CONTRIBUTION OF A SYSTEM EXPERIMENT IN DESIGNING A MIXED CROP-LIVESTOCK FARMING SYSTEM AIMED AT I) IMPROVING SELF-SUFFICIENCY, AND II) PRODUCING BIODIVERSITY AND BENEFITING FROM IT

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FARMING SYSTEMS DESIGN AND EVALUATION

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Abstract — In the context of the ongoing action research dealing with innovative farming systems design and evaluation, we explore a new mixed-crop livestock farming system which aims are: i) enhancing biodiversity and limiting negative externalities (on water quality and soil fertility) and ii) increasing its self-sufficiency, the extent to which the system is able to satisfy its own needs without requiring considerable external inputs. A systemic (at the farm-scale), multi-year and multidisciplinary approach is thus currently set up on the INRA Saint Laurent-de-la-prée research farm (French Atlantic coast), through a system-experiment. The method consists in a series of improvements which are brought progressively to an already existing system. This latter is permanently redesigned in order to approach the desired objectives, following the environmental management approach. To achieve the objectives, the principles of ecologically intensive agriculture concept are promoted as much as possible. The performances of the system will be evaluated through a list of indicators in relation to the three sustainability pillars (multi-criteria approach): i) environmental (biodiversity, water and soil quality), ii) economic and iii) labour charge indicators.

Contribution of a system experiment in designing a mixed crop-livestock farming system aimed at i) improving self-sufficiency, and ii) producing biodiversity and benefiting from it.

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Key words : biodiversity, farming system research and development, indicators, sustainable agriculture, system-experiment

Résumé — Dans le cadre d'un courant de recherche actuel sur la conception et l'évaluation de systèmes de production agricole innovants, nous explorons un nouveau système de polyculture-élevage dont les objectifs sont : i) améliorer la biodiversité et limiter les externalités négatives (sur la qualité de l'eau et la fertilité des sols) et ii) augmenter son autonomie, la capacité du système à subvenir à ses propres besoins sans nécessité de grandes quantité d'intrants. Une approche systémique (à l'échelle de l'exploitation), pluri-annuelle et pluri-disciplinaire est actuellement mise en oeuvre sur la ferme expérimentale de Saint Laurent-de-la-prée (côte atlantique française), à travers une expérimentation-système. La méthode consiste en une série d'améliorations qui sont progressivement apportées à un système préalablement existant. Ce dernier est re-dessiné de manière permanente, de façon à atteindre les objectifs visés, et ce en suivant une approche de gestion environnementale. Pour atteindre ces objectifs, les principes de l'agriculture écologiquement intensive sont promus autant que possible. Les performances du système seront évaluées à travers une liste d'indicateurs en lien avec les trois piliers de la durabilité (approche multi-critère) : indicateurs i) environnementaux (biodiversité, qualité de l'eau et des sols) ii) économiques et iii) sociaux (charge de travail).

Mots clés : agriculture durable, biodiversité, expérimentation-système, indicateurs, recherche et développement sur les systèmes agricoles

INTRODUCTION

It is widely agreed that farming systems developed in industrialised countries are unsustainable. The development of alternative farming systems is thus of great importance for the future. Farming system research and development needs to work on systems aimed at transforming crops and animals into human alimentary products and increasing food security, in ways that are compatible with wildlife and resources conservation.

We describe here a project, the aim of which is to explore a new mixed-crop livestock farming system in marshes able to respond to various agri-environnemental sustainability stakes (reducing the release of pesticides into the environment, conservation of biodiversity, improvement of food self-sufficiency, examination of economic and social concerns…). Dealing with this diversity of objectives requires a systemic (at the farm-scale), multi-year and multidisciplinary approach. This is the reason why a system-experiment is currently set up on the INRA Saint Laurent-de-la-prée research farm (near La Rochelle on the French Atlantic coast), in the context of supporting livestock farming in marshes.

1. OBJECTIVES OF THE PROJECT

This project contributes to an ongoing action research dealing with innovative farming systems design and evaluation (Meynard et al. 2001). Since about 20 years, many tools have been created to evaluate existing farming systems and design and control new ones with respect to sustainability (Reau & Doré 2008). Considering environmental sustainability, many criteria can be taken into account (e.g. air and water quality, biodiversity, emission of greenhouse gases, soil fertility, etc). In this project, the first main research focus of the system is to enhance biodiversity – and limiting negative externalities on water and soil quality (pesticides and fertilisers lunching). The second one concerns increasing its self-sufficiency, i.e. the extent to which the system is able to satisfy its own needs without requiring considerable external inputs.

