(MOCA v 1.0) – MOCA v 1.0 (Coffee plantations agroforestry simulation model)

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Technological Offers type

Software

Research and innovation areas

- Agricultura, silvicultura, recursos naturales, usos de la tierra y crecimiento azul

Where?

Agricultural Environmental Risk Management Research and Study Centre (CEIGRAM). Joint UPM-ENESA-AGROSEGURO Centre
Agricultural Systems Group (AgSystems)

Software description

The aim of the program is to determine the most appropriate tree density for production, and apply the model in different soil and climate change scenarios.

The model was made on the VENSIM®DSS version 5.6 design platform, which applies systems¿ dynamics to resolve a system of differential equations by priority.

Description.

The MOCA model built with VENSIM®DSS version 5.6a is a mechanistic, dynamic simulation model of coffee plantations. The model is divided into two levels, abiotic (climate and soil) and biotic (trees, coffee plants and herbaceous plants), and makes it possible to study the relationships between the two systems using a series of variables and parameters, flow equations and the assumptions made to simplify the real system. MOCA is designed to study coffee yield at regional level and the results cannot be extrapolated to specific estates without a more precise calibration and validation, given that the slope of the ground and coffee plant pruning have not been taken into account.

Calibration and validation.

The calibration of the model's three biotic systems (trees, coffee plants and herbaceous plants) was done with bibliographic data for the main coffee growing areas in Honduras. Climate and soil data must be provided as inputs. While the file relating to climate gives daily temperature, rainfall and solar radiation data, the soil file needs to include information about the texture of at least three soil horizons, as well as their apparent density and depth.

Simulating coffee yields can be done via two different routes. One uses coefficients of the total accumulated biomass distribution. The other uses non-photosynthetic aerial biomass calculated depending on the flowering and fruiting of each plant in relation to the accumulation of non-photosynthetic aerial biomass the previous year, that is to say, the branch formed the year before that will produce flowers. The validation for the Honduras data using biomass distribution coefficients is the one that best describes annual variation (with an r2 correlation coefficient of 0.93), while the yield simulation using non-photosynthetic aerial biomass from the previous year is the one that gives an average yield more in line with the average values seen (residual mass coefficient, RMC, of 0.0062). The yield calculated as the minimum between the two methods does not express the trend well enough, even though it has a very tight average (RMC = 0.0162). Nevertheless, the model requires validation for each place it is used, and depending on the information available one method or the other would be more advisable to calculate coffee production.

Coffee growth and development in the shade is well simulated and describes crop evolution in the field suitably. Plant fatigue, which is a highly important aspect in coffee production, also seems to be well simulated, in full sun crop systems as well as systems in the shade. The model makes it possible to study up to what point it is necessary to insert water restrictions on the growth of coffee plants in the shade in Central America and Honduras. The influence of the photoperiod on coffee growth and production can also be studied, to shed more light on an aspect of coffee production that is unclear in the areas near Ecuador. It can also be used in impact studies on climate change and global change that may affect the crop.

Reference

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