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FERTILISER RECOMMENDATIONS —REVISED EDITION

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The East of Scotland College of Agriculture
Crop Division

Fertiliser Recommendations

Revised Edition

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CONTENTS

NOTES ON RECOMMENDATIONS

MAIN PLANT NUTRIENTS CONTAINED IN FERTILISERS

N	NITROGEN
P_2O_5	PHOSPHATE
K_2O	POTASH

FERTILISER RECOMMENDATIONS—given in KILOGRAMMES PER HECTARE (kg/ha) and (units per acre)

Analyses shown on each 50 kg bag as percentage N, P_2O_5 and K_2O.

For example: —

20:10:10 on a bag means it contains 20% N, 10% P_2O_5, 10% K_2O.

This means that each bag contains: —

10 kg N		20 units N
5 kg P_2O_5	OR	10 units P_2O_5
5 kg K_2O		10 units K_2O

HOW TO COPE WITH METRICATION

The calculation of tonnes of fertiliser required, the number of bags per field and per hectare and the calibration of the spreader are more easily done in metric.

1. Convert all field acreages to hectares (multiply by 0.4).
2. Select your rate of fertiliser in kg N, P_2O_5 and K_2O per hectare (see page 7),
   e.g. 120 kg N, 60 kg N P_2O_5, 60 kg K_2O.
3. Decide on the most appropriate compound fertiliser,
   e.g. 20:10:10.
4. Work out the number of 50 kg bags required per hectare on the basis of N requirement.
   e.g. To apply 120 kg N therefore requires $\frac{120}{50} \times 100 = 600$ kg fertiliser per hectare.

   Each bag contains 50 kg

   Therefore $\frac{600}{50} = 12$ bags per hectare are required.

CONVERSION TO IMPERIAL

To convert kg per hectare to units per acre multiply by 0.8
e.g. 1.25 kg/hectare multiply by 0.8 = 1 unit per acre.

To convert 50 kg bags per hectare to cwt per acre multiply by 0.4
e.g. 2.5 (50 kg) bags/hectare multiply by 0.4 = 1 cwt per acre.

USING THE TABLES

1. **ARABLE CROPS:—pages 28-33 Tables 1, 2 and 3**

   Choose the most appropriate table from the farm type description given at the top of each table.

   VEGETABLE AND BULB CROPS:—pages 34-35, Table 4

   SOFT FRUIT:—pages 36-37, Table 5

   GRASSLAND:—pages 40-45, Tables 6, 7 and 8

   Decide which nitrogen policy is required for established grass—see page 33—and refer to appropriate table for High, Moderate or Low nitrogen input.

   HILL SWARD IMPROVEMENT:—pages 46-47

2. Refer to the crop for which a recommendation is required and the appropriate place it occupies in a crop rotation.

   Read off the recommendation for Nitrogen (N) Phosphate (P_2O_5) and Potash (K_2O).

   Check the need to make adjustment:—see back fold out page.

3. Having made any necessary adjustments to the recommendation, choose a fertiliser and calculate the rate to provide these amounts of N, P_2O_5 and K_2O.

   Where the recommendation for all three nutrients cannot be met exactly by available compounds, choose a fertiliser which provides the correct amount of nitrogen.

4. Recommendations are based on the assumption that the full programme of advice is used throughout the rotation.

SOIL ANALYSIS

Routine soil analysis indicates the pH, lime requirement, and levels of available phosphorus, potassium and magnesium in the soil. Where necessary, the organic matter content and the level of essential trace elements can also be measured.

Because the soil in most fields is extremely variable, the samples must be taken in the prescribed manner to ensure that they are as representative as possible of the whole field.

Samples for analysis should be taken either before or at least 3 months after applying fertiliser, and two years after liming.

The recommendations in the bulletin are based on moderate levels of phosphorus and potassium in the soil. Soil analysis can be used to identify those soils where the levels are much higher or lower than moderate and therefore where stated fertiliser recommendation can be profitably adjusted.

