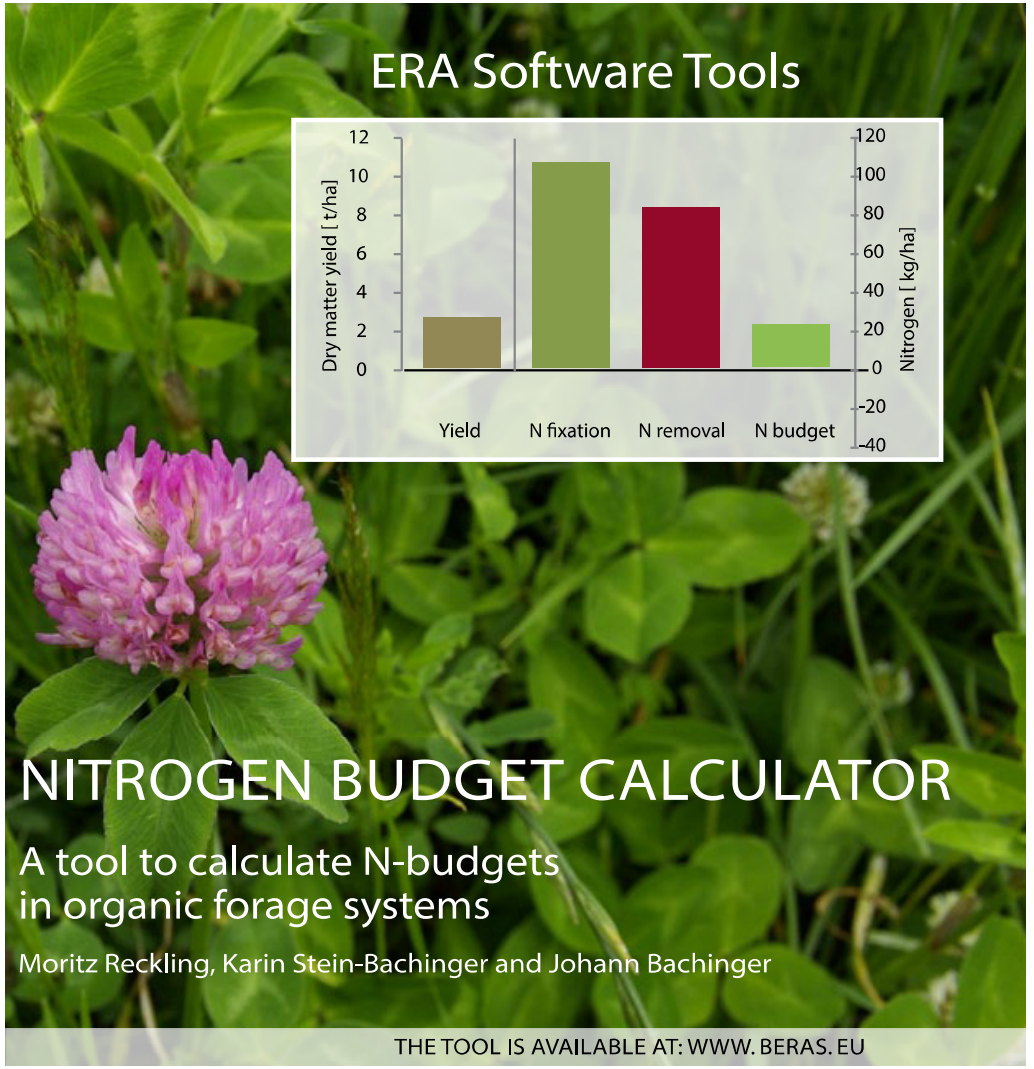
This manual is part of:

Ecological Recycling Agriculture
Vol. I Farming Guidelines
Eds. Stein-Bachinger K, Reckling M, Hufnagel J, Granstedt A (2013)
ISBN 978-3-00-042440-3



The software is also available at:
www.zalf.de/de/forschung/institute/lse/downloads/Seiten/oekolandbau.aspx

Why it matters

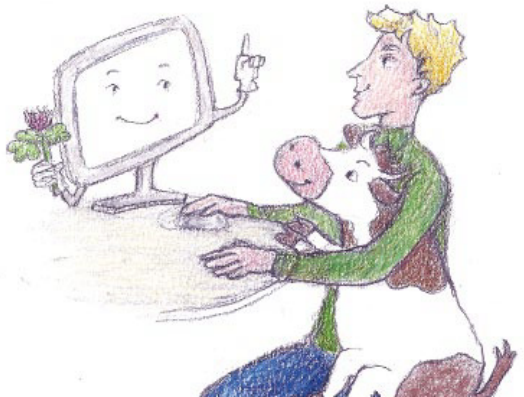
Ecological recycling agriculture (ERA) aims at effective nutrient recycling through self-sufficiency in fodder and manure production and low levels of external inputs. Legumes play a key role in the crop rotation of ERA farms to balance the N-cycle through N-fixation. To ensure a stable production with low emissions to the environment, ERA aims for balanced N-budgets over the whole crop rotation.

