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Optimizing resource use efficiency and carbon footprint in oilseed rape production systems

Henning Kage
Thomas Räbiger, Josephine Bukowiecki, Klaus Sieling, Ingo Pahlmann

Christian-Albrechts-University Kiel, Kiel, Germany

Driven by substantial improvements in yield per hectare and improved quality standards, the development of winter oilseed rape (WOSR) production systems in Europe has been a success story during the past 40 years. Thereby the pioneering role as renewable energy resource boosted production areas during the 90s and early 2000s to more than 6 Mio. hectares within the European Union. Compared to other cropping systems, WOSR based rotations can have low nitrogen use efficiencies and concerns about risks for groundwater quality due to nitrate pollution have been discussed in Europe since the 90s. After WOSR became an important feedstock for biofuel production the greenhouse gas (GHG) emission per produced biofuel energy (specific emission) and the GHG balance of the production system became major research topics.

The main determinants of the GHG balance in WOSR production are seed yield and nitrogen input. Nitrogen input causes GHG emission due to energy consumption of fertilizer production and by direct and indirect N2O field emissions. N2O emissions can be the dominant part of GHG emissions but are difficult to measure and their relation to N input varies substantially between sites and years. Therefore estimates based on emission factors (EF) are still the standard for GHG accounting schemes and knowledge about the effect of agronomic measures on GHG balance is still scarce. In Germany and other EU countries joint research projects have been conducted in order to quantify N2O emissions in WOSR. In general, lower emissions than estimated from EF were measured. Calibrated and validated simulation models have been used to estimate indirect N2O emission due to nitrate leaching and to inter- and extrapolate direct N2O emission measurements. Scenario calculations indicate the non-linear behavior of both direct and indirect emission to nitrogen input. The maximum of the GHG balance therefore is often close to the economic optimum N rate whereas the specific GHG emission is a continuously decreasing function of N input and therefore a problematic indicator.

Options to reduce fertilizer input without sacrifying WOSR yield are field and sub-field specific adjustments of N rate taking the crop N uptake before winter into account. Technically this can be achieved by methods ranging from simple manual weighing of biomass to tractor, UAV or satellite based spectral reflection measurements.

GHG balances should be evaluated at the level of the whole crop rotation where WOSR may benefit from favorable preceding crops like legumes and improves the GHG balance of succeeding crops due to its break crop effects.