2. METHOD

Today, a variety of methods are used to design innovative farming systems, e.g. prototyping (Vereijken 1997) or modelling (Sadock et al. 2008). Here we develop a different

one, although still implied in the agricultural ecological engineering at the whole-farm-scale, and with specific references to real-word testing. This method is typically that used by farmers wanting to bring modifications and improvements to their farming system by their own initiative.

In this approach, instead of designing a new farming system and then testing it in a prototype, some improvements are brought progressively to an already existing system. The experimental system is thus permanently redesigned in order to approach the desired objectives, following the well known environmental management approach consisting of four iterative steps (PDCA cycle): i) Plan (i.e. identify and plan change(s)), ii) Do (i.e. test the change(s)), iii) Check (i.e. evaluate whether objectives have been achieved or not), iv) Act (i.e. plan new improvements to increase the sustainability and feasibility of the system at the practical level). This process of improvement involves the creation of work groups mobilising not only expert knowledge of INRA staff, but also local partners such as environmental associations, technical institutes and farmers.

The total area for the experiment covers 200 ha involving 40 ha of arable land and 160 ha of permanent grasslands and meadows (mainly lowland). Grasslands are grazed (from April to October) by a herd of about 50 cows (Maraîchine breed) and the replacement heifers. The cultivated crops (e.g. lucerne, beans, sunflower, wheat, spring/winter barley) are aimed at feeding the animals and producing straw.

In the “check step” of the PDCA cycle, to evaluate the farming system and analyse its performance, multiple indicators will be used (multi-criteria approach) in relation to the three sustainability pillars:

i) biodiversity indicators (e.g. plant species richness and diversity in grasslands, index of passerines, waders and insects abundances), ii) economic indicators (e.g. gross operating profit, gross margin), and iii) labour indicators (e.g. number of hours per task type) to test the feasibility of the system in term of labour charge. We postulate that a combination of multiple changes, each giving partial benefits, might lead to major improvements in biodiversity and self-sufficiency.

Two other types of indicators will also be followed for the management of the farm: piloting indicators (basic measures used by the pilot to take decisions throughout the crop-year), and well-functioning indicators (to analyse agronomic and livestock performances of the farming system).

3. APPLICATION OF THE PRINCIPLES OF ECOLOGICALLY INTENSIVE AGRICULTURE

To achieve the objectives, the principles of ecologically intensive agriculture concept are promoted as much as possible. This is defined as “taking advantage of the natural properties of agro-ecosystems and using them more intensely” (Griffon 2006). In short, we have focused our actions on three main principles: i) diversification; i.e. diversifying crop types (alfalfa, beans, sunflower, wheat, spring/winter barley, maize), grassland types (e.g. over-sowing some of them) and varying their management (various stocking rates), as well as focusing on the importance of semi-natural habitats (e.g. field margins, hedgerows, ponds…); ii) favouring positive interactions such as optimizing crop rotation (e.g. cultivation of alfalfa to reduce fertilisation needs for the following crop, alternance of winter and spring cereals to help in the control of weeds), and iii) taking profit of the potential uses of biodiversity (e.g. using crop auxiliaries in order to enhance the biological control for crop protection). As a consequence, we would like to create a system « producing » biodiversity (i.e. favourable to the conservation of biodiversity) but also benefiting from it (i.e. taking profit of the biodiversity which serves an agronomic function).

4. EXPECTED RESULTS AND PROSPECTS

Expected results concern four points:

(i) we expect the tested method to be an interesting way to coach the system to innovate towards more environmental sustainability.

(ii) the experiment will provide references on environmentally friendly systems in marshes and on self-sufficiency.

(iii) we postulate that self-sufficiency ensures more environmentally friendly agricultural practices (mainly through inputs reduction). In turn, we will explore in what extent e.g. soil fertility conservation or optimisation of the use of locally available resources and nutrients could promote self-sufficiency.

(iiii) we will tackle the issue of the compatibility of such wildlife-friendly farming with social (labour charge) and economic considerations. This study will allow us to assess whether such agricultural systems are economically acceptable or need to be subsidised (and to what extent).

If the method under test succeeds, we may envisage applying it in a group of pilot farms to take into account farm diversity in terms of socio-economic and pedo-climatic constraints. This could allow testing the validity range of the system and its technical feasibility, i.e. whether or not it is easy to adopt by local farmers.

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