SCA0PEST, a pesticide-free agroforestry cropping system: ex-ante performance evaluation

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Introduction

From mid 2000, in order to address global challenges, European member states' strategies for agriculture have progressively identified and given priority to the set up of a multi-functional farm model. In France, first reflection officially started in 2007 through the Grenelle de l'Environnement initiative from which several priority themes were identified, and dedicated measures approved. Concerning agriculture, four different objectives were selected: (a) the deployment of organic farming up to 20 % of the utilized agricultural area by 2020, (b) the Ecophyto plan for a 50 % reduction of the pesticides use, (c) the enforcement of the High Nature Value (HNV) certification scheme and the certification of at least 50 % of the French farms by 2012, and (d) the energetic diagnosis of at least 100.000 farms every 5 years within the farms' energetic performances (PPE) plan.

If most of the quantified objectives have not been reached by 2014, coming into force of these measures actually goes on and represents a real opportunity for research organisms to participate to both food security and socio-environmental sustainability by the design, test and deployment of new Productive and Efficient Cropping Systems (PECS). Conversely to the majority of the PECS tested within the EXPE Dephy Ecophyto program, some have been imagined to go further the sole re-conquest of water quality by reducing drastically, or even renouncing chemical pesticides. They actually target (i) the reduction of the farm carbon footprint by reducing and/or mitigating GHG emission, (ii) the improvement of local ecological connectivity by contributing to the establishment of new biocorridors and (iii) the financial sustainability of the experimental farms.

Among the forty-one EXPE projects funded in 2012 and 2013, only one is testing and monitoring a pesticide-free agroforestry cropping system: SCA0PEST. It aims to: run an experts' panel conceptualization of the SCA0PEST cropping system by considering locally the actual and future market outlets, the hosting parcel and farmhouse agrotechnical potential, and local epidemiologic pressures; to deploy and conduce in farm conditions the cropping system; assess

global and thematic performances of it; and favour the disclosure of the obtained knowledge and references towards farmers, advisers and agricultural students.

Material

Following the STEPHY methodology (Attoumani-Ronceux, et al., 2011), an experts' panel (n=12) grouping innovative farmers, agricultural advisers, agronomists and researchers worked iteratively during 6 months to the experts' opinion-based design of the SCA0PEST PECS by respecting principles of integrated pest & weed management (Agro-PEPS, 2011). The result was a new and innovative agroforestry PECS for which every single agricultural practice and decision rule are detailed for each one of the 8 crops of the rotation [Alfalfa – alfalfa - winter wheat – oil seed rape – spring barley – field bean – winter wheat – (alfalfa + sunflower)] and related intermediate crops.

By September 2013, the SCA0PEST PECS was then set up within a 34 ha and 5-years old alley cropping agroforestry matrix (N49°28'21'', E2°03'55''). Each year, 6 over the 8 components of the crop rotation are present on a 0.5ha acreage each and are separated by standard trees lines distant of 28 m each other, presenting a mean stand density of 60 trees ha^{-1}.

Basic experimental and agronomic follow up are then organized yearly according to the Rés0pest project experimental standards (Cellier et al., 2014). They are mainly dedicated to the measurement of the crops health status, the spatiotemporal assessment of weeds and pests pressures, and their consequences on yields and harvested supplies quality. In parallel, supplementary protocols are annually conducted in order to estimate the carbon sequestration potential of the agroforestry matrix (Yield-sAFe, Talbot et al., 2014) and to demonstrate the biological control potential of agroforestery by scrutinizing weeds' communities influence on aphids-aphids parasitoids relationships (Brewer and Elliott, 2004). Finally, ex-ante and continuous economic, environmental and social assessments of its performances are performed against a conventional cropping system as reference [Oilseed rape – winter wheat – winter barley].

Results

These results presented concern the sole ex-ante assessment of the performances of both the reference conventional and the SCA0PEST systems.

Depending on raw products sale prices, energy and fertilizers costs, SCA0PEST ex-ante assessment provided limited economic prevision, as direct margin would decrease from 140 up to 250 €/ha (Fig. 1a) when compared to the reference cropping system. This financial loss is mainly due to yield losses, less frequent cash crop revenues and additional costs for seeds. Conversely, environmental performance would be improved as annual GHG emissions from the arable compartment fall down to 1.140 kg eq.CO_2/ha/year (Fig. 1b) meaning 48 % of the reference system with pesticides.

