SOLID | Sustainable Organic and Low Input Dairying

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There is a feed for every need

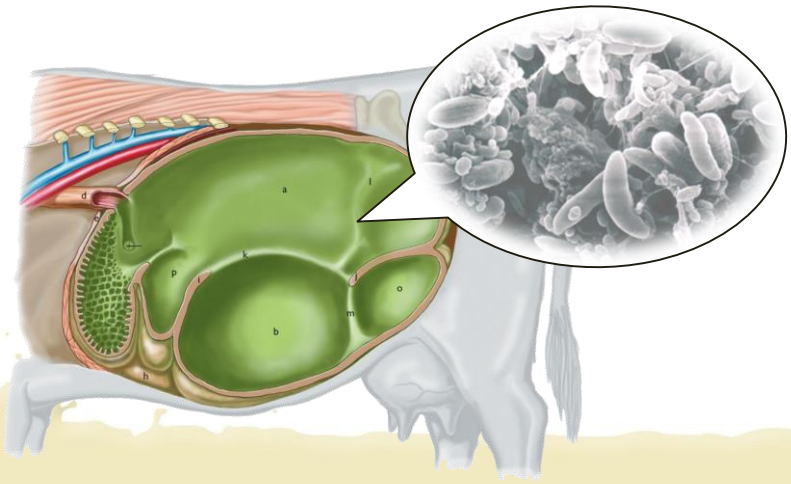
WP3 Forages for productivity, quality, animal health and welfare in organic and low input dairy systems

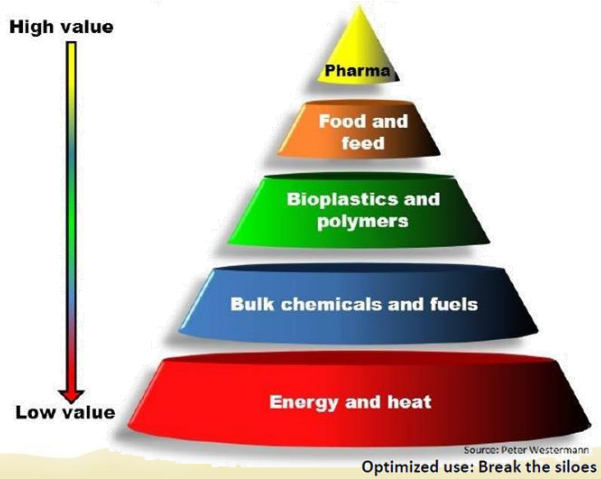
WP leader Prof. Marketta Rinne, Natural Resources Institute Finland (Luke) and SOLID WP3 team

SEVENTH FRAMEWORK PROGRAMME

Ruminants are special in being able to convert fibrous biomass into high value human foods

- Organic and low-input dairy farms rely on forages produced on-farm
- By-product feeds may be beneficial to smooth out temporal feed shortages
- Use as feed may be economically and environmentally efficient recycling of the nutrients in the by-products
  - Added value compared to e.g. burning, biogas production or composting for soil amendment





Source: Peter Westermann
Optimized use: Break the siloes
Between biotech, chemistry and healtl

