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BOOK OF ABSTRACTS

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How can we support farmers in the management of complex systems? A case study on multi-trophic rice-fish farming systems in Guinea

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Short abstract

In some contexts, the complexity of systems occupying a socio-ecological niche is a challenge for research and advisory services, as are multi-trophic rice-fish farming systems. Using a case study of a research and development project in Guinea, we reconstructed the action research process and the role played by each actor, and conducted semi-structured interviews with the participants farmers, technicians, researchers and project managers. We describe the implemented participatory and collaborative experimentation, that allowed each farmer to identify, test and evaluate fish farming practices in their ponds, guided by a technician. All groups of stakeholders (farmers, technicians, and researchers/project executives) perceived improvements in their ability to manage or advise about multi-trophic rice-fish farming systems, and collective exchanges played a key role in the process.To support farmers in the adaptation and mangement of complex systems, the goal is not to anticipate all the situations farmers might encounter, but to equip them with knowledge and experimentation skill in order to deal with a wide range of situations. Co-learning allowed the project staff to link their knowledge about biological phenomenon with the repertoire of technical options available to farmers considering their constraints and priorities. However a change in posture from all stakeholders is a prerequisite to enable co-learning.

Extended abstract

Purpose

The transition towards sustainable agricultural and food systems requires agricultural innovations addressing global food security challenges such as hunger, malnutrition, health and poverty (Tamburino et al. 2020). However, innovations might be complex and site or context specific. Rather than the adoption of an innovation, it become more suited to talk about the adaptation of an innovation, especially in sub-saharan Africa (Glover et al. 2016).

The concept of socio-ecological niche (Ojiem et al. 2006), defined as the integration of agro-ecological, socio-cultural, economic and institutional factors at various spatial and organizational levels, allows to define which options fit best in a given context using farming system analysis (Descheemaeker et al. 2016). However, in some contexts, the complexity of the systems occupying a socio-ecological niche challenges research and advisory services.

Multi-trophic fish-farming in rice fields, or complex rice systems , are an example of complex systems combining several agricultural approaches such as mixed species, organic farming, vegetable gardening (Khumairoh et al. 2019). In rice-fish farming, farmers aim at recreating at smaller scale (dam pond) and in a shorter cycle (6 – 12 months) the same natural mechanisms at play at larger scales (rivers and oceans) and over several years, that allow to regularly harvest, near the house, fresh fish for consumption and sale. To do so, farmers mobilize biological phenomenon (Hunter & Price, 1992) based on trophic chain management (Lazzaro & Lacroix, 1995) to generate biomass in a limited space and time. A set of practices allows to anticipate, stimulate or reduce biomass in one or several primary trophic compartments. Primary organisms will in turn allow to increase or decrease biomass from secondary organisms, which are later consumed by fish (Tilapia - *Oreochromis niloticus* and Hétérotis - *Heterotis niloticus*).

Due to this complexity, farmers have to undergo several trial-and-error cycles in order to start a stable production system, with different levels of water fertilization, water management, and fish densities, with the aim of establishing references for the number of fish, desired fish size and desired cycle length (Glasser, et al. 2001). In summary, a rice-fish farmer must first discover the best way to manage water renewal in order to facilitate fertilization and thus bring the number of fish in coherence with the desired objective in the given time. Then, depending on the opportunities of cash, labour, fertiliser, fish food, equipment, structures (Bosma, et al. 2011 ; Kabir, et al. 2020), this complex farming system can be increased in its productive capacity to allow less intraspecific competition. The opposite can also be done, that is keeping the individual weight of the fish the same but increasing their number.

This contribution aims at illustrating a method that accompanies and supports farmers in the tests and adaptations of complex multi-trophic rice-fish farming systems. The goal is also to record the evolutions in the perceptions and competences of participant farmers, technicians and researcher regarding the management of complexity and variability. We discuss the issues at stake for the support of farmers in the adaptation and management of complex systems.

Design/Methodology/Approach

We present a case study of a collaborative research approach on rice-fish farming in Guinea. Guinea is a West African country with an unstable economic situation since decolonisation (Pacquement, 2020). In the forest region, where the project is located, the main agricultural activities are coffee plantations, oil palms, rubber trees, market gardening, rainfed hillside rice and flooded rice in the lowlands. The Commercial and Family Fish Farming Development Project (PisCoFam) is financed by the French Development Agency (AFD) by 10 million euros over 5 years. The Ministry of Fisheries, Aquaculture and Maritime Affairs of Guinea (MPEAM) is in charge of the project and the NGO APDRA Pisciculture Paysanne is in charge of the implementation. The Centre de Coopération International de Recherche pour le Développement (CIRAD) is coordinating the projet research activities in partnership with APDRA.

