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Fertilizer consumption in Norway

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About 50 years ago farmyard manure was applied to the greater part of the agricultural area, whereas artificial fertilizers were of minor importance. Since then fertilizer consumption has increased rapidly, and the types of fertilizer used 50 years ago have mostly been replaced by other types.

Nitrogen, phosphorus, and potassium

The growth in consumption of nitrogen, phosphorus and potassium is shown in table 1 by the fertilizer statistics for the years 1951-85.

The nitrogen consumption had more than tripled during the 35-year period referred to. The consumption rose very rapidly from about 1960 to late in the 1970's. Since then the rise in consumption has terminated. The relative figures for the increase in consumption of P and K are similar, and considerebly lower than those for N. The consumption figures for 1981/85 show only a slight increase in K quantities and no change for P. During recent years the consumption of both P and K has decreased. The lower P consumption is partly a result of reduced content of P of the most commonly used NPK-compound.

Table 2 shows the consumption of N, P, and K in ferti-

lizers per ha agricultural area in Norway compared with some other European countries.

Fertilizer N is applied at considerably higher rates in Norway than in Finland and Sweden, but at lower rates than in Denmark. The fertilizer rate in Norway is of the same magnitude as in the two German states, and is far lower than in the Netherlands. Table 2 also reveals that high rates of P and K are applied in Norway.

Despite the degree of uncertainty attached to such statistical data, they provide a useful basis for comparison among countries. Such figures are of course dependent on the natural conditions for plant growth, cropping systems and economical policies in the different countries. Variations in the quantity of farmyard manure in relation to the agricultural land available in each country must also be considered.

Nevertheless,the consumption of fertilizers is high in Norway, especially when the length of the growing season is taken into account. On many livestock farms the amount of manure produced is sufficient to cover at least some of the plant nutrient requirements. On such farms excessive amounts of P are often applied.

About 95 percent of the total fertilizer consumption in Norway consists of compound fertilizers. The extensive use of NPK-fertilizers is mainly due to laboursaving in handling and spreading as compared to the use of calcium nitrate, superphosphate, and potassium fertilizers separately.

Table 1. Relative consumption of N, P, and K in fertilizers 1951-85. Average of 5-year periods.

	1951/55	1956/60	1961/65	1966/70	1971/75	1976/80	1981/85
N	100	129	157	198	244	296	317
P	100	114	128	142	158	170	170
K	100	115	119	131	161	174	179

Table 2. Rates of N, P, and K applied in fertilizers in some European countries in 1983, kg per ha agricultural area (FAO fertilizer yearbook, 1984).

	N	P	K	Total
Norway	116	28	73	217
Sweden	70	13	25	108
Finland	82	29	52	163
Denmark	146	18	45	209
W. Germany	114	27	70	211
E. Germany	111	23	56	190
Belgium-Luxembourg	133	28	86	247
Netherlands	238	19	49	306

Table 3. Contents of S, Mg, Cu, and N in fertilizers 1950-85. Relative figures.

Year	S	Mg	Ca	N	S	Mg	Ca
1950	100	100	100	100	55	3,6	191
" 55	95	101	94	100	51	3,5	172
" 59	58	63	81	100	23	1,7	111
" 64	61	305	74	100	21	6,2	85
" 70	81	432	71	100	20	6,7	59
" 75	105	488	39	100	23	6,9	29
" 80	125	622	39	100	21	6,9	23
" 85	82	572	39	100	14	6,3	21

However, the increased use of highly concentrated compound fertilizers also affects the supply of other plant nutrients, such as sulphur, magnesium, and calcium.

Sulphur

Table 3 includes a summary of the changes in the content of S, Mg, and Ca in fertilizers during the period 1950-85. Considerable quantities of S were previously applied as superphosphate. The increasing use of NPK-fertilizers resulted in a significant decrease in S application during the 1950's. Over the same period, the number of livestock farms was strongly reduced in parts of the country, resulting in decreased quantities of manure. Around 1960, S-deficiency was detected in a number of crops in Norway.