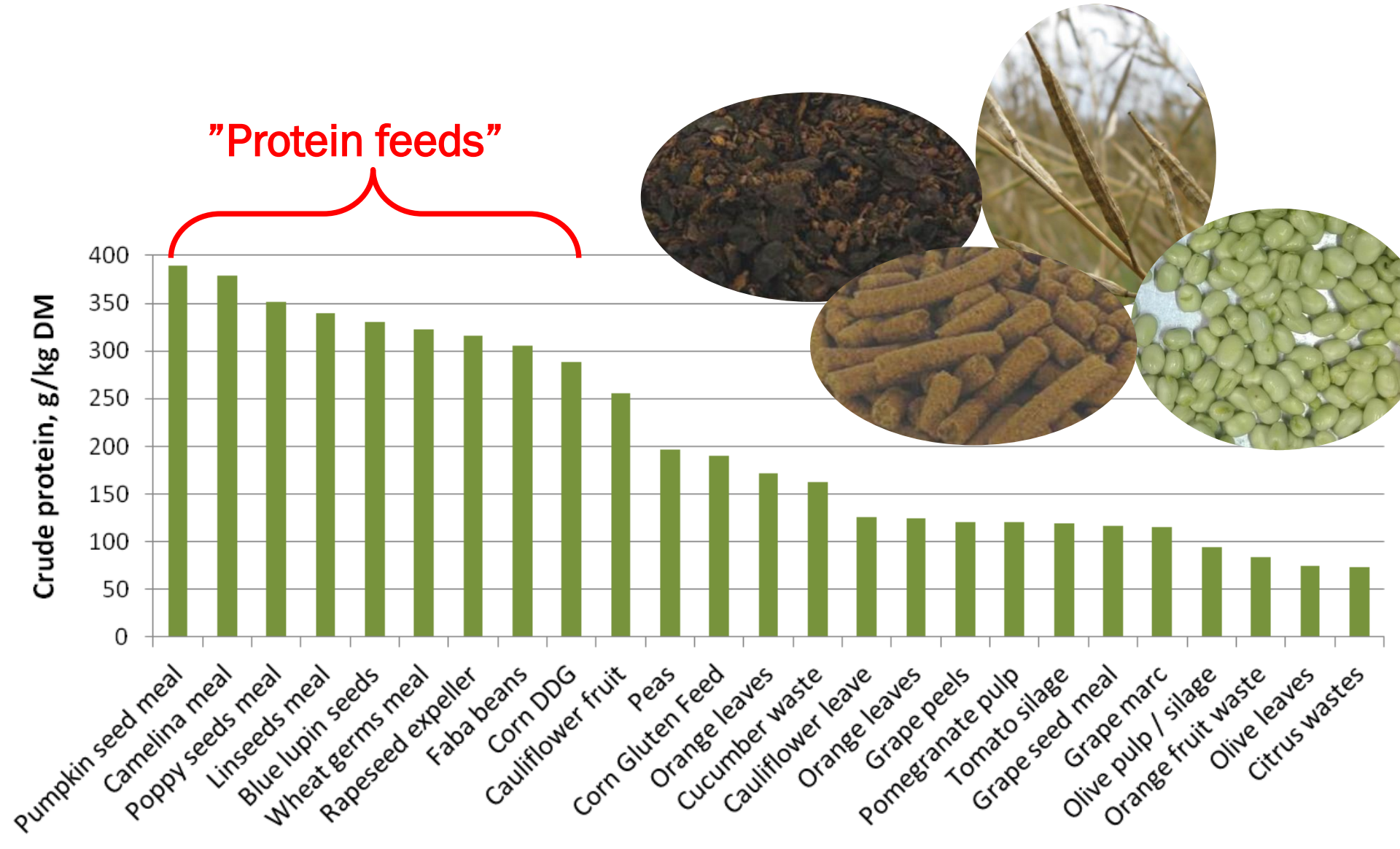
Various aspects of feeding in organic and low input systems were targeted in four tasks:

- Task 3.1: Development of novel and underutilized feed resources including by-products from processing of renewable raw materials
- Task 3.2: Assessment of an agroforestry system in terms of a novel integrated willow-based bio-energy/organic dairy production system, especially the role of woody perennials for feed supplementation in organic dairy systems
- Task 3.3: To derive estimates of energy utilization by dairy cows on high forage diets
- Task 3.4: Development of a decision support model for optimum management of forages and by products in organic and low input systems

European wide screening of novel & underutilized feeds: Research can support wider utilization of novel feeds

- We first conducted a literature review
- In the next step, feed samples were collected from farms, companies, and other projects in Finland, Spain, Romania and UK for laboratory analyses
- Finally some feeds were evaluated in on-farm trials
  - Spain: Tomato, olive, cauliflower and citrus side streams
  - Romania: Camelina meal, grape marc

Feeds were screened for various characteristics, here results of crude protein concentration



Europe needs to improve it’s self sufficiency in protein feeding of farm animals

- Again, thanks to rumen microbial protein production, ruminants are not as dependent on high quality proten supplementation as single stomached animals
- However, approximately 10 % increase in milk production can be expected when basal feeds are optimally supplemented with high quality plant protein
  - Desicion about level of supplementation is an economic question
  - Higher protein supplementation also decreases the nitrogen use efficiency in milk production