The case study is composed of two parts. First, the reconstitution of the action research process and the role played by each stakeholder, through the study of the project documents and interviews with key stakeholders. Second, we conducted semi-directive interviews with the participants: farmers (n=17), technicians (n=7), researchers (n=2) and executives of the PiscoFam projects (n=3). In addition, we used participatory observation during collective sessions.

The objective of the interviews was to collect information to understand the learning that took place on the technical practices and the results on the farm, but also on the method used. The data collected was also intended to identify whether there had been a change of attitude in each category of participant.

Findings

a) A cyclic and collaborative process based on farmers' experimentations

The first result consists of a thorough description of the collaborative research and the roles played by each stakeholder (figure 1). The research-action process allowed each participant farmer to identify, test and assess one or several fish-farming practices in their own rice ponds, paired with a technician. Each technician follows two or three fish farmers during two years.

Each technician collects data during their visits (3 visits/month) coinciding with technical operations such as fish stocking or fish harvesting. This allows to observe the evolution of the pond biomasses in addition to the discussion with farmers.

Moreover, all involved stakeholders (farmers, technicians, researchers) conduct collective work at three key-moments : at the start of the process to agree on the activities and the assessment criterias, and at the end of the first and the second production cycle to discuss their assessments of the results and of the process itself.

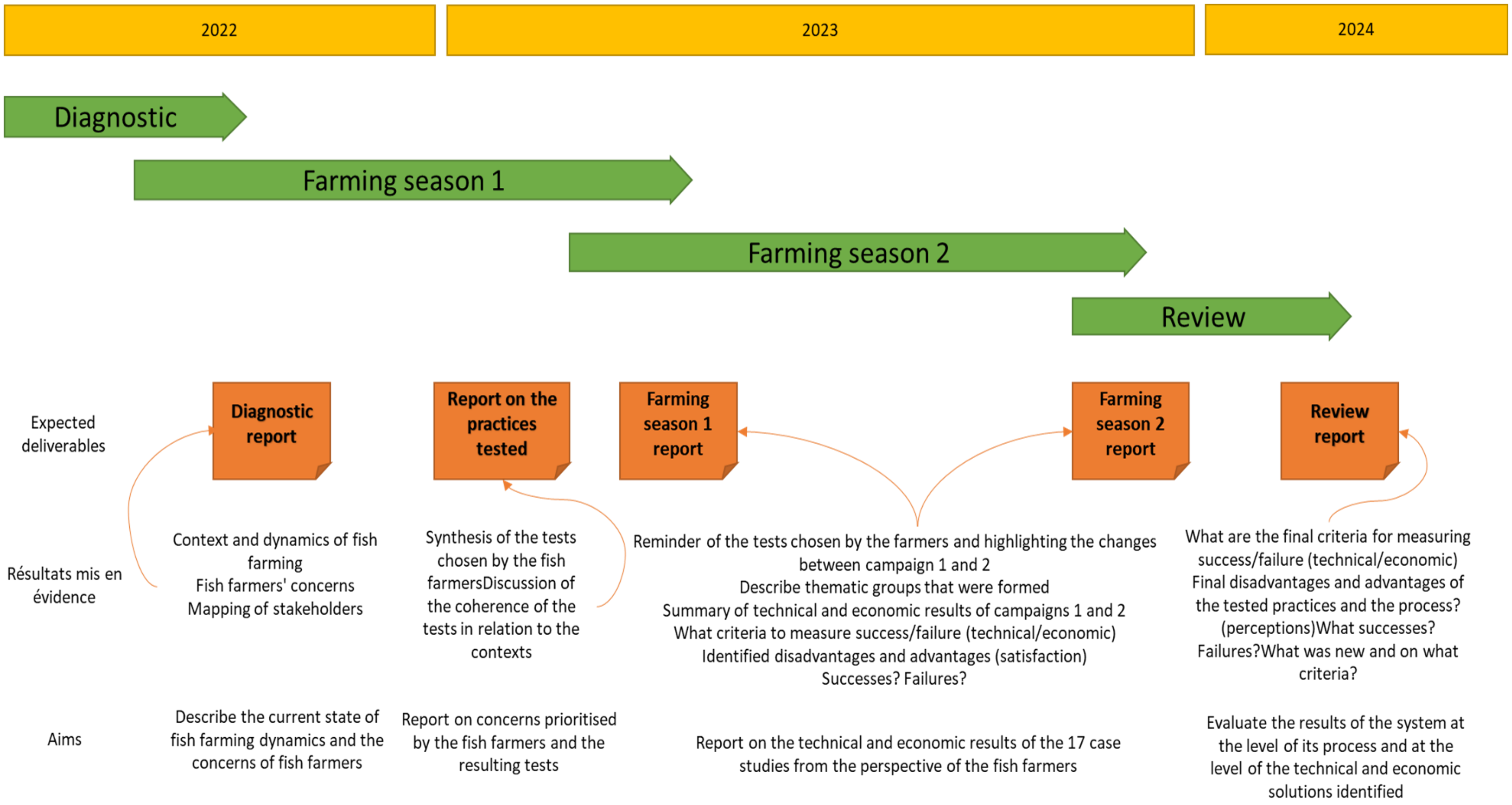

Figure 1 : Timeline of the cycle monitoring system (source : authors).

b) *Co-learning among stakeholders to support the adaptation of complex rice-fish farming systems*

The results of the interviews with stakeholder show that each group (farmers, technicians, and researchers/project executives) perceived improvements in their ability to manage or advise about multi-trophic rice-fish farming systems, and that collective exchanges played a key role. Farmers have had to express their concerns and priorities, which were discussed with a technician to reach the identification of a technical option to be tested in their rice-field plot(s). During the production cycle, farmers contributed to observations and data collection in the agro-ecosystem, and took part in the analysis of the data and the resulting fish, rice and vegetable yields. Another contributing event identified by farmers are the collective debates that allowed to exchange and compare experiences with other farmers, some of whom shared the same constraints or objectives. They have become able to take part at run tests and master new technical options, namely regarding fertilization and feed management. They also perceive a better understanding of the interactions between the agroecosystem components and their management practices. Farmers expressed their satisfaction about the different technical options they have learned, and show or expect better technical and economic results for production cycle.