The following table is a guide to the adjustments which should be made when the soil is low in phosphorus and/or potassium. Savings on fertiliser are possible when soil levels of phosphorus and potassium are above moderate, but it may be preferable to apply recommended rates of P and K to maintain the soil P and K status. When in doubt consult your adviser.

PHOSPHORUS

Crops	**Soil Status Low**
	kg/ha (units/ac) P_2O_5
Cereals, peas, beans, grass	+30 (+24)
Potatoes, swedes, kale, oil seed rape	+50 (+40)

POTASSIUM

Crops	**Soil Status Low**
	kg/ha (units/ac) K_2O
Cereals, swedes, peas, beans, oil seed rape	+30 (+24)
Grass, kale	+50 (+40)
Potatoes	+60 (+48)

EFFECT OF WEATHER ON RECOMMENDATIONS

ANNUAL RAINFALL

The recommendations made in tables 1 - 3 have taken into account the amount of rainfall normally associated with each farm type—eg, drier for a cash-cropping system and wetter for a grass-arable system. There are exceptions to this, and adjustments are recommended as follows:—

Intensive cash-cropping in areas of higher rainfall than normal for this system—reduce nitrogen rates by 25 kg/ha (20 units/ac).

Grass-arable farms in dry areas—increase nitrogen rates for arable crops by 25 kg/ha (20 units/ac).

WINTER RAINFALL

The residual nitrogen in the soil depends on the previous cropping and on drainage losses during winter. Little residual nitrogen can be expected after long runs of cereals, but after ploughed-in grass, folded crops, or crops heavily fertilised and in all cases where grass forms about half of the rotation, residual nitrogen can be expected: To adjust for differences in the loss of this residual nitrogen during the winter, about 25 kg N/ha (20 units/ac) can be added to the fertiliser recommendation after a wet winter and deducted from the recommendation after a dry winter. As a guide, wet and dry winters can be regarded as those with about 70 mm (2½ in) of rain above or below the average for the period October to February inclusive.

VERY WET SPRINGS

If excessive rain in spring leads to drainage flow and loss of nitrogen already applied, a top dressing of 25 - 40 kg N/ha (20 - 32 units/ac) should be given to replace the loss.

NUTRIENT REMOVAL FROM CROPS

Where approximate crop yields are known, calculating the quantity of nutrients removed can be a helpful guide for rotational manuring. Comparing the input from fertilisers with offtake in the crop, can identify imbalances in fertiliser policy. This approach is most useful for phosphate and potash.

Nutrients removed by certain crops

		kg nutrient/ha		
		N	P_2O_5	K_2O
Barley	5 t/ha grain	85	40	30
	3 t/ha straw	15	5	40
	Total	100	45	70
Wheat	7 t/ha grain	130	60	40
	4 t/ha straw	20	5	35
	Total	150	65	75
Potatoes	36 t/ha tubers	126	41	212
Silage	30 t/ha (2 cuts)	160	42	180
Hay	7.5 t/ha	90	35	120

In some cases there appears to be a discrepancy between the offtake value and fertiliser recommendation, eg phosphate for potatoes or potash for silage. It is important to consider how individual crops utilise the fertiliser applied.

Potatoes require large quantities of each major nutrient in a readily available form for rapid early growth. However, only some 41 kg P_2O_5/ha are eventually removed in the tubers. The remainder will be retained in the soil and increase the phosphate reserves.

Both cereals and grass have the ability to take up potash far in excess of their requirements (luxury uptake). Thus soil potash levels are often found to be low where creal straw is removed regularly or grass is frequently conserved.

pH AND LIMING

The pH is a measure of acidity or alkalinity and ranges from around 4.0 (very acid) to 8.0 (alkaline) in Scottish soils.

The lime requirement of an acid soil is assessed by analysis and reported in tonnes per hectare of ground limestone. The two values quoted on a soil analysis report are the amounts of lime required to bring mineral soils to pH 6.5 (suitable for most arable crops) and a lower amount to bring the soil to pH 6.0 for grassland, assuming a 15 cm (6 in) soil profile.