Fruit and vegetable by-products

- Roughly half of the fruits and vegetables in EU go to waste
  - Losses occur at all steps: Agricultural production, processing, distribution, consumers
- The materials are typically moist and easily spoiled, but with proper management (e.g. ensiling), can successfully be used as animal feed

Tomato waste co-ensiled with cereal straw in Spain




Variable solutions can have local significance

Whole-crop cereal forages allow diversification of forage feeding

- Grain legumes provide an option to maize with higher protein content, less dependent of N fertilization and suitable for environments where maize does not grow

Results from Finland

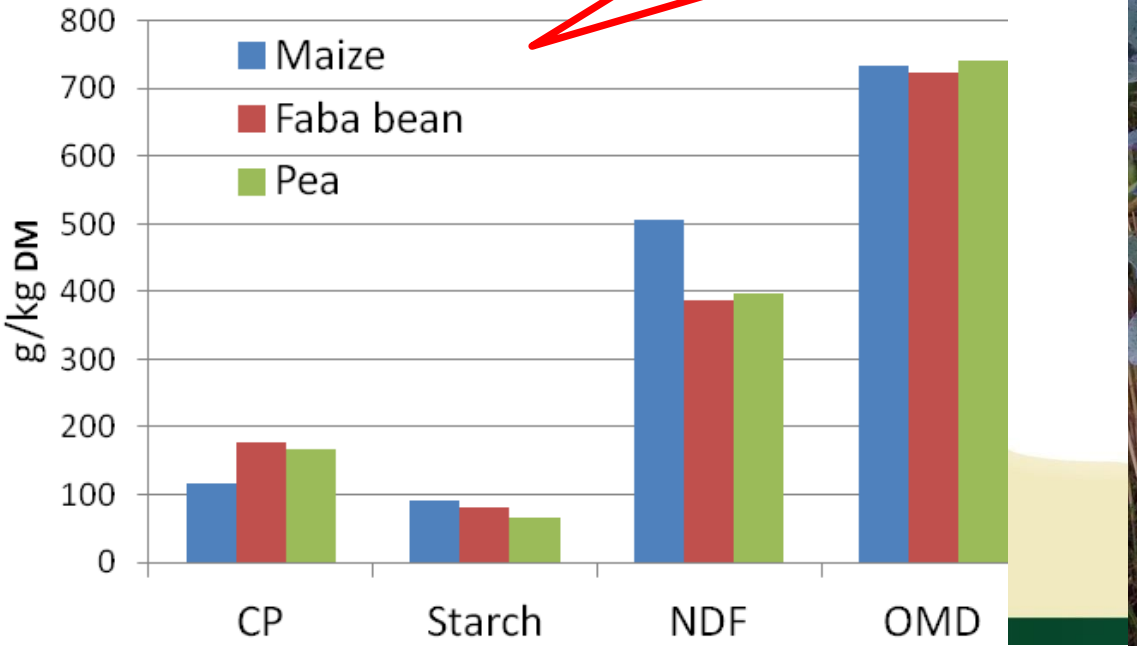


Photo: ©MTT Kaisa Kuoppala

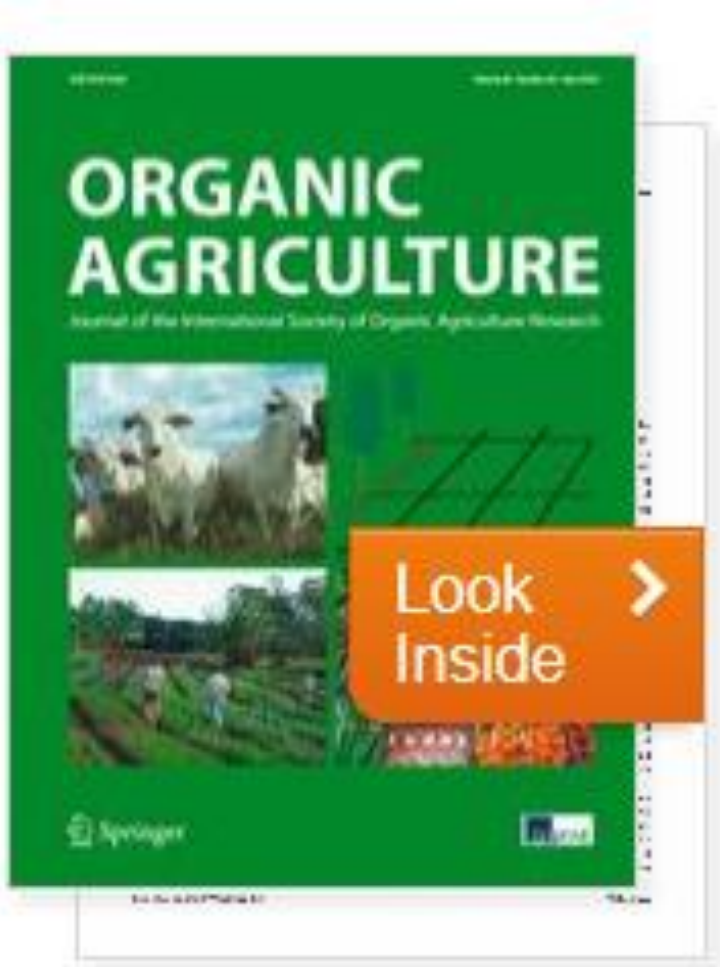
Agroforestry can provide multiple benefits

- Agroforestry can contribute to increasing overall productivity, but browsing from trees has low feed value
- Additional benefits include increased biodiversity, modifying the microclimate to improve animal welfare and soil carbon sequestration
- The cost of establisment of agroforestry systems is relatively high

Sampling of short rotation willow for both wood chips and feed in UK

Detailed report of ”novel feeds” work conducted in the SOLID project is available in ”Organic Agriculture”:

Rinne, M., Dragomir, C., Kuoppala, K., Smith, J. and Yáñez-Ruiz, D. 2014. Novel feeds for organic dairy chains. Organic Agriculture 4:275–284.



Forage based diets increase the maintenance energy requirements of dairy cows

- Dairy cows offered diets containing a large forage proportion (for example within low input or organic farming regimes) have a higher energy requirement to maintain their basal activity than those managed within higher concentrate input systems based on a large calorimetry data set from Northern Ireland (AFBI)
- Although the magnitude of the effect is rather small, there is a need to revise current energy rationing systems based on these results

SOLID DSS demonstrates on-line how feed supply and requirements can be balanced at farm level

- The SOLID DSS is a decision support system which helps to optimize the management of feed resources and feed supply systems within organic and low input dairy systems in Europe to minimize the risk of feed shortages.
- The model serves both organic and low input farms as long as they depend mainly on on-farm produced forages – and cannot buffer forage shortages with concentrate feeds
- Available at: https://zalf-lse.github.io/solid-dss/

SOLID-DSS / Sustainable Organic and Low-Input Dairying - Decision Support System / github project

