Pillars and challenges of a three-scale approach for designing innovative agroecological cropping systems – Case-study of the Diagnosis, Assessment, Training and Extension (DATE) approach

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1. Introduction

Shifting from conventional to agroecological based cropping systems faces differerent issues, mostly methodological and technical (Steiner, 1985, Malézieux et al., 2009).This paper aims to present the Diagnosis, Assessment, Training and Extension (DATE) approach used in different tropical contexts aiming to scale-out innovative and locally adapted farming systems.This approach has been used in in different tropical countries under small farming contetxs e.g. Madagascar, Laos, Cameroon, to design innovative cropping systems based on Conservation Agriculture principles (Séguy et al., 2006).The pillars and the challenges of this DATE approach are to work simultaneously at three scales i.e. field, farm, territoryintegrating two main concepts of cropping system designing, the *de-novo* and the *step-by-step*approaches (Meynard et al., 2012).

2. Results

2.1 The overall DATE approach

The DATE approach is a multi-scale and multi-stakeholder approach which combined four main tools (Figure 1):

- A. A permanent agromic survey and diagnosis conducted at the territory and the farm levels to mostly highlight socioeconomical constraints and opportunities and technical bottle-necks;
- B. The design (the *de-novo approach*) on representative geological and climatical sites of innovative cropping systems in relation with the above points i.e. constraints, opportunities and bottle-necks;
- C. The test and their progressive adaptation (the *step-by-step* approach) of farmers chosen options in real situation on a network of farms;
- D. The scaling-out of the validated options based on farmer-to-farmer exchanges with the support of NGO, public or private sectors.

2.2 The territorial level

At the territorial level, a permanent diagnosis involving different stakeholders will define both opportunities and constraints integrating the diversity of landscape's mosaics and the socio-economic context. As an example, the diversification of crops can become compatible with farm specialization if the cohabitation of specialized farms is organized at territorial level. Cattle free grazing as well as crop parasites impacts need to be assessed at this level. Further an exhaustive survey on socioeconomic farm characteristics should be useful in order to link these characteristics to their socioeconomicalconstraints, opportunities and their technical bottle-necks. Finally a set of the different farm classes will be realized.

2.3 The farm level and the *step-by-step* approach

From this overall survey done at the territorial level a selection of representative farms will done according to their classes.On these farms the*step-by-step* design approach will be carried-out to form anetwork of pilot farms where farmers will combine external and local knowledge to build their own systems. For that from the onset selected options coming from the *de novo* approach (see below) were tested and compared with the conventional practices. At this level innovative cropping system impacts were assessed integrating other main farm components such as livestock, financing capacity.In Figure 2 different designs are put as examples. In A scattered blocks will be used to test on a large number of farms the same pair-comparison of a conventional practice compared with a sole innovation. In B randomized blocks could be implemented to compare in one farm a set of innovations compared with the conventional practice.

2.4 The field level and the *de-novo* approach

At the field scale, the *de novo* design approach consists to explore a diversity of solution to offer to farmers a wide choice of agroecological cropping systems and thereby prepare different futures that break away from existing systems. Specific design with non-fixed objectives for creativity was firstly carried-outintegrating the learnings from the survey and the diagnosis and newknowledges coming from external experiences.Intercropping (two crops or more grown simultaneously together) is one the main principal way to develop agroecological cropping system mainly to avoid weed developpement in permanent no-till cropping. Many studies revealed that intercropping may favorize synergies in combining crops which have different requirements in term of their, (i) solar requirement C3 vs. C4 crop photosynthetic pathways, (ii) their cycles short vs. long cycles (iii) their vegetative stand,prostated vs. climbing species (iv) their root systems taproot vs.fasciculated(v) their nutrients'requirement grasses vs. legumes. The best example isthe maize-bean intercrop which has been practiced for more than 2000 years and revealed to develop the above synergies.Designing intercroppings face specific constraints and need a set of indicators (Table 1).We put in Figure 3 the different designs which could be used to explore the windows of opportunies in designing new intercroppings. In A we put a row-column design testing the different combinaison of four densities for two crops which could be useful to determine the best one. In B a more classical design with randomized block which take into account soil fertility as a main factor and the cropping system as the second one (Federer, 1991).From these controlled experiments thematical designs could be implemented to answer to new questions with fixed objectives that do not change.

3. Conclusion

The originality of this DATE approach is based on creativity and a permanent questioned design involving agronomists andpilot farmers, combining local and external knowledges, and has been used especially where the deterioration on the environment is the driving force of farming system changes, such as in rainfed highlands of Madagascar.In exploring new agroecologicalcropping systems, new questions appear and generate new thematic studies which should open a window of knowledge for a large range of disciplines e.g.soil fertility and crop pest management.

4. References

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Steiner K.G., 1985. Cultures associées dans les petites exploitations agricoles tropicales en particulier en Afrique de l'Ouest.GTZ, Eschborn, 347 p.