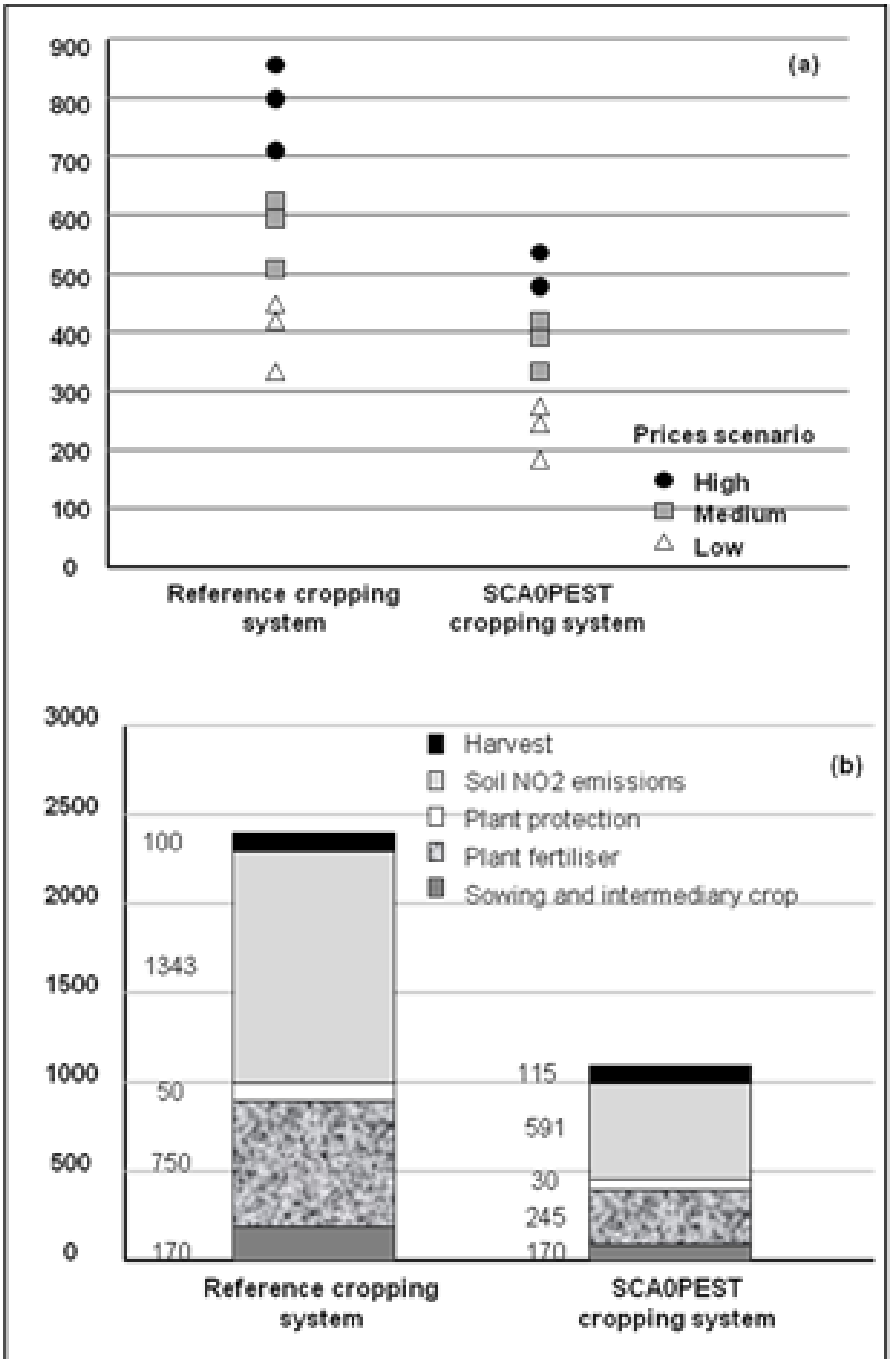

Fig 1 : (a) Financial balance as direct margin (€/ha/year) using the Stephy tools and (b) GHG emissions quantification (eq. kg CO_2/ha/year) using the eGES tools for both the reference conventional and the SCA0PEST cropping.

Discussion and conclusions

If considered as a whole, previous financial and environmental results tend to disadvantage the SCA0PEST system. Fortunately, inclusion of a 2-years alfalfa production (9t/ha/year) within the rotation could provide a supplementary 150-230€/ha indirect gain when incorporated at 25% within the dairy cows ration of the hosting farm (IDELE,

2011), offsetting part of the predicted financial losses. Moreover, despite the fact that farmers cannot expect environmental payements for CO_2 emission reduction yet, a mean estimation of 650 eq. $KgCO_2$/ha/year (Yield-sAFe model, results not shown) for the annual carbon sequestration by the standard trees lines suggest that the SCA0PEST PECS should at least perform financially as well as the conventional reference system and demonstrate of a quasi-null carbon footprint of the system.

Additionally, other agriecological benefits such as enhanced biologiocal control of pests or yield increase due to microclimate improvement (e.g. through water availability increase) would be later expected and could enhance SCA0PEST performances. On the other hand, weeds and pests could be out of control in the next future or local climate change could result in drier springs; then, these local modifications could endanger the expected yeilds and related financial and environmental performances of the system.

Today, after the first year of the trial, uncertainty is too important to precisely figure out the potential of such a system. And even if SCA0PEST is promising, further diagnosis and future assessments would have to confirm the performances of this innovative free-pesticide agroforestry cropping system.

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