Early in the 1960's 1,6 percent of S was added to the S-free NPK-compounds. From about 1970 two Cu-containing NPK-compounds with a high S content were produced (sulphate -based NPK), resulting in a considerable increase in the total S application rates. Later on one of the high-S NPK-compounds was replaced by a low-S type, and this is why the S application rate has markedly declined in recent years.

The whole agricultural area is now supplied with S-containing fertilizers. On average, 16 kg S per ha is applied in fertilizers. In addition, some S is received from the atmosphere. However, the effect of atmospheric S on plant nutrition is difficult to evaluate, not only because of the problems in reliable assessment, but also due

to variations in distribution patterns and leaching losses.

Since S was first added to NPK-fertilizers about 1960, S deficiency has rarely been noticeable in Norway. However, S deficiency may still occur on light soils of low humus content in regions of extensive leaching, especially with intensive growing of crops with high S requirements.

Magnesium

About 1950 it was realized that Mg deficiency was responsible for crop yield depressions in Norway. This situation was related to the cultivation of large areas of poor soils, reduced application of farmyard manure in many districts, and strongly increased consumption of fertilizers. The Mg content of fertilizers was low, and it continued to decline untill the end of the decade.

Changes in the quantity relationship between K and N on the one side and Mg on the other, contributed to a worsening of the Mg situation. Due to the antagonism between K^+ and Mg^{2+}, the high K:Mg ratio in fertilizers undoubtedly resulted in reduced uptake of Mg in crops in the 1950's. A strong increase in the N:Mg ratio in fertilizers at the same time may have indirectly reduced Mg uptake, for instance as a result of a synergistic effect between NO_3^- and K^+.

Since about 1960-62, 1.2 percent Mg has been added to the NPK-fertilizers. This addition has strongly increased the Mg application, from about 0.8 kg per ha agricultural

area in 1959 to about 4 kg per ha some years later. In recent years fertilier Mg has amounted to 7 kg per ha agricultural area. During the years 1959-85 the K:Mg ratio of fertilizers decreased from 56 to 10, and the N:Mg ratio from 60 to 16.

At present, the supply of Mg in plant production seems to be adequate. In addition to fertilizer application, Mg may be supplied in dolomite by liming of acid soils, and by application of magnesium salts. Dolomite and dolomitic limestone are now used extensively in some districts.

Calcium

Due to a strong reduction in the content of Ca in fertilizers, some attention has been paid to its status as a plant nutrient. Previously, nitrate of lime, superphosphate, and NPK-fertilizers together provided large amounts of Ca. In 1971 the Ca content of NPK-fertilizers was strongly reduced, with a consequent considerable decline in the total Ca application (Table 3). Around 1950 the Ca content in fertilizers corresponded to about 60 kg per ha agricultural area, whereas current application is about 25 kg per ha. The ratios between Ca and N, P, and K in fertilizers were greatly changed over this period.

Long-term field experiments show that application of current NPK-fertilizers results in lower Ca content of crops compared to the application of corresponding rates of N, P, and K in nitrate of lime, superphosphate, and

potassium fertilizers (Aasen, 1977). Continous use of NPK-fertilizers reduces the amount of available Ca in soils. Therefore, if liming is omitted, a risk of Ca deficiency may arise in the long term.

However, liming has increased strongly in recent years for several reasons, and the annual application of Ca in lime is now several times that applied in fertilizers. Therefore, at present the Ca status of cultivated soils in Norway is generally good.

Micronutrients

Increased use of highly - concentrated fertilizers is of importance to the supply of micronutrients. As early as about 1940 it became obvious that B-deficiency was widespread. A small amount of B was added to NPK-fertilizers in 1950. In addition, a B-containing nitrate of lime is often used to prevent deficiency in sensitive crops. The consumption of B in NPK-fertilizers amounts to about 100 tons per year, corresponding to roughly 100 g B per ha agricultural area.

