What does a "Greening by forgone nitrogen fertilization" cost?

Dr. Thomas de Witte
Thünen-Institute of Farm Economics
Braunschweig – January 2013

The aim of the EU Commission to provide seven percent of arable land as ecological compensation areas has been widely rejected by farmers. Therefore in Germany it is discussed to allow arable crops on these areas as long as they are not fertilized with nitrogen during the cultivation. The hope is to promote legumes indirectly and still enable a productive use of the greening areas.

The detour via N fertilization is necessary because direct production-related subsidies are no longer allowed under consideration of WTO agreements. However, the drawback in this construction is apparent: Farmers will ask themselves whether it is more profitable to grow legumes or to forego nitrogen fertilization in other crops.

This question was analyzed for different farming locations in Germany by consultants at an ***agri benchmark*** workshop. They compared the expected losses of gross margins from legumes to losses of gross margins by foregone nitrogen fertilization for different crops. The following farming locations were considered:

(1) Heavy soils
Magdeburger Börde (low precipitation)
Cologne-Aachen Bucht (mid-level precipitation)
Elbmarsch (high precipitation)

(2) Light soils with low precipitation and little organic fertilization:
Altmark (Saxony-Anhalt)

(3) Light soil with high precipitation and high level of organic fertilization
Wildeshauser Geest in northwest Lower-Saxony

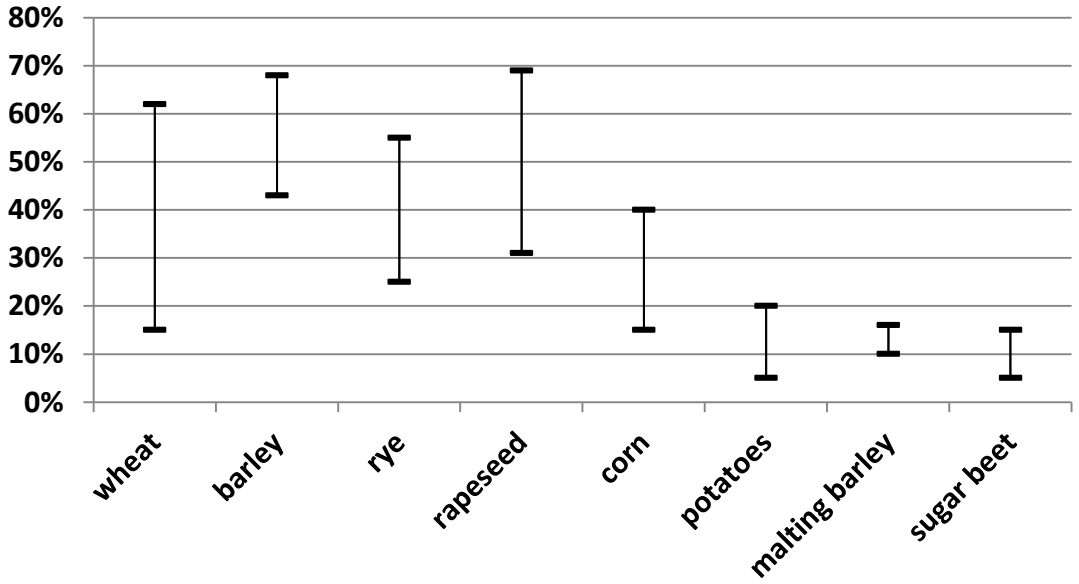
The wording "no nitrogen fertilization during cultivation" leaves wide room for interpretation. If only the time period between the seeding and harvest is taken into account as cultivation, corn silage could still get organic fertilizer before seeding. Therefore it is assumed that no nitrogen can be spread before the seeding of a summer crop. However, cash crops can be planted and fertilized with nitrogen in the previous fall. Furthermore it is assumed that the ecological compensation areas can alternate annually in the rotation.

