictions…) at different levels.

The felt and expressed constraints by the adopting farmers hide, in reality, various contextual blockings which fall under different determining factors within the area. The integration of those factors to the design process of the innovative cropping systems is vital if we want to offer adapted and sustainable solutions.

The set of specifications is a guide for the conception of innovative and adapted cropping systems going through the crossing analysis between the determining factors and the farmers' objectives and motivations. This set allows the identification and resolution, under methodical and progressive manners, of the different CA adoption bottle necks and leads to the design of adapted and adaptable cropping systems. As a matter of fact, to take account, step by step, of the different determining factors previously identified at different levels, and many of them cannot be resolved only by innovative cropping systems, is a warranty to secure the conception of adapted cropping systems.

It does not matter how efficient is a cropping system as it cannot overcome, as itself, farming production environmental blockings which determine any rural development interventions and innovations adoption.

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