Available at: https://zalf-lse.github.io/solid-dss/

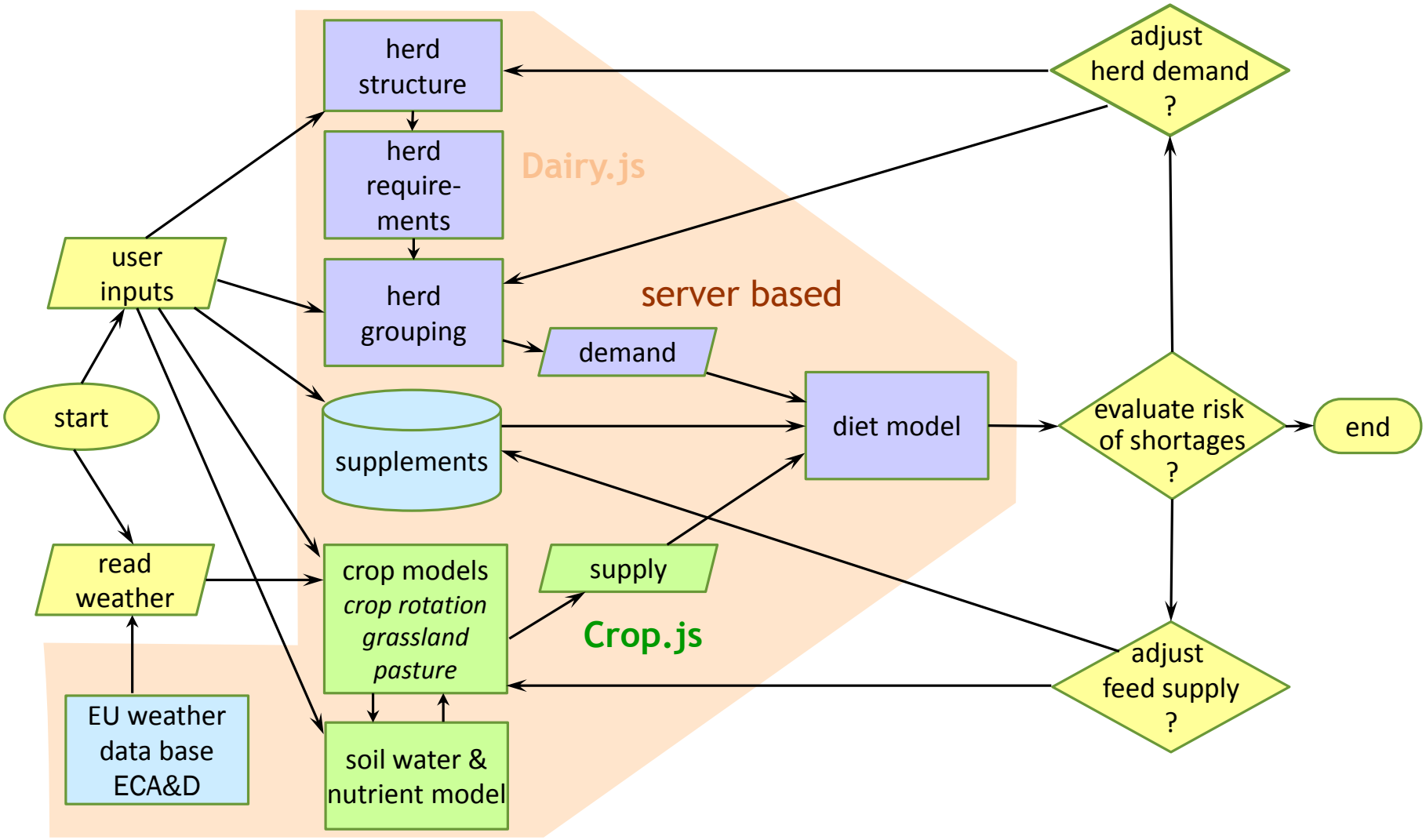
Usage

This decision support system helps you to estimate the longterm balance of forage supply grown on arable & grassland and demand from your dairy herd and identify potential shortages and overconsumption. Before you run the simulation you should go through these steps:

- Set your location and edit soil parameters.
- Set the properties of your dairy herd.
- Edit your rotations if you produce forage crops on arable land.
- Set grassland and pasture availability.
- Check yor inputs here and finally run the simulation.
- View results here, adjust simulation parameters and run the simulation again if necessary.

Please find additional help and more background information on our Wiki pages.

