

SOLID-DSS – an online application balancing forage supply and demand in organic low-input dairy farming

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Abstract

As part of the EU research project SOLID, a decision support system called SOLID-DSS is currently being developed. SOLID-DSS will offer decision support to organic low-input dairy farmers by modelling both the status quo of the dairy herd as well as future scenarios, and then evaluating all changes regarding the risk of feed shortages. Thereby, the user will be able to compare management changes with regard to their ability to lower the risk of feed shortages. SOLID-DSS consists of three sub-models: a crop model simulating forage growth and quality throughout the year, a herd model describing the herd structure, and a diet model suggesting diets for all groups of cows throughout the year. Work on SOLID-DSS is still ongoing, with the final aim of an online-application usable in many European countries.

Introduction

In organic low-input dairy farming, the forage proportion of the cows' diets is usually higher than on conventional farms, and the herd's requirements are largely met by grazing and conserved forage from permanent grassland or perennial leys. The risk of weather induced on-farm feed shortages is therefore of greater importance, and optimal use of home-grown forages improves the independence from the price volatility of feed markets.

As part of the EU research project SOLID (Sustainable Organic and Low Input Dairy Systems; www.solidairy.eu), a decision support system is currently being developed which will evaluate dairy farm management with regard to the risk of feed shortages. By simulating management changes, this online application shall offer support for management decisions and help balance forage supply and demand to reduce the risk of feed shortages. This research has received funding from the European Community's 7th Framework Programme (FP7/2007-2013) under the grant agreement number FP7-266367.

Description of SOLID-DSS and the underlying models

Input

In order to describe the current situation of a farm, the user has to provide information on the location, the area and type of farm land, details of plant production and grazing management, and characteristics of the dairy herd.

Modelling

SOLID-DSS then simulates the farm using the two sub-models crop model (feed supply) and herd model (feed demand). The third sub-model, the diet model, connects supply and demand and produces the output for the user.

The crop model simulates forage (grassland and a set of arable crops) growth and quality throughout the year, based on climate data derived from ECA&D (European Climate Assessment & Dataset 2014) data. The crop model is derived from MONICA (Nendel et al. 2011), a dynamic soil and generic crop growth model, extended with an implementation of the crop model of SGS Pasture Model (Johnson 2013). The data produced by the crop model are the amount (dry matter) and quality (contents of energy and protein) of feed available in all given time periods throughout the year.

The herd model describes the herd structure, including number and categories of cows and their calving pattern. For most parameters, e.g. the lactation curve (both milk yield and milk solids), the herd model will offer default values that can be adjusted by the user. The data supplied by the herd model is a description of all groups of cows (dry, lactating, young stock), including the number of cows and their production level in all given time periods throughout the year, and their requirements of energy and protein. Because the decision

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support system should be usable throughout Europe, energy requirements will be calculated according to several national systems of feed evaluation (United Kingdom, France, Germany,...). In the prototype, only dairy cows will be considered, but later-on other animal categories will be added (heifers, calves, beef cattle,...)

The data supplied by the crop and the herd model are then connected in the diet model. Both over- and undersupply of energy and protein are minimized using a linear solver and diets for all groups of cows throughout all periods of the year are suggested. The user can then test these diets in specialized diet optimisation programs for further detailing. The feed intake of the cows will be predicted using the model Grazeln (Faverdin et al. 2011, Delagarde et al. 2011), and will be treated as a constraint when formulating the diets.

Output

The output of SOLID-DSS will include the suggested diets throughout the year, and an indicator reflecting the risk of feed shortages that the farm is currently facing. An example: In one out of ten years, the forage supply in early spring is not sufficient to satisfy the herd's requirement due to a long winter and a delayed first turn out to pasture.

Area and limits of utilization

SOLID-DSS can assist both in regard to short-term management questions as well as to long-term strategic planning. In the short term, SOLID-DSS can simulate just one year of the current management, and the resulting diets for the different groups of cows can then be used as recommendations to distribute the available feeds optimally throughout the year.

For long-term strategic planning, simulations of the status quo and the situation originating from different management changes, both over numerous years, can be compared and all changes can be evaluated against the status quo. Because SOLID-DSS will not be able to predict e.g. harvest dates and yields exactly, and in reality it is not possible to manage a farm in an ideal manner (optimum harvest date plus optimum grazing day plus ideal herd structure etc.), all management options will be evaluated in their probability to lower the risks: How much would an improvement in management towards an ideal situation reduce the risk of forage undersupply?

Basically there are three possible areas of intervention to reduce the risk of a feed shortage: An increase on the supply side, a reduction on the demand side, and a better balance of demand and supply. To increase the feed supply, additional land for forage production can be acquired, cash crops can be substituted with forages or intermediate crops can be grown. Therefore a possible question might be which forages should be grown on additional land to minimize the required area. A reduction on the demand side can be achieved by altering the herd structure, e.g. changing the number and production potential of cows or keeping cows longer to reduce the proportion of non-producing heifers. The third intervention area is the better allocation of feeds. The reduction of waste due to improper diets can be an important factor for reaching a better feed security. Possible questions could be how grouping of cows affects feed allocation and the reduction of over-supply of energy and protein, and the optimal supplementation of available forages.

Outlook

In an agricultural production influenced by a changing climate and changing perceptions of the general public towards farm animals, we believe that flexible production systems and open communication with consumers will be the main factors of success. In this regard, we see SOLID-DSS as a valuable tool that offers decision support to farmers and can also be used for easy communication of the characteristics of grassland-based dairy farming. Work on SOLID-DSS is still ongoing, and as soon as the prototype is running, all further development will be assisted by evaluation with real data and case studies.

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