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Application note

FDMS, Farmland Diversity and forage production unit Management Simulator

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Abstract

FDMS (which stands for Farmland Diversity Management Simulator) is an original software able to simulate the effect of farmland diversity and forage management practices on land use during a growing season in dairy farming systems. In this paper we describe how students, scientists or advisors can use this software to test different environmental scenarios (weather data and field characteristics) and management strategies at the farm scale.

Keywords: Dairy farming system; Farmer's decision rules; Grass growth; Object-oriented model

1. Introduction

Farmland diversity (differences between fields with respect to altitude, aspect, vegetation, soils), which is a characteristic of low-input farming systems, has an impact on the spatio-temporal availability of forage. As a result, farmers organize their practices according to field characteristics. But farmland diversity is seldom included in existing models of farming systems (Batchelor et al., 2002), in which sources of diversity are usually limited to soil nutrient content and/or soil water capacity (Cros et al., 2003). By linking biophysical and decision sub-models, the Farmland Diversity Management Simulator (FDMS) enables assessment of the consequences of a range of farmland configurations, weather conditions and decision strategies for land use practices at the farm scale. In FDMS, grass growth and forage management practices (rules or indicators that trigger these rules) are a function of differences between fields and weather criteria. Three major decision strategies can be simulated (a basic strategy and two improved strategies) corresponding to an increasing consideration of between-field diversity in decision rules monitoring the forage production units (grazing and conserved forage production units). For example, the rules plan the fields to be grazed, turnout date or harvesting dates. A detailed description of the structure of the biophysical and decision sub-models and the process of validation is given in Andrieu et al. (2007). The aim of this paper is to give a brief overview of the software to show how it can be used by students, scientists and advisors to discuss and test interactions between farmer's decision strategies and the environmental conditions (weather, field characteristics) of the farm.

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2. Materials

2.1. Performing a simulation

The software was developed using Python, an interpreted, interactive, object-oriented programming language, freely usable and distributable (www.python.org). The Python implementation is portable: it runs on different operating systems (UNIX, Windows, MacOS, etc.). In order to run the simulator, the Python interpreter must first be installed on the system. The program runs on minimal hardware configurations. However, for reasonable execution speed, at least PIII 500 MHz is recommended.

FDMS will be available at www.clermont.cemagref.fr/GT/DFCF/DFCFaccueil.htm.

FDMS uses three types of inputs: a weather data file (*file.met*), a farm file (*file.exp*) and a decision-maker file (*file.dec*). The weather data file is a daily list of rainfall, radiation, evapotranspiration, and average temperature data. The farm file corresponds to the basic structural characteristics of a farm (maximum stocking rate of the barn, herd size, list of fields with their specific attributes). The decision-maker file is a set of implemented decision rules that, depending on the size of the herd, and on weather data and field characteristics, plans their assignment to the different forage production units (FPUs) and then monitors the progress of the different actions (turnout to pasture, moving of the herd, cuttings, etc.) on a daily basis.

For the three inputs used by the simulator (*file.met*, *file.exp*, *file.dec*), default files are configured: data from a weather station located in the centre of France (altitude: 800 m, latitude: 45.70°, longitude: 3.02°), a farm of 12 cows and 16 diversified fields and basic strategy rules (Andrieu et al., 2007). If desired, the user can choose to start the simulation using them, but he or she can also modify them ("Edit" function), download existing files ("Open" function) or create new ones ("New" function) using the File menu of the menu bar or the "Inputs configuration" functions of the interface that open specific data forms. For the creation of a farm file, the user must first specify the maximum stocking rate and initial stock of hay in the barn at the beginning of simulation. Then the user must indicate the herd size using a scroll bar and create the grassland fields using the "Add a field" button. For each field created, the user must indicate the distance to the cowshed, the altitude and initial grass availability and, using a drop-down menu, choose between three kinds of aspects (flat, southern or northern exposure). The user must also (i) using check boxes define the field ability to be mechanized for hay making or to carry grazing animals, (ii) indicate the soil water capacity, (iii) using a drop-down menu, choose between 5 preset types of grassland vegetation and (iv) give a name to the field. To create the decision-maker file, using a multiple-choice list, the user must choose one of the three decision strategies. Once the strategy has been selected, the thresholds that trigger the rules during the simulation (for example, the minimal biomass or the minimal sequence without rain triggering the hay cut) can be modified.

Using the "Start the simulation" button, the user can then start the simulation, which, unless otherwise directed, begins at year 1 and ends at the end of the weather data series. But the starting year and duration of the simulation can be specified using the "Beginning" and "Duration" drop-down menus or stopping it in the course of the simulation using the "Stop the simulation" button.

2.2. Software outputs

Using the Export menu of the Menu bar, the outputs of the simulation can be exported in CSV format ("Activities", "Field herbage production", "General", "Allocations" functions); using check boxes, the user has to specify the fields or variables to be exported. The variables are then presented as data tables, each column corresponding to a variable and each line to a simulated day. The variable exported can be the nature and amount of forage eaten by the herd, the herd's location, harvests ("Activities"), outputs of the biophysical sub-model – for example herbage growth rate – ("Field herbage production"), forage availability ("General") and the allocation of the fields to one of the FPUs ("Allocations").

In HTML format the "Calendar" function allows export of a calendar of the daily use of the fields, with the amount and the feeding value of harvested forage indicated in case of cutting. Export generates as many files as simulated years.

Using the Graphs menu of the Menu bar, some of these outputs ("Activities", "Field herbage production", "General") can also be visualized as graphs; using check boxes or buttons, the user has to select the variables to be projected on the axes, the corresponding units, the fields and the year desired.