FREQUENCY

Soils lose lime largely through leaching. This process is accelerated by fertilisers, especially ammonium compounds. The soil pH on all fields should be checked by soil analysis every five years. On intensive arable farms where high rates of nitrogen are used the soil pH should be checked more frequently—every second or third year.

TIMING

The timing of lime application is important where the crops grown in rotation differ in their susceptibility to acidity. The pH should be kept at the higher end of the range for crops susceptible to acidity and at the lower end for crops more acid tolerant.

In most situations lime should be applied after potatoes because of the risk of potato scab at high pH. Remember that lime is not immediately effective and should be applied fully one year before the most sensitive crop in the rotation. A field of barley following potatoes may not be at the optimum pH for the crop. **It is better to apply smaller dressings more frequently,** i.e. every two to three years rather than heavier applications every five to six years. An added advantage of more frequent spreading is more uniform application. The uneven distribution of lime by spreaders is a major problem that has to be overcome in order to achieve a uniform pH over a field.

When lime is applied to soils which are slightly acid (pH 6.0 - 6.3) it can be spread before ploughing. Where the soil is moderately acid (below pH 6.0), lime should be applied on the ploughed surface, as early as possible. If the lime requirement of an arable crop is in excess of eight tonnes per hectare (3 tons/acre), half should be applied before and half after ploughing.

Ground limestone and ground magnesian limestone are the main liming materials used. **Magnesian limestone is as efficient as calcium limestone and in addition supplies magnesium (see page 16).**

Excessive liming can lead to trace element deficiences (see page 23)

pH RANGE FOR CROPS GROWN ON **MINERAL** SOILS

pH range	Degree of acidity	Comments
Below 5.5	Very acid	Many arable crops in danger of failure.
5.5 - 6.0	Acid	Barley, wheat, swedes, turnips and other brassicas, mangolds, beans, peas, lucerne and red clover are likely to suffer from acidity. This is more likely to be evident as patches within the field which have a lower pH than the rest.
5.8 - 6.3	Moderately acid	Suitable pH range for permanent grass, potatoes and oats.
6.0 - 6.5	Very slightly acid	Suitable pH range for rotational grass and most arable crops. e.g. potatoes, barley, wheat, oil seed rape, swede, turnip, kale, carrot, leek, onion, parsnip, redcurrant, raspberries and strawberries. mangolds, peas, beans, lettuce and blackcurrant require a pH at the upper end of this range.
6.5 - 6.9	Nearly neutral	Suitable range for lucerne and celery. Possibility of trace element deficiencies in crops on many soils—especially manganese on light soils. Increased likelihood of scab in potatoes.
Above 7.0	Alkaline	Trace element deficiencies are more likely in most soils, Whiptail in cauliflowers and clubroot in continuous brassicas are both reduced.

NB—All crops can tolerate a lower pH level on **organic** or **peat** soils than those quoted above for **mineral** soils.

TYPES OF SOLID FERTILISER

When selecting a fertiliser the first consideration is to provide nitrogen, phosphate and potash in the correct proportions for a particular crop. The physical properties of the fertiliser chosen are no less important to the farmer. It may be necessary to pay a small premium in order to obtain a quality product, but this can be off-set against fertiliser wasted because it sets solid in storage, or against delays caused by a dusty product blocking the spreader.

Fertilisers based on ammonium nitrate have the best physical properties. The granules are hard, resist breakdown, and very little dust is present. Certain manufacturers achieve similar physical properties by stabilising the fertiliser granules with oil/colloid mixtures or special polymers.

Other products can be made by mixing cheaper forms of nitrogen (e.g. urea) with ammonium nitrate by solid granulation. These fertilisers have softer granules which may breakdown resulting in caking and a large amount of dust.

Solid fertilisers may also have the various constituents mixed to give a certain N, P, K analysis. Not only are these fertilisers dusty and prone to caking, but there is also a large range of particle sizes. This may result in uneven distribution of nutrients.

