INTEGRATING A FINANCIAL MODULE IN THE WEB-ECOYIELD-SAFE MODEL FOR BIOECONOMIC ASSESSMENT OF AGROFORESTRY ECOSYSTEMS

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Abstract

When analysing different land uses, since they usually translate into different and not comparable goods and services, it is essential to evaluate their financial performance. Using the biophysical outputs already provided by the web application Web-EcoYield-SAFE, a new module was integrated in order to add financial outputs to the range of information already available to the user. To demonstrate its usage, the financial cumulative net margins (with and without grants) are shown for a case study based on silvoarable experiments in the UK.

Keywords: financial modelling; online platform; stakeholders; user-friendly; model; scenario comparison;

Introduction

Numerous studies have indicated that financial return is an important determinant of whether farmers implement agroforestry (Graves et al. 2009; García de Jalón et al. 2017a). Actually when considering the implementation of agroforestry systems, there's an evident need to evaluate its biophysical development as well as its socio-economic aspects. Since long-term experiments for these systems are still scarce, so are empirical datasets for entire tree rotations. This makes modelling an essential tool when implementing agroforestry systems, to evaluate their performance and feasibility.

A new financial module is here proposed to be included within Web-EcoYield-SAFE, a web-based decision support tool that allows farmers and advisors to estimate the long-term growth and environmental impact of agroforestry systems (relative to agriculture and forestry). This module is based on the Farm-SAFE model (Graves et al. 2007, 2011), and will allow users to compare the financial and economic performance of arable, forestry and agroforestry systems.

Farm-SAFE adaptation and integration into Web-EcoYield-SAFE

The proposed financial module integrates Web-EcoYield-SAFE, a web implementation of EcoYield-SAFE (Palma et al. in preparation), a development of the agroforestry process-based model Yield-SAFE (van der Werf 2017).

This financial module was developed in Python, working as a web service directly accessed by the interface. It was based on the Farm-SAFE model, a Microsoft Excel-based spreadsheet model (Graves et al. 2007, 2011) developed during the SAFE project to initially assess the financial profitability of silvoarable systems (Dupraz et al. 2005).

The new module performs the financial assessment on the basis of the annual net margins. Following Graves et al. 2007, for the crop component, the revenues and costs were applied according to the proportion of the arable system. Revenues include grain, straw and grants. It was also assumed that cropping would only continue if the intercrop net margin was profitable, after which it was assumed the intercrop area would be fallowed. The financial data for the tree component comprised the revenue from timber, firewood and subsidies, and the costs of woodland establishment and management.

The financial net margin was calculated as revenues (R: € ha^{-1}) minus costs (variable VC and fixed FC: € ha^{-1}). Revenues and costs were discounted and converted into discounted net present values (NPV: € ha^{-1}), denoted using Eq. 1:

$$NPV_F = \sum_{t=0}^{n}\left(\frac{(R_t - VC_t - FC_t)}{(1+i)^t}\right) \quad (1)$$

where R_t , C_t were respectively revenue and costs in year t (€ ha^{-1}), i was the discount rate, and n was the time horizon for the analysis. The financial profits of the different systems were compared in terms of an equivalent annual value (EAV: € ha^{-1} $year^{-1}$) using Eq. 2:

$$EAV_F = NPV_F\left(\frac{(1+i)^n}{(1+i)^n - 1}\right)i \quad (2)$$

Case study

In order to demonstrate the usage of the financial module, a case study was chosen that compared three land use systems: 1) an arable system with four-year crop rotation (wheat, wheat, barley and oilseed); 2) a forestry system with a poplar plantation (156 trees ha^{-1}) and 3) a silvoarable system with poplar tree (156 trees ha^{-1}) with cropped alleys with the same rotation of the arable system. These were based on experimental silvoarable sites in Silsoe, United Kingdom, with a 20 year rotation period (Graves et al. 2010).

The analysis was performed for a 4% discount rate using prices and costs from García de Jalón et al. (2017b).

Results and discussion

The financial module

The new module is divided between system components (crop, livestock and tree), revenues (main and by-products prices), grants and cost types (variable, fixed and labour costs) (Figure 1).

To assess the profitability of a given system some steps need to be addressed: (1) identify the main characteristics of the site and system components; (2) define additional financial input values, such as the plot area, discount rate, management operations, labour, grants, costs and prices; and, finally, (3) run the established scenario, which will, in turn, run EcoYield-SAFE to generate the biophysical data needed and then the new financial module to generate the financial and economic outputs, which include economic indicators such as net present value, cash flow and equivalent annual value.

These outputs can be viewed on the web-app, in a graphical form, or downloaded as a CSV file for further examination.