The Figure 1 shows results of annual nitrogen field trials and therefor gives an impression of the possible yield losses due to forgone nitrogen fertilization. Grain and rapeseed yields can decrease up to 70 percent without nitrogen. However, the relative yield decreases range very widely, primarily for two reasons:

- The soils' natural nitrogen supply. For soils with more than 40 soil points advisors roughly calculate that the soil can supply one kilogram nitrogen per soil point. However, not more than 80 kg nitrogen supply should be expected from the soil.
- Furthermore, the weather conditions have a very strong influence on the soils nitrogen supply. With high precipitation in the dormancy period, an increased amount of nitrogen is leached. During the growing season high precipitation, in combination with high temperatures promotes mineralization. Due to the weather influences, the natural nitrogen supply of the soil can vary up 60 percent around the standard values.

In contrast, the relative yield losses and the range of the losses are much lower for corn and sugar beets. The reason is that the nitrogen uptake of the root crops has a better overlap to the nitrogen mineralization in soil. Therefore, they benefit more from the nitrogen supply of the soil.

Figure 1: Relative yield losses with missing nitrogen fertilization (in %)



Own diagram based on: Heyn (2010), Jacobs (2009), Koch (2009) Schneider (2012), LWK NDS (2012), Sieling (2012)

Figure 2 displays the expected yield decreases for the considered locations and Figure 3 the resulting losses in gross margins. The calculations are based on a price assumption of 185 €/t for feed wheat. The remaining prices were derived on the basis of historic price relations. As there are only regional prices for corn silage the parity price to the displaced crop was considered. At the parity price corn silage earns the same gross margin as the displaced crop, which generally is stubble wheat or rye. Nutrient prices of 0.96 €/kg N, 1.11 €/kg P_2O_5 and 0.75 €/kg K_2O were assumed. The preceding crop effects of legumes (as for rapeseed and sugar beets) comprise of nitrogen savings of 30-50 kg/ha as well as a yield increase of the following wheat compared to stubble wheat.

Figure 2: Yield decreases at the considered locations (dt or t/ha)

