

# Site-specific Nitrogen Management

## Model Recommendation on the Test Stand of Practical Farming

*Field trials in Saxony compared the nitrogen simulation model „Hermes“, based on various recommendations, with the fertilisation variants „LUFA/Sensor“ and „zero application.“ In both test years, 2000 and 2002, the „Hermes“ model predicted the nitrogen requirements for the „Sportkomplex“ field. No reductions in yield or quality were discovered from using the „Hermes“ model in the experimental field. At the same time, approximately 40 kg less nitrogen per hectare, compared with the fertilisation variant „LUFA/Sensor“, were saved in both seasons.*

Heterogeneity, e.g. by different soil conditions on fields is already well-known for several years and has been examined. This heterogeneity also occurs with nitrogen need of the plants. With site-specific nitrogen fertilisation it is possible to react to this different need. The technical solutions of this site-specific nitrogen fertilisation are available in practice. However the exact calculation of the fertiliser amount proves difficult. A regulation is required on which positions more or less fertiliser is needed. A sensor based fertiliser application, e.g. Hydro N-sensor, can deal with the current nitrogen need of the plant. Fertilisation through a model recommendation tries to „look into the future“. Not only the current nitrogen need is computed, but also a forecast over a certain time period is made. But models have to reflect the reality sufficiently enough. In the case of nitrogen for example complex conversion processes in the soil must be computed correctly.

### Model description and experimental design

The use of a model for nitrogen need in practise is one research aim in the project MO-SAIC. In this project are involved: the company Südzucker AG, the company Amazonen Werke, the company Agrocom, the Centre for Agricultural Landscape and Land Use Research (ZALF) and the Institute for Agricultural Engineering Bornim (ATB). The simulation model „Hermes“, developed by Dr. Kurt Christian Kersebaum (ZALF) [1], was used for the computation of the fertilisation recommendations. On the basis of soil-, management- and daily weather data, the model simulates the following processes in the system soil/plant: the water balance, the mineralisation of nitrogen, the denitrification, nitrate transport with the soil water and also the growth and the nitrogen uptake of the plants.

The model „Hermes“ uses temporally stable soil information (e.g. texture, humus content). Based on a  $N_{min}$  distribution measured in the year before (late summer or autumn) the changes for the nitrogen content of

the soil are calculated specifically for the location. This calculation takes into account the above mentioned processes, the plant growth and actual weather data.

The necessary fertiliser need till the next fertilisation can be forecasted by model calculations.

The trials for site-specific fertilisation were established on the farm in Lüttewitz, owned by the Südzucker AG. The farm has a size of approximately 400 hectares and is located in the federal state of Saxony, in the so called area „Lommatzcher Pflege“. The altitude above sea ranges from 200 to 280 meters. The average annual precipitation amounts to 660 mm and the annual average temperature to 8 °C.

The soils are Stagnic Luvisols, they have an average German Soil Appraisal („Bodenpunkte“) of 70 (67 to 75). The area is hilly, partly very sloping.

The field selected for the trials is called „Sportkomplex“ and has a size of approximately 30 hectares. On this field, a grid for fertilisation with 64 plots, 8 • 8 plots, has been established. The size of each plot amounts to 54 meters by 54 meters.

In the year 2000 and 2002 five different fertilisation strategies on „Sportkomplex“ were applied:

- Variant „zero application“ (8 plots): no fertiliser was applied.
- Variant „LUFA/Sensor“ (8 plots): The first nitrogen application based on the „LUFA“ recommendation of the federal state of Saxony on the basis of a  $N_{min}$ -analysis in spring. Second and third nitrogen application were calculated with the Hydro N sensor. For each plot a separate nitrogen amount was calculated.
- Variant „Hermes average“ (8 plots): the model „Hermes“ gave an average value for the whole field.
- Variant „Hermes percent“ (8 plots): the value from the variant „Hermes average“ was increased by 30% in the year 2000 and decreased by 30% in the year 2002.
- Variant „Hermes site-specific“ (32 plots): For each plot its own fertiliser recommendation was calculated through „Hermes“.

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### Keywords

Nitrogen fertilisation, modelling, site specific nitrogen

### Literature

- [1] Kersebaum, K.C.: Application of a simple management model to simulate water and nitrogen dynamics. ECOLOGICAL MODELLING 81 (1995), S. 145 - 156

For crop rotation reasons winter rape was cultivated in the year 2001. The model „Hermes“ doesn't simulate the fertiliser need for this crop yet sufficiently. So only the variant „zero application“ (8 plots) has been maintained, the other fertiliser variants (56 plots) were uniformly treated. The fertiliser was applied with an Amazone Za-M Max spreader. The regulation of the fertiliser quantity took place with an Agrocom ACT on-board computer.

Before combine harvesting, a hand harvest for each of the 64 plots was done in the years 2000 and 2002. The protein content was determined with the plants of this hand harvest.

The yield was measured with a yield measuring system on the combine. For each fertiliser plot the average yield was calculated, forming a circle around each centre of a plot with a diameter of 18 m. The yields in these circles were averaged.