PHOSPHATIC FERTILISERS

Phosphatic fertilisers are available in a wide range of chemical forms. As well as differing considerably in price they vary widely in fertiliser efficiency. Not all are suitable for use in every situation. It is essential to know what particular type of phosphate fertiliser is being applied.

SUPERPHOSPHATES

In both normal superphosphate (18 - 21% P_2O_5) and triple superphosphate (up to 47% P_2O_5) the main constituent is mono-calcium phosphate. The phosphate in both fertilisers is water soluble and immediately available for uptake by crops. These fertilisers are effective over a wide range of soil types and pH levels. Superphosphate can effectively be applied as a 3-yearly dressing and is not leached from the soil.

For many years superphosphate has been the standard against which other phosphate fertilisers have been compared. So far none has been found to be consistently superior.

AMMONIUM PHOSPHATES

Ammonium phosphates are forms of phosphate commonly used in the manufacture of compound fertilisers. The fact that they are soluble in water means they are quick acting and as effective as superphosphates.

ROCK PHOSPHATE

Ground rock phosphate or ground mineral phosphate is the product obtained from soft mineral calcium phosphate deposits. These are finely ground to increase the availability of the phosphate to plant roots. Usually they contain between 27 - 32% P_2O_5 of which at least 55% should be soluble in 2% formic acid. None of the phosphate is soluble in water.

Rock phosphates from Tunisia have consistently been rated most highly in field trials. Others are obtained from harder rocks, such as those from Florida, and these have been found to be less efficient.

Ground rock phosphates are best used for improving the soil phosphorus status of deficient soils under grass. They can be used on swedes, turnips, kale and rape, but should not be used on potatoes. Their effectiveness is enhanced by high organic matter content, low pH and high rainfall. They should not be used on nearly neutral or calcareous soils.

MIXTURES OF WATER-SOLUBLE AND INSOLUBLE PHOSPHATE

The presence of water soluble phosphate overcomes the low availability of insoluble phosphate in the first year after application. These fertilisers can be used where the aim is to maintain the soil pH below 6.5, even after liming.

They may be particularly useful in the following situations:—

(a) For areas to be reseeded, restored or reclaimed, because both water soluble and insoluble phosphate is given in one application.

(b) For maintainance phosphate applications on grassland.

(c) For improving phosphate reserves on arable land where the average rainfall exceeds 760 mm (30 in).

NITROPHOSPHATES

Unlike superphosphates which have much the same composition wherever they are produced, nitrophosphates are more variable. Depending on their formula nitrophosphates contain 50 - 80% of the phosphate in water soluble form. The remaining phosphate will become available to the plant, but not as quickly as water soluble phosphate.

Some nitrophosphates contain potassium, added as potassium chloride, and such fertilisers are marketed as granular compounds.

For cereals and grass these fertilisers are as effective as those based wholly on water soluble phosphate. For potatoes and other responsive crops only fertilisers with 50% or more water soluble phosphate should be used and only when the soil phosphate status is moderate or above. On phosphate deficient soils where a reasonable response to phosphate is anticipated for potatoes or vegetables, the phosphate should be applied all in water soluble form.

PHOSPHATIC NEUTRAL FILTER CAKE

This material contains 21% P_2O_5. Although sparingly soluble in water the phosphate is available for plant uptake. Many experiments have shown that over a wide range of pH levels and on all normal farm crops, with the exception of potatoes, it is practically as good as superphosphate.

It is probably the closest currently available equivalent to high grade basic slag.

OTHER MATERIALS

There is a wide range of phosphatic fertilisers available. For advice on the effectiveness of new products consult your adviser.

MAGNESIUM

Magnesium is removed from the soil by leaching and by crops and it may be necessary to add a magnesian fertiliser in order to maintain a satisfactory level of available magnesium in the soil. Such additions are recommended for arable crop production when the available soil magnesium level is very low or low, as indicated by soil analysis.