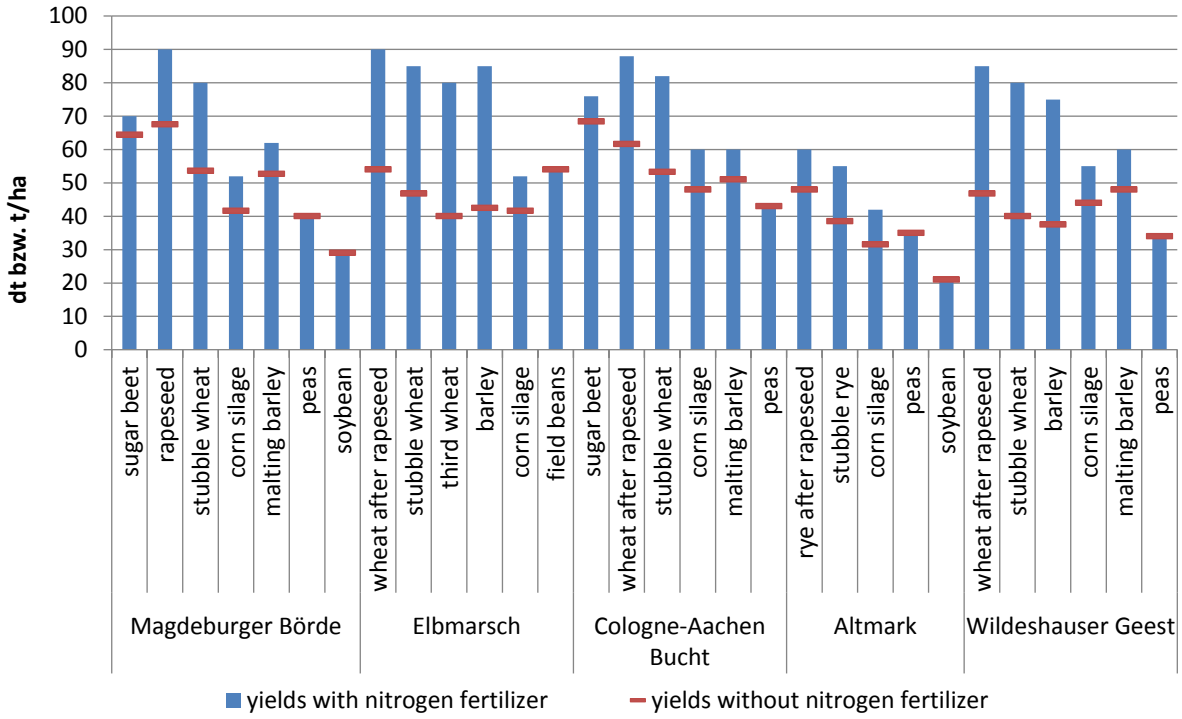
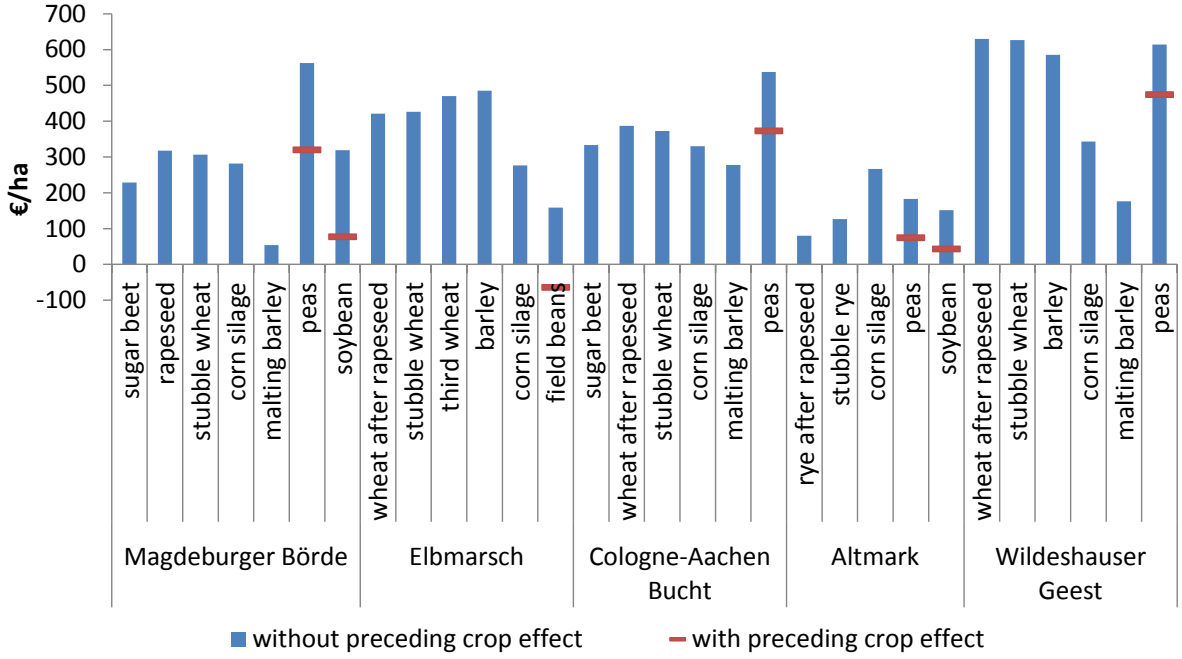


Figure 3: Comparison of the losses in gross margins at the analyzed locations (€/ha)



Malting Barley all over?

Malting barley is generally on all the locations a very competitive option to minimize gross margin losses for a "Greening by forgone nitrogen fertilization". However, with a nationally increasing malting barley supply, decreasing malting barley prices have to be expected. Thus this option can not to be realized everywhere in the long run.