The results show that after accompanying farmers in 2 fish production cycles, the technicians have a systemic vision of the farms and of the rice-fish plots, considering ecological and economic interactions that determine the success of a fish production cycle. Technicians perceive that they are able to estimate the monetary value of rice, fish and vegetable production on a given plot, considering its management. They consider farmers' objectives and constraints, especially in relation to non-technical objectives. They have become able to facilitate a discussion with the farmers about different technical options, and to identify farmers' criteria of satisfaction.

The main researchers involved in the process, in coordination with the remaining research team of the project, identified a better understanding of the criteria relevant to characterize fish-farms in the area, as well as indicators relevant to farmers (exceeding yield and economic indicators). This contextualized knowledge allows a better analysis of the socio-technical landscape at play for fish-farming in Guinea. The other main contribution identified is the ability to implement participatory and collaborative experimentation with farmers, which could be mobilized in the future for co-design with farmers. (Meynard et al. 2012). Capacity building for technicians (rather than knowledge acquisition) and the implication of local institutional stakeholders were the main challenges for the implementation the research-action and its perennity.

Practical Implications

On the topic on advice to support on-farm adaptation of complex rice systems, Khumairoh et al. (2019) proposed a simplified version of Farmer Field Schools. However the approach presented here differs. Indeed Khumairoh et al. (2019) consulted farmers during an initial preparation step about the rice system characterization and challenges, that allowed to anticipate the technical options answering the expressed challenges. Simplified FFS were then implemented and farmers could provide feedback. We argue that it can also be relevant to build an approach aiming at building skills for farmers through the on-farm experimentation and adaptation of the complex systems, with the help of a technician, and as a complement to collective meetings with other farmers. The aim is therefore not to anticipate all the situations farmers might encounter, but to equip them with knowledge and experimentation skill in order to deal with a wide range of situations. This appears especially relevant in the case of complex systems such as multi-trophic rice-fish farming systems.

Theoretical Implications

In some contexts, the complexity of the systems occupying a socio-ecological niche challenges research and advisory services. We discuss the importance of co-learning (Descheemaeker et al. 2016) in the process of supporting farmers in their adaptation and management of complex systems. Co-learning allowed the project staff (technicians, researchers and project executives) to link their knowledge about biological phenomenon with the repertoire of technical options available to farmers considering their constraints and priorities. However a change in posture from all stakeholders is a prerequisite to enable co-learning.

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