The type of compound used and the frequency of application depend on soil pH. Magnesian limestone is recommended both to raise the pH and supply magnesium. Five tonnes per hectare (2 tons/acre) of a good quality magnesian limestone (approximately 40 per cent $MgCO_3$) will supply sufficient magnesium for eight to ten years. When the soil does not need lime, apply 80 kg/ha (71 lb/acre) calcined magnesite for responsive crops e.g. potatoes, vegetable and soft fruit crops.

After the available soil magnesium has been raised to a satisfactory level, and when further liming becomes necessary, magnesian limestone may be used alternately with ordinary limestone to maintain the magnesium status and to correct acidity.

Hypomagnesaemic tetany

Soil levels which are adequate for crop production may, however, produce crops with an inadequate amount of magnesium for animals. For livestock production therefore, magnesium compounds should be applied whenever the soil status is less than "high" or when there is a history of hypomagnesaemic tetany.

Soil magnesium is not always a reliable indicator of the magnesium supply to the animal as the availability of dietery magnesium decreases as the nitrogen and potassium levels increase. **Hypomagnesaemic tetany can occur even when the soil magnesium level is designated high.** It is advisable therefore, to feed a magnesium compound during the danger periods when in doubt about the magnesium supply to the animal.

Potassium fertilisers should not be applied in spring to grazing fields because of the danger of reducing the level of magnesium in the herbage.

SULPHUR

Over most of the East of Scotland College area, inputs of sulphur from the atmosphere are higher than in North East Scotland where deficiencies have been demonstrated. As yet there are no records of field crops in the College area responding to applied sulphur.

The sulphur requirement of cereals is relatively low, but brassica crops (for example oil seed rape, swedes, Brussel sprouts) and grass for conservation may respond to sulphur in certain conditions. Responses may occur in areas where low supplies of sulphur from atmospheric pollution coincide with sulphur-deficient soils, as in parts of Angus, Berwickshire and possibly Perthshire. Even with susceptible crops, responses are unlikely, except on light-textured soils or soils with high pH and low organic matter contents.

Soil extractable sulphate levels may be used as a guide to problem soils. The best method of diagnosing sulphur deficiency reliably is the determination of sulphur content of the plant. Where sulphur deficiency is suspected, have the diagnosis confirmed by plant analysis taken during the period of rapid growth in spring.

Should sulphur deficiency be diagnosed it can be corrected by the use of fertilisers containing sulphur, e.g. ammonium sulphate or calcium sulphate (gypsum) or by the use of sulphur spray products.

LIQUID FERTILISERS AND FOLIAR FEEDS

LIQUID FERTILISERS

Liquid fertilisers supplying N, P_2O_5 and K_2O are solutions of normal fertiliser materials in water. They are generally as effective as equivalent quantities of water-soluble fertiliser applied in the solid form and are acceptable and widely used alternatives to solid fertiliser.

The advantages of liquid fertilisers are the ease of storage and handling and the rapidity and accuracy with which they can be spread. Liquid fertilisers can be conveniently placed into the soil where the plant can use the nutrients efficiently. Normally, liquid fertilisers have to be adopted as a system. Experience has shown that the system is better fitted for larger farms.

When selecting liquid fertilisers careful note should be taken of the analysis. Liquids can be sold on (1) a weight/weight basis (kg nutrient per 100 kg product). This is directly comparable with solids which are also sold on a weight/weight basis; (2) a weight/volume basis (kg nutrient per 100 litres product). Liquid fertilisers have a specific gravity of approximately 1.2. The analysis quoted would then be kg nutrients per 120 kg product.

UREA

Urea is generally a less effective fertiliser than ammonium nitrate. On average, the relative efficiency of nitrogen in urea is about 90% of that in ammonium nitrate, when moderate rates of nitrogen are applied. With high rates, applying in excess of 100 kg N per hectare (80 units per acre) in a single application, the relative efficiency of urea is even less. Top dressing of urea, particularly in dry weather, tends to result in lower efficiencies but incorporating urea into the soil gives better results, particularly on soils which are slightly acid. Moderate rates worked into the seedbed in spring are likely to be almost as effective as the equivalent amount of nitrogen in ammonium nitrate. Combine drilling of urea is dangerous and liable to damage germination of seed.