Importance of N-budgets

In organic farming systems, the N-surplus is much lower than in conventional systems [2, 7, 11] and below the maximum amount of 60 kg N-surplus allowed by the European Nitrate Directive (91/676/EEC) [20]. However, studies also show negative N-budgets at field level in some organic farms which can result in lower yields [11]. Therefore, field level N-budgeting is recommended on a regular basis to ensure that legume-grass mixtures lead to a net gain of N that can be used by subsequent crops.
The N-budget calculator facilitates a quick assessment of N-fluxes in legume-grass mixtures and simulates effects of an adapted management. In combination with the Legume estimation trainer the effect of the legume proportion is visualized.

Who can use it?

The computer tool does not require any prior software skills, nor any installation. It can be used by farmers, advisors, lecturers and students. This manual provides background information, user instructions, assistance for interpretation of results and sample calculations.



How it works

The N budget calculator is designed for arable forage systems with legume-grass mixtures (different species and varieties of grasses, clover and alfalfa). The tool estimates the N input (as biological N fixation) and N output (through crop harvest) to calculate the N budget per ha for one or several cuts.

Data required

The yield is either calculated from the crop height or it is entered as a value. The harvested yield at 5 cm cutting height is calculated using standard values for dry matter and harvest losses. In the case of mulching, the crop yield remains on the field and gaseous losses are assumed to occur. The N-content of the harvested crop is calculated according to the legume to grass ratio with standard values. All standard values can be changed in the 'extended data' sheet.
Further N-losses (e.g. leaching and denitrification) are assumed to be balanced by the atmospheric deposition and non-symbiotic N-fixation and therefore neglected.

Optional harvesting methods and their characteristics* [4, 13, 14]

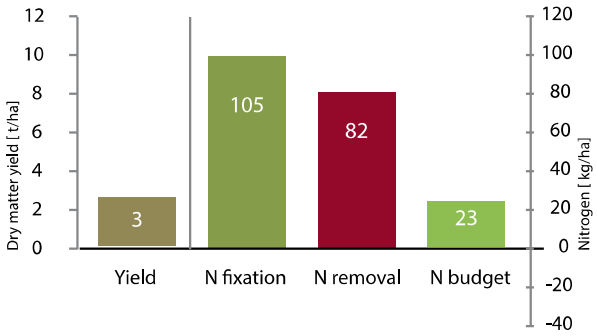
Harvesting method	Harvest timing	Dry matter content (%)	Harvesting losses (% DM)	Gaseous losses (% N)
Green forage	Early	20	5	-
Wilted silage	Medium	35	20	-
Dry hay	Late	85	35	-
Mulching	Early	20	-	10

*Standard values can be changed in the 'extended data' sheet

User interface

The user interface shows the data input and results. The results include the gross yield, total N-fixation, N-removal through crop harvest and the N budget.

DATA INPUT		
Average height	[cm]	45
Harvesting method	[select]	silage
Harvesting losses	[%]	20
Legume Proportion	[%]	50
RESULTS		
Yield (harvested)	[t/ha DM]	3.2
N fixation	[kg N/ha]	105
N removal	[kg N/ha]	82
N budget	[kg N/ha]	23



How to use the tool

The N-budget calculator is a software tool in Microsoft Excel and works with two data sheets.

- 'N budget calculator' presents calculations based on a small number of input data characterising the legume-grass mixture (e.g. yield, harvesting method and legume proportion).
- 'Extended data': input data and calculation functions can be altered (for use by experts).

Minimum software requirements

Microsoft Excel, minimum version 2003 (XLS)

Learn about your N budget in 10 steps

1. Open the Excel document
2. View the sheet 'N budget calculator'
3. Go to the data entry field
4. Enter ***either*** the average height of the legume-grass mixture at the harvest time (cm) ***or*** the estimated yield (in tons fresh matter)
   → See the method for yield estimates in the chapter Legumes
5. Select the harvesting method (green forage, wilted silage, dry hay or mulching)
6. Enter harvesting losses manually (in %) ***or*** use the standard value by leaving the cell blank
7. Enter the estimated legume proportion in the mixture at harvesting time (in %)
   → Use the Legume estimation trainer to train your observation skills
8. Read the calculated results
9. Change the input data to visualize the effects of management changes
10. To estimate the N-budget for the whole year with several cuts, calculate the N-budget for each cut separately and add the values together:

Example

1st cut: - 15 kg N/ha
2nd cut: +10 kg N/ha
3rd cut: +13 kg N/ha
N budget: 8 kg N/ha

Interpretation of results

What does the N budget tell you?

The N-budget result is positive, balanced or negative. Different management options to increase the N inputs and decrease the outputs are given. Calculation examples provide an indication of which factors have the strongest effects on the N-budget.

Interpretation of N-budget results and possible management options

N-budget (kg N/ha)	Interpretation
-10 and lower	N-output exceeds the input. N is used from soil reserves and no N is contributed to the system. This management is not sustainable, leads to a depletion of soil N and can result in lower yields in the future.
-10 to +10	Additional N-output equals the input. N fixed by the legumes is removed through the harvest and hardly any N remains in the system.
+10 and higher	Additional N-input exceeds the output and leads to a net gain of N to the system which can be used by subsequent crops.

