The role of fish farming in the farming system in the Betafo areas of Madagascar : approach by agronomic analysis and socio-economic inquiries.

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1 Introduction

The reasons for the diversification of a smallholder's farming system are intricate, in particular when the diversification concerns fish farming: it can be justified by economic, environmental (water management) or agronomic reasons.
Various sources indicate that rice-fish farming has maintained itself in the Betafo areas of the Vakinakarach (Madagascar) and even more so, it may have considerably expanded. If economic reasons seem obvious, the role of fish farming among the soil fertility of rice plots is to investigate, especially in a context where soils have a low (poor) organic matter level and where it is crucial to maintain the rice plot fertility, an essential element of these smallholders farming system (Rabeharisoa, 2004). This issue arises as cattle manure resources are decreasing, linked to the increase of demographic pressure (Blanc-Pamard, 2000). To face this main fertility constraint, diversification with vegetable during the off-rice season, especially tomato cropping, is often presented as a good lever to answer it; it is also supposed to finance the supply of organic and mineral fertilisation. On an other hand, to be more profitable, rice fish farming needs ponds to stock fish during the off-rice season which is also the colder season.

2 Materials and Methods

In order to answer this questioning, a pilot study was conducted in 2007 in this area during the off-rice season (June to September) where rice plots are used for vegetable cropping (tomato) or fish farming. This exploratory study induces the sampling of plots in order to identify basic hypothesis about fertility management in order to enable further analysis. Inside plots, a balance of organic matter, of nitrogen, of phosphorus (Olsen) and other soil major indicators (pH, CEC) was conducted as the same time as an inquiry on the economic results of these crops among smallholders. 11 plots were studied (5 with tomatoes and 6 with fish farming cycle). Each amount of organic and mineral fertilisers was collected as well as crop exports during the off-rice season. Soil was sampled down to 20 cm inside the hard stratum under the mud which was also collected. Differences in C and N contents between the two sampling dates were tested (Student T-test) to assess the effect of each farming system on soil fertility.

3 Results and discussion

Although vegetable plots received higher quantities of organic matter, the results (cf. figure 1) show a significant increase ($p<0.05$) of N content during fish farming cycle and a stagnation during tomato cycle. Similar evolutions are noticed on Carbon content ($p<0.1$, figure 2).
On the economic aspect, tomato cropping systems bring a positive gross margin profit and fish farming a negative one, especially because all the fish are kept for stocking the following cycle (average was respectively 11 191 Ariari/are and -1 012 Ariari/are),. Tomatoes require a higher cash-flow (6 286 Ariari/are and 1 012 Ariari/are respectively). Fish farming during this season provides a tool to restore the fertility with limited financial means.

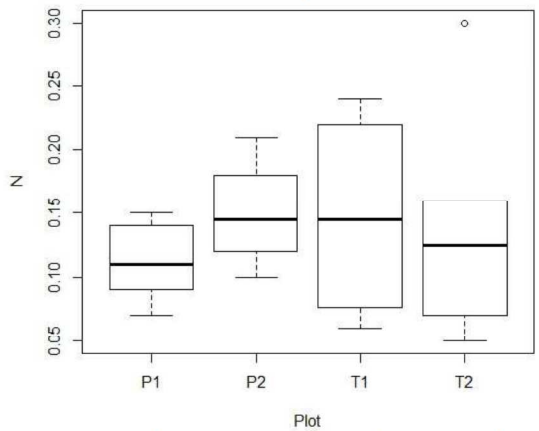

Fig. 1. Soil nitrogen in % in the collected soil samples. 1 and 2 refer to the soil samples before and after the off-rice cycle respectively. P and T refer to fish and tomato farming systems respectively. Error bars represent standard deviation.

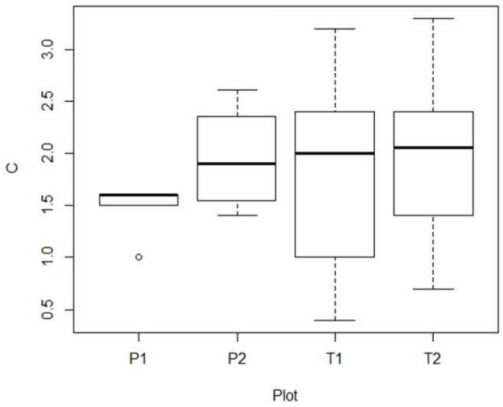

Fig. 2. Soil carbon in % in the collected soil samples. 1 and 2 refer to the soil samples before and after the off-rice cycle respectively. P and T refer to fish and tomato farming systems respectively. Error bars represent standard deviation.

These results confirm that under water, a soil stocks higher organic matter than in a dry environment (Shibu *et al.*, 2006) especially in low trophic environment. Compared to N supply, the balance shows a strong decrease for tomato cycles. (Rochette, 2008)

During the off-rice season, this study shows that, for a smallholder facing cash-flow constrains, fish farming can offer an efficient alternative known as "Masaka" in the traditional knowledge (Bouayad-Agha, 1995). From an economic point of view, it enables him to get positive environmental impacts for the next rice cycle and to improve is further gross margin on the following rice cycle by combining fish-farming and rice. At farm level, plots which are not valorised by vegetables due to lack of financial means and organic fertilisation supply, can still be valorised by fish-farming.

4 Conclusions

Despite classical restrictions of this methodology, results show that the strategy to maintain soil fertility has to be taken into account to explain how fish farming is integrated, in particular by the observed nitrogen and carbon increases it provides. This kind of analysis should be extended to the whole cropping and breeding systems to correctly analyse the rationality of the integration of fish farming inside irrigated rice systems in the area studied.

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