Structure and data flow within the Solid DSS



Crop and Forage Production

Total arable area

50 | ha

Grassland cut threshold

2500 | kg DM / ha

Total permanent grassland area

50 | ha

Grassland hay share

10 | %

Permanent grassland legume share

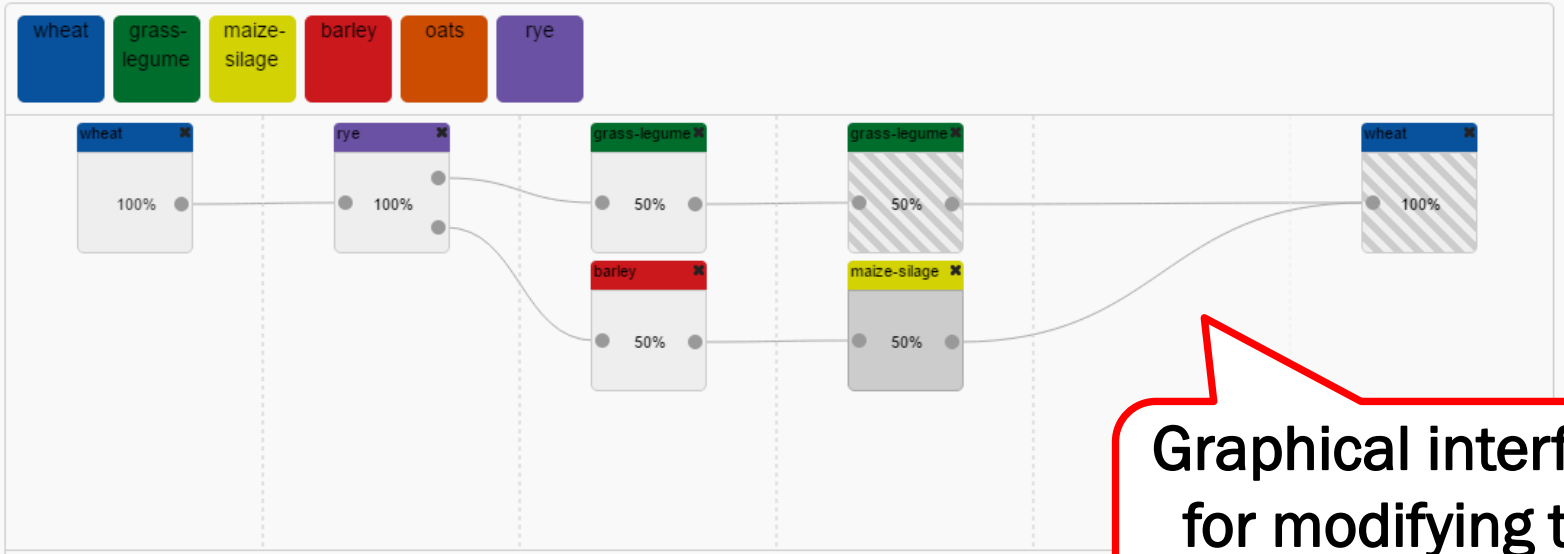
50 | %

Yearly nitrogen input on permanent grassland

50 | kg N / ha

Crop rotation

Drag and drop crops into the rotation, connect them and edit their properties. Only forages (maize silage and grass-legume) will be used in the diet calculations. Add the amout of concentrates available at purchased feeds.



