On-farm fertilisation plan algorithm

Introduction

The FaST Action implements in participating Member States and Regions, including Romania, a platform and a farmer's app for the generation and re-use of solutions for sustainable and competitive agriculture based on space data (Copernicus and Galileo) and other public and private datasets.

The aim is to develop a comprehensive digital ecosystem for sustainable farm and land management in Europe and to support farmers in their administrative decision-making processes, for farm profitability and environmental sustainability. Also, it will provide a reliable on-farm landing spot for digital solution developers (including satellite-based solutions) and service providers, and it will reduce administrative burdens for farmers and Paying Agencies, and streamline communication between the farmers and public authorities.

In this frame, the platform and farmer's app in participating Member States has to be developed,.

Background

The nutrients management is an up-to-date issue in the last period, in the frame of adapting the European Union environmental regulation. The main problem is the groundwater pollution, mostly in the nitrates vulnerable communes (NUTS5 level), leading to the potable water pollution from public or individual wells, most of them placed not far from households(DUMITRU et al., 2006). The main source of pollution is the relative great and unprotected manure quantities reaching the groundwater, being a potential danger for ground and surface water quality. Another pollution sources are the sewage sludge effluents, the waste residues (organic and inorganic) accumulated in the surface water bodies or infiltrated directly in soil, contamining water in the well water, as well as the solid compost piles.

Therefore it is a need to develop nutrients management plans at local level (LAU2 or farm). In Romania, a large action plan at the Vulnerable Area to Nitrate Pollution level was developed in order to prevent, reduce or retrieve surface and ground water bodies pollution with nitrates from agricultural sources in areas assigned as Vulnerable or Potential Vulnerable Areas to Nitrate Pollution. This plan holds the main measures that should be taken by farmers as well as by local authorities, having also an important role in public awareness, information dissemination and in measures applications tracking.

On-farm fertilisation plan algorithm

The algorithm takes into consideration the needs of actual crop, the vegetal residues of previous crop, the further increase of nutrients pressures (in the terms of kg N manure per hectare available for disposal), as well as the increasing livestock (leading to increasing areas for manure recycling). The individual farms could sometimes share the manure amounts with their neighbors. The aim of the Nutrient Management Algorithm is therefore: a safe disposal of sewage sludge and other organic residues; the insurance of minimum environmental losses of nutrients, as well as minimum transport costs, and an efficient nutrients use for the crop.

The management algorithm for (organic and mineral) nitrogen fertilizers is based on the description of N cycle in soil-plant-hidrosphere system, taking into account the following soil N forms: inorganic nitrogen (nitrates), organic nitrates from vegetal residues incorporated in soil, organic nitrates in active and stable form associated with soil humus stock, organic nitrates from organic manure. The nitrogen alteration processes between different N forms (humus mineralization, vegetal residues decomposition and the associated mineralization, denitrification and imobilization) are described through equations for chemical cinetic associated, the reaction speed being influenced by temperature, soil moisture, and the different nitrogen ammount from each form types. Mineral nitrates flux percolating under the roots depth (leaching) is calculated as function of water drained flux and average nitrates concentration on soil profile.

The time step for calculation is monthly average. The used equations are similar to those of SWAT methodology (Neitsch et al., 2001). The water balance in soil-plant-hydrosphere system (potential and actual evapotranspiration, drainage) is based on Thornthwaite-Mathers method (Thornthwaite et al., 1957), using average monthly air temperature and accumulated monthly precipitations.

Running the application, the management plan (mineral fertilizers ammount for a balanced fertilization) for a certain crop (type and expected yield), a certain previous crop (type, yield, the vegetal residues management) and farm manure use will be calculated.

The following inputs will be used:

- soil type and soil parameters;
- climatic data;
- farm localization and area;
- number of animal;
- the methods of manure application;
- the expected yield;
- the previous yield, as well as the percent incorporated in soil.

The soil data is presented in second chapter.

Climatic data

The average monthly air temperature and precipitation values are necessary. If these values are not available, the application uses a database with monthly air temperature and precipitation values on a 10 x 10 km grid for two series of years 1961-1990 and 1991-2000, developed in ATEAM/MARS project.

The previous and the expected yields

The input data regarding the previous and the expected yields could be chosen by the user, by assisting the user to evaluate the average yields for different crops for each commune. The nitrogen used by plants is further calculated by a specific subroutine using the transfer coefficients provided by the Code for Good Agricultural Practices.

The vegetal residues from previous crop

The vegetal residues from previous crop are evaluated as function of two parameters provided by the user: the percent of secondary yields incorporated in soil and the date of incorporation.

The manure quantity applied

The livestock owned by each farmer is specified. Also, the manure collecting and storage methods, as well as storage period are specified. If it is necessary, the starting and ending date for grazing, as well as the manure storage method for grazing period are specified. If the manure quantity is higher than the Nitrates Directive recommendations, the application warns the user in order to share the exceeding with other farmers.

The software outputs

The final result of this algorithm is the assessmment of mineral fertilizers necessary to balance the nitrates export to the present crop as well as the nitrates flux leached under the root depth. This leached flux is evaluated according to the application date and to the applied quantities (with an interface interactive for the user).

Therefore, the outputs are as follows: the animal concentration (UVM/ha), the nitrates ammount for the expected yield, the mineralizated nitrogen from vegetal residues, and from manure, the imobilized nitrogen, as well as the nitrogen leached. The final output is the needed mineral fertilizers, used for an uniforme fertilization.

The structure of the algoritm is presented in Annex 1. It consists mainly in several subroutines presented below.

This report presents the subroutines of On-farm fertilisation plan algorithm in a .doc file, a calculator for transform the livestock manure contribution to the N balance, as an .xls file, the flowechart of the process in a .pdf file, and two files presenting two Pedotransfer Rules developed in ICPA, regarding the estimation of Bulk Density and Soil Organic Carbon and Humus stocks based on soil type and texture, as .xls files.