Top dressing with urea during winter or very early spring can cause severe scorch to young cereal plants in frosty conditions.

INJECTION OF AQUEOUS AMMONIA AND ANHYDROUS AMMONIA

Two liquid fertilisers supplying straight nitrogen are aqueous ammonia and anhydrous ammonia. Aqueous ammonia is a solution of ammonia gas in water and contains 28 per cent nitrogen. Anhydrous ammonia is a gas liquified under pressure, containing 81 per cent nitrogen. Both fertilisers must be injected into the soil to prevent loss of nitrogen. Anhydrous ammonia has to be stored under pressure.

The application to grassland of large quantities of either aqueous or anhydrous ammonia in a single injection can lead to sward damage and a delayed response. Moreover the total quantity of herbage produced throughout the season from a single massive application is frequently less than from the equivalent quantity of nitrogen applied in split dressings of either solid or liquid fertiliser. However, summer growth of grass in droughty conditions can be better after a single large injection of nitrogen in spring.

FOLIAR SPRAYS

Whether applied to the soil or foliage, liquid fertilisers are intended to apply nutrients through the plant roots. They should not be confused with foliar sprays which are intended to supply nutrients through the leaf. With the exception of specific trace-elements in solution (e.g. manganese and boron) applied to deficient crops, there is no evidence that foliar sprays are of economic value to crops in Scotland.

FERTILISER PLACEMENT

Placement of fertiliser near the seed can give increased efficiency of nutrient uptake but with some crops, high application rates can damage seedlings or delay emergence. Damage is more likely on light soils and in dry, cold springs.

CEREALS

On soils low in available phosphate and potash, fertilisers are more effective if combine drilled, i.e. if fertiliser and seed are placed together. Too high a concentration, particularly of nitrate or chloride, added in the fertiliser close to the seed, can impair germination. The total quantity of nitrogen, phosphate and potash combine drilled should not exceed about 180 kg/ha (144 units/acre) e.g. 450 kg/ha (3.6/cwt acre) of 20:10:10 compound. The balance of the fertiliser required can be broadcast to avoid damage. Compound fertilisers which contain part of their nitrogen as urea should not be combine drilled at rates supplying more than 30 kg N/ha (24 units N/acre) as urea.

Combine drilling fertiliser containing ammonium-N (i.e., most of the commonly used fertilisers) has the effect of lowering soil pH in the vicinity of the seed. This in turn makes soil manganese more readily available. Thus on soils prone to manganese deficiency in cereals, combine drilling can alleviate or prevent the problem.

Fertiliser placement drills feed the fertiliser down a separate coulter and place it between and below alternate rows. Fertiliser placement is potentially less damaging at brairding; other effects are similar to those of combine drilling.

POTATOES

When fertiliser is placed in a band close to the seed (5 cm below and 5 cm to side) or is broadcast over open ridges, it is used more efficiently then when broadcast before opening the ridges for planting. Consequently about 20 per cent less fertiliser is required when it is placed. High rates of fertiliser placed near the seed tubers can damage developing roots and sprouts, which will reduce and delay emergence, particularly of chitted seed. Where the recommended rates of fertiliser are high, i.e. a 1-1-1½ NPK compound fertiliser supplying more than 100 kg N/ha (80 units N/acre) it is safer to broadcast all or half on the flat before ridging.

Placement of liquid fertilisers (commonly 8 cm below and 8 cm to side of seed) is also an efficient method up to a limit of compound fertiliser supplying 160 kg N/ha.

Deeper placement of fertiliser than quoted above for solids and liquids may be advantageous in dry seasons, but it is advisable to split the fertiliser, placing only half and broadcasting the other half before ridging.