Cu-deficiency occurs in Norway on certain soil types. On the basis of intensive experiments, two Cu-containing NPK-fertilizers were introduced in about 1970, intended for use in certain districts. At present, only one of the Cu-containing formulas is available.

Addition of other micronutrients to fertilizers is not of current interest in Norway. There have been differing

views about the addition of iodine, selenium, zink, and cobalt to fertilizers to meet the needs of livestock for these nutrients. In Norway these nutrients are now added to feed concentrates.

Environmental aspects of fertilizer use

The influence of fertilizers on eutrophication of lakes and streams and on the content of groundwater is a matter of general concern.

Leaching of nitrate is affected by climate, soil type, rates of applied N, and plant growth conditions. The prerequisite for leaching losses is a surplus of water in soils. Heavy rain early during the growing season may result in loss of nitrate, but this is mostly of less importance. The leaching losses of N occur mainly outside the growing seasons. It is assumed that the nitrates are leached out in the autumn before the soil is frozen in most parts of the country. Therefore, the N losses are primarily affected by the residual mineral N at harvest and the organic N mineralized outside the growing season.

Field runoff measurements show that poor growth and reduced N uptake in dry years may result in extensive leaching when the soil water content is restored in autumn (Uhlen 1985). This emphasizes the effect of the growing conditions on nitrate losses. Favourable conditions result in high yields which leave only small amounts of available N in the soil at the end of the growing season,

even at higher fertilization rates.

So far, drainage water analyses from experiments on mineral soils in Norway show no increase in P content due to the application of fertilizer P (Uhlen 1985). The P contents of drainage water are usually in the range of 50-100 g per ha. In undecomposed peat soils, however, phosphate ions are leached as easily as nitrate (Sorteberg 1974 b).

Results of field studies show in most cases a greater transport of P from cultivated and fertilized areas than from forest land. The P losses from cultivated land may be due to soil erosion, and to the effects of fertilizers, manure and plant debris. However, it is difficult to infer from this type of investigation, the exact effect of fertilizers on total P losses. There are a number of reasons for the greater runoff of N and P from cultivated soil than form natural habitats.

LITTERATURE

FAO fertilizer Yearbook, vol. 34, 1984.

Lyngstad, I. 1971. Nitratundersøkelser i dyrka jord. Institutt for jordkultur, stensilert, 109 pp.

Låg, J. 1963. Tilføring av plantenæringsstoffer med nedbøren i Norge. Forsk.Fors.Landbr. 14: 553-563.

Saalbach, E., K. Würtale, P.W. Kürten, and H. Aigner 1970. Schwefel, Natrium, Magnesium. Boden ü. Pflanze No 14, 141 pp.

Sorteberg, A. 1974a. Virkningen av magnesium på avlingsstørrelse og magnesiuminnhold ved ulik kalking og ulike nitrogenforbindelser. Forsk.Fors.Landbr. 25: 537-558.

Sorteberg, A. 1974b. Avlingsstørrelse og opptak av fosfor hos havre dyrket i torv rik på kvitmose, og utvasking av fosfor fra torv og myrjord. Festskrift for F. Steenbjerg, København 1974, 179-194.

Uhlen, G. 1985. Plantenæringsstoffer fra landbruk som forurensning i vassdrag. Institutt for jordkultur, Serie B 3/85, 4 pp.

Uhlen, G. 1986. Overflateavrenning fra grasarealer. Norges landbruksvitenskapelige forskningsråd. Sluttrapport No 645, 11 pp.

Ødelien, M. 1948. Mikroelementenes betydning for planteproduksjonen og husdyrbruket i Norge. Nord.Jordbr. Forsk., 711-721.

Ødelien, M. 1967. Mikronæringsstoffer, magnesium, svovel og kalsium. Ny Jord 54: 49-65.

Ødelien, M. and I. Lyngstad 1982. Gjødsel og gjødsling i Norge 1930-1980. Jord og Myr. 6: 56-67.

Aasen, I. 1977. Ulike gjødslingssystem - verknad på jord og avling. Norsk Landbruk No. 8, p. 4-5, and 29.