Graphical interface for modifying the crop rotations

maize-silage, 6.25 ha each year

Nitrogen input

80 | kg N / ha

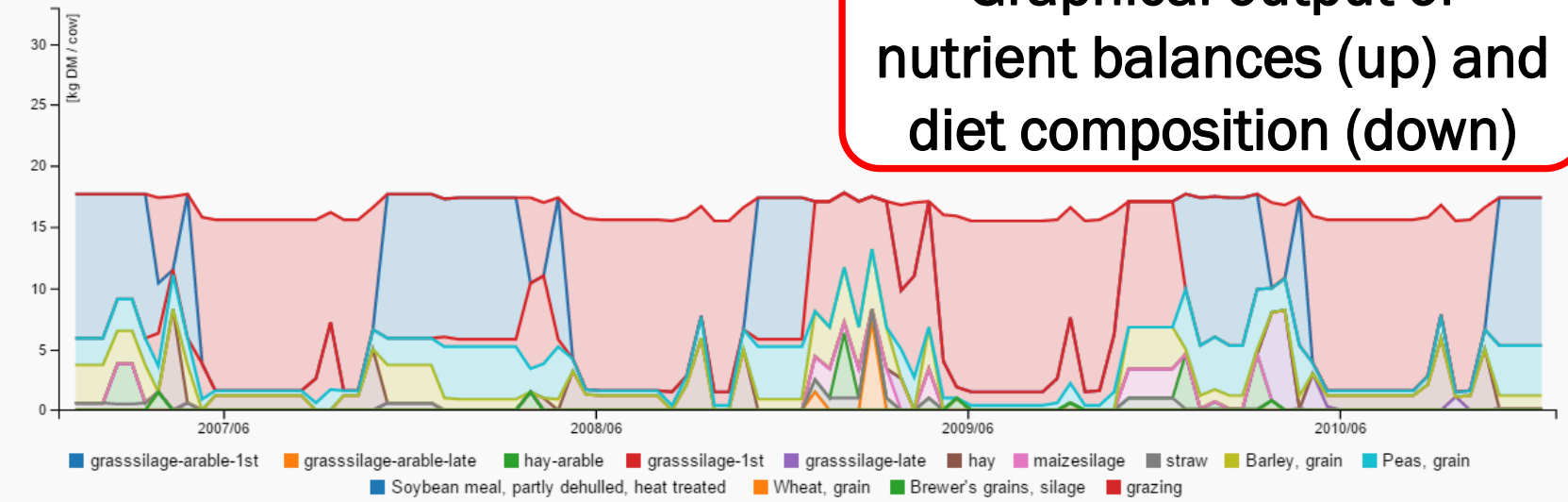
Irrrigated

No | -

Group 2, 17 cows

Energy and protein deficit and surplus in % requirements

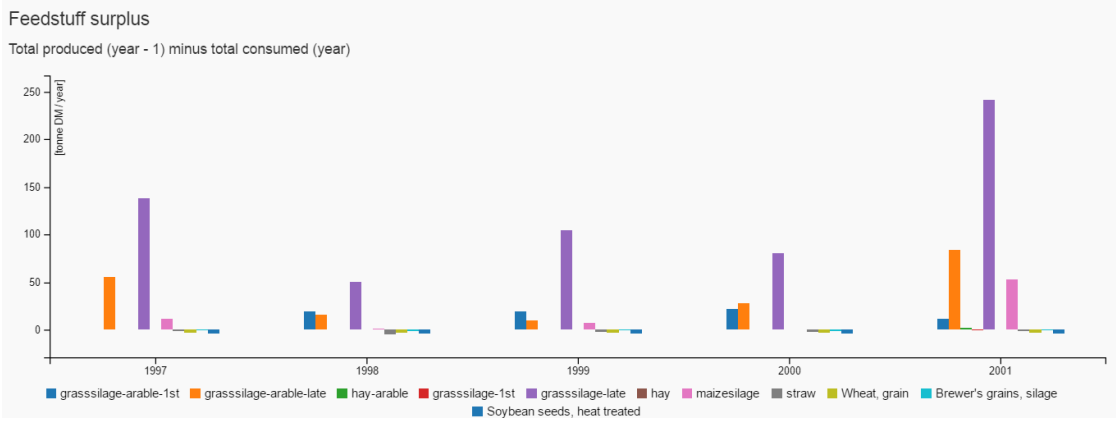
Total mixed ration

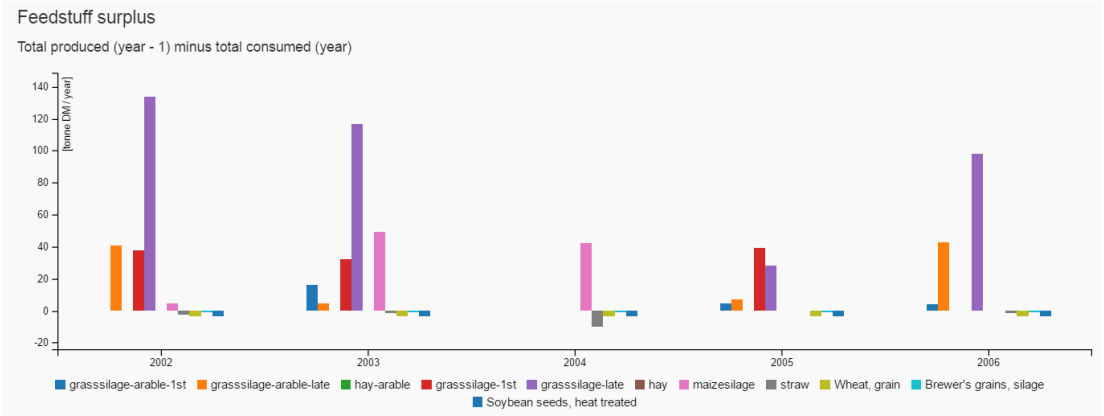


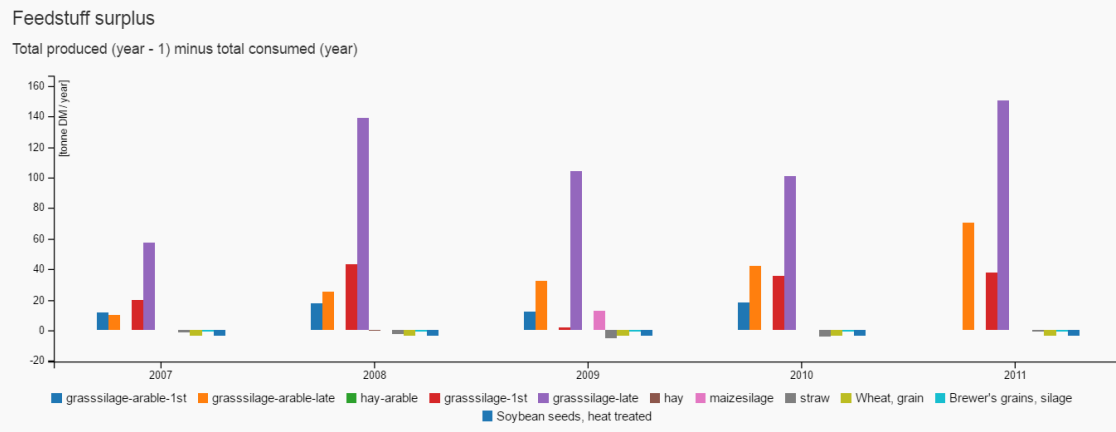
Graphical output of nutrient balances (up) and diet composition (down)

Repeated simulation runs of consecutive periods with the same input data settings, as shown in the three figures within the period from 1997 to 2011, can provide a visual risk assessment of potential annual forage shortages.

On the basis of such time series the effect of changes in the farm and herd structure in the crop rotation and provided feedstuff can be used for optimising the forage and feed production.







Pros and Cons of SOLID-DSS

- Available freely on-line at Available at: https://zalf-lse.github.io/solid-dss/
- Programmed in well documented open-source code → easy to use in future projects
- First open-source crop model able to model whole crop rotations (e.g. for a five year rotations, there are five step wise parallel runs)
- Arable and permanent grassland forage production and pasture grazing are directly linked up with a herd specific diet LP optimisation module
- Very limited need of commonly available input data (e.g. because daily weather data are provided Europe-wide; 1996-2010 from ECA&D project (http://www.ecad.eu))