To achieve positive N budgets a change of management is required by

- increasing the legume proportion (legumes)
- increasing the yield
- changing the harvesting method

If your N budget is positive, maintain the condition and ensure that the N is kept in the system until taken up by the subsequent crop (legumes).

Hints for farmers

This calculator provides a quick and rough estimation of the N-budget of your legume-grass fields. Results should not be over interpreted. If negative results occur, check if the N budget calculator can help to improve the situation!

Enjoy experimenting with this ERA software tool!

Sample calculations

You can learn about the effects on the N-budget by changing the input variables e.g. by increasing or decreasing the yield, harvest losses and legume proportion.
Note: If the harvesting method cannot be changed, the legume proportion remains the key factor influencing the N-budget!

Two examples

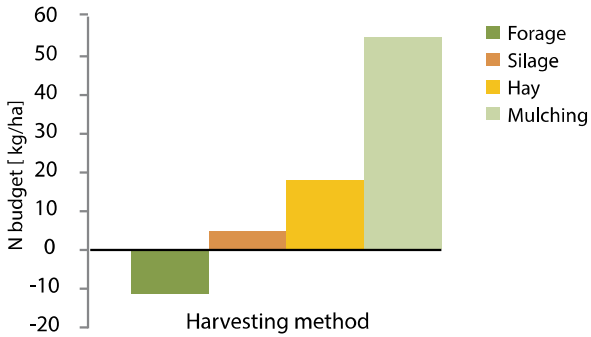
A farmer has four fields of legume-grass each with a gross yield of 3 t/ha (e.g. first cut at 5 cm cutting height). The calculated N-fixation is about 65 kg N/ha in each field.

Question: Under which conditions is the N-budget negative or positive?

Case A

- Fixed parameter:
  40 % average legume proportion in each field
- Variable parameter:
  different harvesting methods

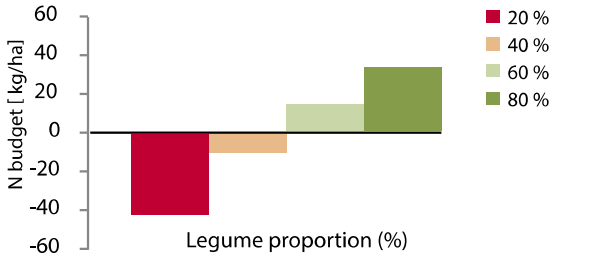
→ Compare the effect on the N-budget



Case B

- Fixed parameter:
  harvesting method (forage)
- Variable parameter:
  20 – 80 % legume proportion

→ Compare the effect on the N-budget



Main factors influencing the N budget on legume-grass fields

- Legume proportion has a major effect and can be influenced by management (Legumes)
- Harvesting method has a major effect, but depends on the feed demand
- Yield has a medium effect and can be influenced by management
- Harvesting losses have a minor effect (higher losses mean less N-removal resulting in a more positive N-budget at field level)

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The Leibniz Centre for Agricultural Landscape Research (ZALF) in Germany explores ecosystems in agricultural landscapes and develops ecologically and economically tenable land use systems while taking into account societal demands. The Institute of Land Use Systems focuses on the assessment and further development of sustainable farming systems, including organic farming.
www.zalf.de

Södertörn University in Sweden is lead partner of the EU project BERAS Implementation. The University conducts education and research to develop and disseminate knowledge on how human activities affect the natural world, as well as how to create the right conditions for environmental, social and economic sustainable development.

The Biodynamic Research Institute in Sweden works with long term on-farm studies to develop ecological and biodynamic agriculture for Nordic conditions with a focus on soil fertility, the environment and food quality.

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Photographers

PURPOSE

The environment of the Baltic Sea is endangered. Input of plant nutrients from highly intensive and specialized agriculture are a main source. BERAS Implementation can solve this problem through a systemic shift to Ecological Recycling Agriculture in association with the whole food chain from farmer to consumer.

WHO CAN USE THE GUIDELINES?

The guidelines will help farmers and advisers to practice and develop Ecological Recycling Agriculture. This type of agriculture will improve the environmental conditions of the Baltic Sea. They can be equally used for educational purposes, by decision makers and by politicians.

CONTENTS

The guidelines consist of four books that cover the following topics:

The Farming Guidelines give basic practical recommendations for implementing ERA and present proven agronomic measures and optimization strategies for effective nutrient recycling within the farm and between different farm types during and after conversion. Included are Software Tools that help to assess and improve sustainable crop rotation planning and nitrogen fluxes on a farm level.

The Economic Guidelines give advice and support to farmers how to plan the conversion process and highlight how the changes to ERA farming will affect farm economy.

In the Marketing Guidelines farmers can find support and ideas on how to more effectively promote and sell organic and ERA products.

The Farm Examples provide a personal presentation of different farms around the Baltic Sea, mainly farms in conversion to ERA, their challenges and future plans.

The books are available at www.beras.eu in digital form.

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