Sugar Beets, corn silage and soybeans in the loess areas:

In the Magdeburg Börde the gross margins decrease by 320 €/ha if peas are grown instead of stubble wheat, even if the preceding crop effect is taken into account. Due to the high soil nitrogen supply of 80 to 90 kg/ha and the good utilization of this supply the losses of gross margins for sugar beets and corn silage are limited to 220, respectively, 280 €/ha. Thus the losses are 100 to 160 €/ha lower than in the legume scenario. Furthermore it is possible grow soybeans at this location. According to field trials a yield of 2.9 t/ha seems feasible under practical conditions. Considering the preceding crop effects the soybeans gross margins are only 80 €/ha below those for stubble wheat. Therefore growing soybeans is the most competitive adaptation strategy to a "Greening by forgone nitrogen fertilization" under these assumptions. However, there are only little practical experiences with soybeans at this location.
For the Cologne Aachen Bucht a similar picture can be drawn. Compared to conventionally fertilized stubble wheat peas generate gross margin losses of 370 €/ha. If sugar beets or corn silage are grown without nitrogen input the losses can be reduced by 40 €/ha to 330 €/ha.

Field beans in Marshes:
Marsh soils are also very fertile but the natural soils nitrogen supply is much lower. Therefore, the yield decreases are higher without nitrogen input. A high black grass pressure especially in stubble wheat additionally characterizes these locations. Therefore, here field beans are already competitive to stubble wheat.

Soybeans on sandy soils in Eastern Germany:
On the dry and sandy locations of East Germany the nitrogen supply of the soil is very limited. In addition, organic fertilizer is hardly used due to the low animal density. Even in the current situation only 100 to 120 kg nitrogen are spread on rye. That is why missing nitrogen input only leads to a yield reduction of 25 to 30 % percent; the subsequent gross margin loss is 80 to 130 €/ha. The loss is just about as high as with peas. Also at these locations impulses for soybeans can be foreseen if a "Greening by forgone nitrogen input" will be implemented. With on farm yields of 2.1 t/ha soybeans would only have 40 €/ha lower gross margins as conventional rye.

Corn silage on sandy soils in Northwest German:
In the Wildeshausener Geest sandy soils with 30 to 50 soil points and a humus content of 1.5% are dominating as well as in the Altmark. However, the annual precipitation is 700 to 800 mm and therefore about 60 percent higher than in Eastern Germany. Due to the high animal density, soils have been organically fertilized for many years. This leads to a higher nitrogen dynamic in the soil. For cereals expect yield losses of 45 to 50 percent are without nitrogen input. However, for corn silage the yields are only expected to drop by an estimated 20 percent. The reason is that winter hard cover crops can be grown which increases the nitrogen availability for corn silage in the following year by approximately 40 kg/ha. This results in a gross margin loss of 340 €/ha compared to conventional corn silage. For peas the loss would increases to 470 €/ha. If in contrast to the assumption of this study no fertilizer were allowed for cover crops, stronger yield reductions have to be expected, especially for corn silage. Consequently, the competitiveness of legumes would increase heavily in such a scenario.

Overall, it should be noted that many competitive alternatives to domestic grain legumes are available for a "Greening by forgone nitrogen fertilization". In the midterm in many cases it is

more attractive to grow grain, sugar beets or corn silage without nitrogen input. In the end, a similar regulation sets impulses for soybean growing. However, first the harvest problems due to the low pod set have to be solved. Additionally more field trials on soy crops are necessary to test if the limited individual studies are reproducible on a large scale in practice.

Thomas de Witte, Thünen Institute Braunschweig
In cooperation with:
Niels-Geert Binder, Wiebke Steinmann (Landberatung Hoya)
Stephan Deike, Lothar Müller (Landberatung GmbH Sachsen-Anhalt)
Inge Schneider (LWK Nordrhein-Westfalen)
Reimer Mohr (Hanse-Agro)