Economic and environmental optimization of nitrogen fertilizer recommendations for cereals in Norway

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Results of ca. 300 annual N fertilizer trials performed between 1991 and 2014 in spring and winter cereals have been used to evaluate optimum nitrogen fertilizer rates for cereals in Norway, in terms of both economic returns and the balance between N supply and removal. On average, spring barley and oat yields increased little beyond 120 kg N ha^{-1} in fertilizer. Somewhat higher optimum fertilizer rates were found for spring and winter wheat. Regression equations for yield and N uptake in grain and straw were derived, related to N fertilizer input and the yield level obtained in individual trials. The latter was used as an indicator of yield expectancy, which in Norway is the basis for N fertilizer recommendations to cereals. These equations accounted for around 90% of the variation in yield and 80% of that in N uptake. Quadratic N responses were significant in all cases, as were interactions between N responses and yield level. The yield equations were used to calculate economically optimum N fertilizer levels with varying ratios of product price to fertilizer cost at contrasting levels of yield. The optimum N fertilizer level for barley and oats was found to increase by ca. 8 kg N ha^{-1} per Mg increase in expected yield. The equivalent figure in wheat was ca. 16 kg N ha^{-1}. In the case of barley and oats, optimum N fertilizer levels decreased by ca. 4 N ha^{-1} per unit increase in the cost/price ratio. For wheat the corresponding figure was ca. 7 N ha^{-1}.

The equations for N uptake were used to calculate simple N balances between fertilizer input and removal in crop products. Large N surpluses were indicated at low levels of yield expectancy, but the surpluses decline markedly with increasing yield level, despite greater N fertilizer inputs at high yield. Calculations made for national average yield levels in recent years showed N surpluses of 50–60 kg N ha^{-1} when only grain is removed, but somewhat less when straw is removed also. Limiting N input to obtain zero balance

between N supply and N removal reduces yields considerably at average levels of yield expectancy. If one assumes that a certain level of surplus supply is acceptable in order to compensate for the 'unavoidable' N losses that occur even in the absence of fertilizer, the gap between economic and environmental optimum fertilization becomes smaller.