5. Illustrations

Table 1.Agronomical indicators of intercropping systems

Indicator type	**Assessment**	**Main factors of variability**
Yield performance	Land Equivalent Ratio	Crop above-ground (light) and below-ground (nutrients) (+ practices)
	Density Equivalent Ratio	
	Competitive Ratio	
	Stability	
Labor Productivity	Work time	Socioeconomic factors (+practices)
	Work drudgery	
	Calendar bottle-necks	
Soil Fertility	Soil physical properties	Geomorphology (+ practices)
	Nutrient recycling	

	Nutrient accumulation	
	Organic and microbial activities	
Pest and deseases	Weeds	Climate Genetic (+practices)
	Fungus – Virus	
	Insects	

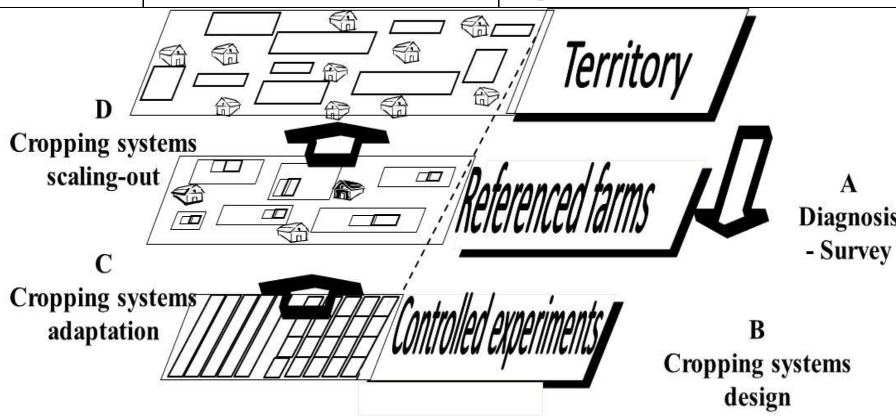


Figure 1.The global DATE approach.

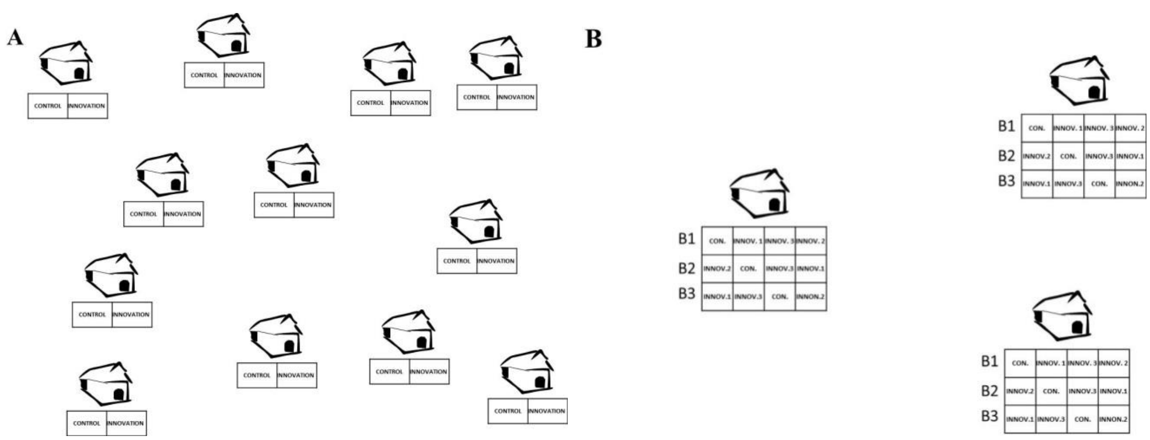
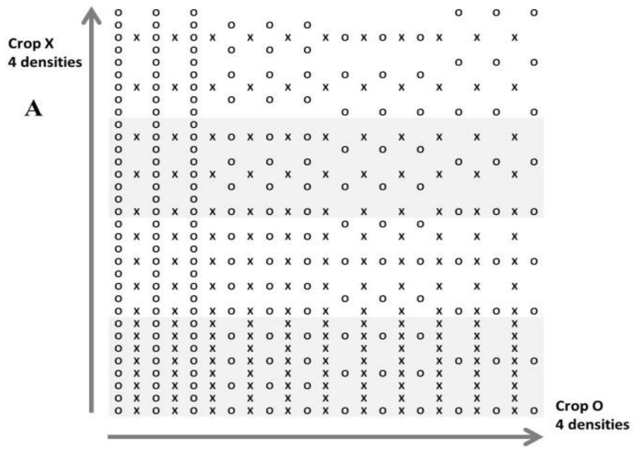


Figure 2. The *step-by-step* design approach in an on-farm experimental network: A, Spread blocks, one by farm, with two treatments (control and innovation) in a great number of farm > 20; B, Classical design with more than two treatments and with two or more blocks; in each farm a specific innovation is tested.



B

Block 1	F1	Rotation 1 Crop 1	Rotation 1 Crop 2	Rotation 2 Crop 2	Rotation 2 Crop 1	Rotation 3 Crop 1	Rotation 3 Crop 2
	F2						
Block 2	F2						
	F1						
Block 3	F1						
	F2						
Block 4	F1						
	F2						

Figure 3. The *de-novo*design approach on controlled experiments: A, a row-colum design; B, a split-plot design.