ROOTS

Fertiliser can be either broadcast or placed for root crops. In order to avoid the danger of root damage with placement drills, the fertiliser should be 5 cm (2 in) below the seed.

Where fertiliser is broadcast for crops sown on the ridge, this should be done prior to ridging so that it is enclosed within the ridge.

SLURRY AND ORGANIC MANURES

Slurries and other organic manures are potentially valuable sources of plant foods. They should be treated as such and every effort made to utilise them in such a way that maximum benefit can be obtained from the nutrients they contain. **They should not be regarded simply as waste products but should be incorporated in the fertiliser programme for the farm.**

NUTRIENT CONTENT

The fertiliser value of organic manures depends on the nature and the diet of the animal from which they are derived and on the method of storage and age of the manure. Typical values for the nutrient levels of some common manures and slurries are given in tables i and ii on pages 23-24, but actual values for any given material can differ widely from these. In particular, the nutrient levels of slurries which have been diluted with rain or wash water can be much lower and their true value difficult to assess.

The most satisfactory method of assessing the value of diluted slurries is to calculate the fertiliser value directly from the number of animals involved and the period for which they have been housed. Table iii gives the quantity of available N, P_2O_5 and K_2O excreted per week by different classes of livestock. How these figures are used is illustrated in the following example.

What fertiliser allowance can be made where slurry from 90 dairy cows housed for 26 weeks is spread over 20 ha (50 acres) of grassland in the spring?

From table iii

10 cows excrete:

7 kg (14 units) N, 2.5 kg (5 units) P_2O_5 and 13.5 kg (27 units)K_2O per week.

∴. 90 cows excrete:

63 kg (124 units) N, 22 kg (43 units) $P_2O_5$and 121 kg (238 units) K_2O per week.

In 26 weeks, this will amount to:

1638 kg (3224 units) N, 572 kg 1126 units) P_2O_5 and 3146 kg (6192 units) K_2O.

This is applied to 20 ha (50 acres)

∴. Fertiliser allowance per hectare is 82 kg N, 29 kg P_2O_5 and 157 kg K_2O. (or per acre is 65 units N, 23 units P_2O_5 and 125 units K_2O).

TIMING OF APPLICATION

The values of available nutrients given in the tables assume that organic manures will be applied in spring when their nutritive value can be utilised most effectively. If they are applied in winter, much of the nitrogen and some of the potash may be lost by leaching or other processes. If early application of slurry is unavoidable, allowance must be made for this loss in calculating nitrogen content. Table iv shows the relationship between time of application and the approximate amount of nitrogen available for spring growth.

NUTRIENT IMBALANCES

Cow slurries are relatively rich in potassium and low in phosphate. They are suitable for grass which is to be cut, but to obtain the full benefit of the potassium, additional N may be required. On soils deficient in phosphate, extra phosphate fertiliser will also be required.

Frequent dressings of slurry to grassland can result in excessive levels of potassium in the soil which reduces herbage uptake of magnesium. This may cause hypomagnesaemic tetany in livestock. Alternating straight nitrogen fertiliser with slurry will help to prevent this.

AVOIDANCE OF POLLUTION

The volume of slurry in one application should be restricted to 55 cubic metres per hectare (4840 gallons per acre). At least one month should elapse between applications. In order to prevent run-off, slurry should not be applied to steeply sloping fields or water-logged soils. During periods of hard frost slurry should not be applied to sloping land.