- By calculating several multi-annual periods a site specific risk assessment of forage shortages can be performed (e.g. through including historical drought years 2003)
- Necessary simplifications (limited crop spectrum, simple cutting regime, storage of conserved forage only for one year, crop models are limited to non groundwater influenced soils, no grazing for dry cows)
- Model outputs of non-calibrated plant-soil simulation models in absolute terms should only be used restrictedly under real farm conditions
- But in relative terms provides a deeper understanding of the complex relationships and dependencies of sustainable organic and low input dairy systems. → well suited for agricultural extension and teaching

There is a feed for every need!

- The amount and quality of feeds offered to animals have significant effects on feed intake and milk production, which largely dictates the economics of the farm
  - Feed cost is the single largest variable cost in milk production
- Take into account effects that feeds have on animal health and product quality
- Use local strengths
- Be innovative
  - Bio-refineries provide potential new opportunities to the feed sector
  - In organic production, feeds need to be certified organic, and consumer acceptance kept in mind

Special thanks to WP3 team ☺ and other SOLID colleagues!

- David Yáñez-Ruiz, Catalin Dragomir, Christina Marley, Kaisa Kuoppala, Jo Smith, Tianhai Yan, Conrad Ferris, Johann Bachinger, Jan Vaillant, Lisa Baldinger, Werner Zollitsch and many others