## Results and discussion

Three nitrogen applications were done in the year 2000 and 2002. *Table 1* shows the total sum of applied nitrogen. The fertilisation strategies „Hermes average“, „Hermes site-specific“ and „Hermes percent“ and „LUFA/Sensor“ respectively show thereby in the year 2000 similarly high nitrogen amounts.

This is also true for the year 2002, except for the changed strategy „Hermes percent“. The range for the nitrogen amount of the fertilisation strategy „Hermes site-specific“ in the year 2000 was from 75 to 157 kg nitrogen per hectare. In the year 2002 this range amounted to 70 to 172 kg nitrogen per hectare.

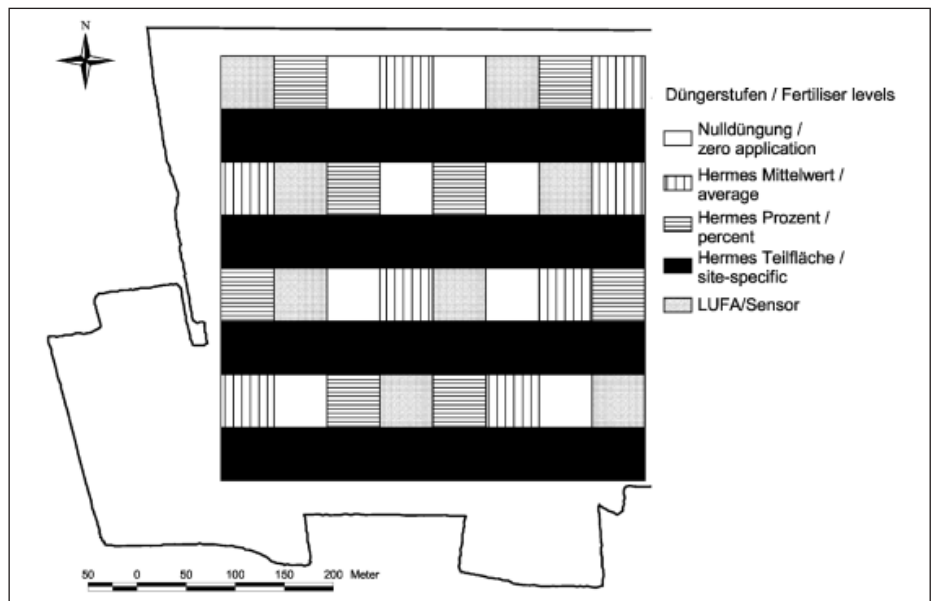
The mean values of yield are presented in *Table 2*. In both years, 2000 and 2002, only

*Table 1: Nitrogen application in the years 2000 and 2002 on the field „Sportkomplex“*

Strategies	Nitrogen in kg/ha	
	2000	2002
Zero application	0	0
Hermes average	136	135
Hermes percent	178	95
Hermes site-spec.	139	136
LUFA/Sensor	(75 - 157)	(70 - 172)
	179	177
	(154 - 195)	(150 - 202)

*Table 2: Yields in the years 2000 and 2002 in the field „Sportkomplex“*

Strategies	Yield in t/ha	
	2000	2002
Zero application	5,4	5,6
Hermes average	8,0	6,7
Hermes percent	8,2	6,8
Hermes site-spec.	8,0	6,7
LUFA/Sensor	8,1	6,7



*Fig. 1: The test field „Sportkomplex“ with the grids and their fertilising strategies*

the variant „zero application“ differs significantly from the other four variants. It is remarkable, that the yields of these four variants differ only slightly. This is particularly interesting, taking into account the different nitrogen offers. The generally smaller yields in the year 2002 can be explained by the extremely strong precipitation short before the harvest took place in August, which led to lodging on a large area. The determination of the protein content brought a similar result. Also only the variant „zero application“ differs significantly in both years only compared to the other variants. The protein content of these four variants was about 14% in the year 2000

## Conclusion

In both years, 2000 and 2002, the model recommendations of „Hermes“ forecasted the nitrogen need on the examined field „Sportkomplex“ thoroughly. Concerning the yield and the quality, here protein content, no negative effects could be observed.

The nitrogen savings in this trial is to be emphasised, comparing the variant „LUFA/Sensor“ with the variant „Hermes site-specific“ in the year 2000 40 kg nitrogen per hectare and in the year 2002 41 kg nitrogen per hectare less nitrogen were applied.

The amounts of the nitrogen fertilisation of the variant „Hermes site-specific“ are approximately alike in both years, 139 to 136 kg nitrogen per hectare. However the range amounted from 75 to 157 kg nitrogen per hectare in 2000 and from 70 to 172 kg nitrogen per hectare in 2002.

A very positive aspect while using the mo-

del „Hermes“ is the „look into the future“, i.e. not only the current nitrogen need is taken into consideration for the fertilisation recommendation, but also the potential development in the future. Very helpful is the availability of regional meteorological data.

Before the use of the model „Hermes“ different soil parameters must be measured once. Also  $N_{min}$  values of the previous year are necessary.

## Acknowledgement

The project was funded by the company Südzucker AG, the company Amazonen Werke and the company Agrocom.