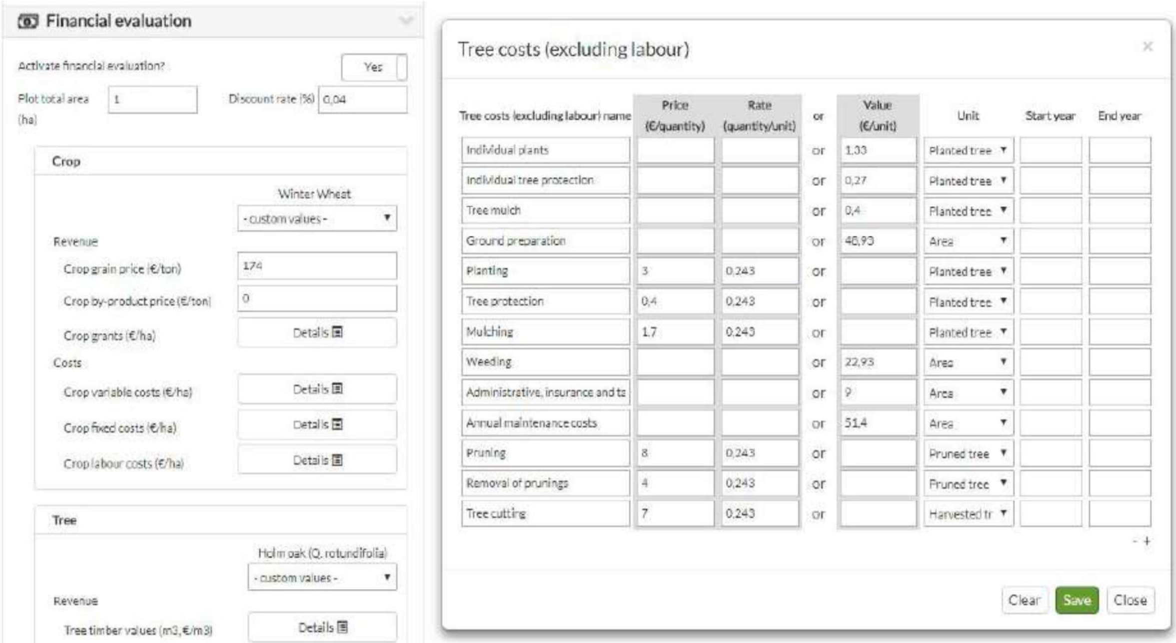

Figure 1: Financial module interface detail.

Case study

Figure 2 shows the financial cumulative net margins with and without grants for the presented arable, forestry and silvoarable systems. At the end of the rotation, for both analyses with and without grants, the arable system was the most profitable landuse, followed by the silvoarable and forestry system.

Only for the first 3 years does the forestry system presents a higher cumulative net margin then the silvoarable system, due to the fact that it was considered eligible for receiving planting and maintenance grants that are paid in the first 5 years (García de Jalón et al. 2017b). When excluding grants, forestry land use only reached positive net margin values at the end of the rotation (with the clearfell).

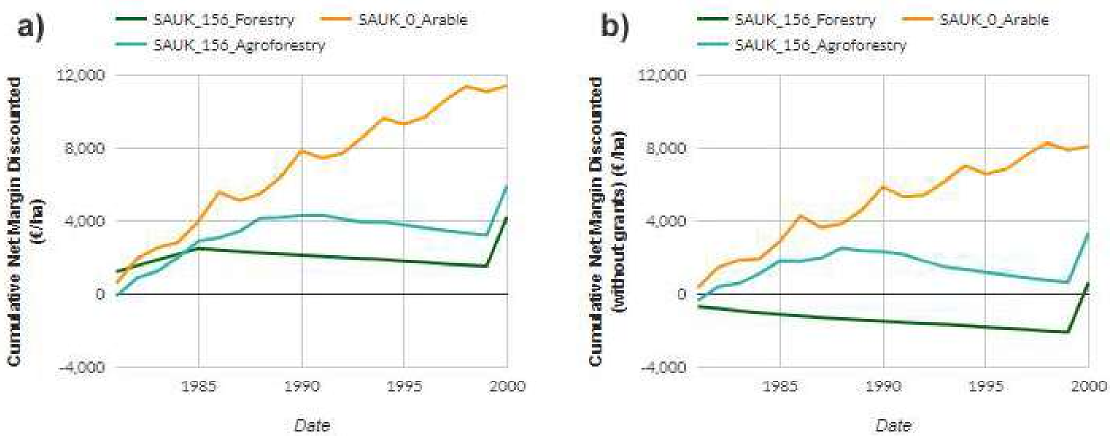

Figure 2: Financial cumulative net margin with (a) and without (b) grants.

Conclusion

The integration of the new financial module within the Web-EcoYield-SAFE model now provides users with a tool that can be used to undertake integrated biophysical and financial appraisals of agroforestry systems, thus improving assessments of the impact of different management decisions.

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