Table i Available nutrients in some common manures

	kg/30 tonnes (units/12 tons)		
	N	P_2O_5	K_2O
Farmyard manure	30 (30)	30 (30)	50 (50)
Deep litter	300 (300)	300 (300)	120 (120)

NB: Nutrient value of FYM varies widely

TABLE ii Available nutrients in some undiluted manures

	kg/10 cubic metres*			units/1000 gal		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Dairy cows	23	8	45	20	7	40
Fattening pigs	40	23	27	36	20	24
Laying hens	94	69	81	84	62	72

*10 cubic metres = 10,000 litres = 2200 gal
kg/10,000 litres is approximately equal to units/1000 gallons

TABLE iii Available nutrients excreted per week by livestock

	kg/week (units/week)		
	N	P_2O_5	K_2O
10 Dairy cows	7(14)	2.5(5)	13.5(27)
10 Young cattle (250 kg)	2(4)	0.5(1)	3.5(7)
10 Fattening cattle (400 kg)	4(8)	1.5(3)	8(16)
100 Fattening pigs (70 kg)	12(24)	7(14)	8(16)
1000 Laying hens	7.5(15)	5.5(11)	6.5(13)

TABLE iv Timing of application (N efficiency)

Time of application	Nitrogen available for spring growth (%)
September and October	0 - 25
November and December	26 - 50
January and February	51 - 75
March and April	76 - 100

The response to organic manures in summer can be very variable. **Heavy applications of slurry in autumn or winter can lead to winter kill in grass.**

SEWAGE SLUDGE

The fertiliser value of sewage sludge in terms of nitrogen, phosphate and potash is limited unless substantial quantities are applied. Where raw or undigested sewage sludges are applied, disease organisms are a potential hazard to grazing animals. Moreover they may be carried from one field to another by birds. It is not advisable to apply such sludges to pasture, to land which may grow seed potatoes or to land which will grow vegetables to be eaten raw by humans.

Sewage sludge is a very variable material, particularly as regards trace-element composition. This variability is increased when sludge is contaminated by metals present in industrial effluents discharged into sewers.

High levels of zinc, nickel and copper are often present in sludges produced in industrial areas, and these can have toxic effects on plant growth. The highly toxic element cadmium, which is readily taken up by plants from contaminated soil, is also present in many sludges. Thus a potential user of sewage sludge should be aware of its source and its trace-element content before deciding to use it. Sludges from rural areas are less likely to contain harmful levels of trace elements, and if digested, may be safe to apply to the land.

Maximum tolerable levels of some potentially toxic metals commonly present in sludges which may be applied to agricultural land are:

	Maximum tolerable concentration in sludge* (mg/kg DM)
Cadmium	20
Molybdenum	25
Nickel	600
Chromium	2,000
Lead	1,500
Zinc	2,500
Copper	1,500

Unless sludge contains levels of potentially toxic elements well below the ceiling limits, no more than 10 tonnes of sludge dry matter per hectare should be applied within a five year period.

* See SAC Publication No. 76.

CONSULT YOUR ADVISER IF YOU ARE COMTEMPLATING USING SEWAGE SLUDGE

TRACE ELEMENTS

Specialist advice should be sought on deficiency problems as they arise and before remedial action is taken.

In most soils, regular additions of trace elements are unnecessary. The rate of depletion by cropping of all these elements is very small in relation to the total potentially available supply. Trace elements, except boron, are not normally incorporated in compound fertilisers.

Deficiencies occur either because the available content of the particular element is inherently low in the soil or because it has been substantially lowered by liming, or by cropping and leaching losses. Liming reduces the availability of most trace elements, but molybdenum and selenium are exceptional in becoming more available at high pH levels. The availability of most trace elements is greatest in acid, water-logged conditions. It should be borne in mind that soils belonging to certain soil series, particularly those derived from old red sandstone, tend to be deficient in trace elements.

Certain levels of trace elements in the soil are considered necessary for satisfactory plant growth and the health of grazing animals. The treatments given on page 27 are recommended when deficiencies occur. Elements such as iodine, iron, manganese, selenium and zinc are not required as soil fertilisers. Where selenium deficiency occurs in farm animals, additional selenium may be supplied either by injection by a veterinary surgeon or by supplying a mineral supplement containing selenium.

Consult your adviser for information on the soil series on your farm, and on any suspected trace-element deficiency in crops or livestock.

TRACE-ELEMENT RECOMMENDATIONS

Element	Chemical compound	Foliar* sprays	Soil dressings	Remarks
Boron	Boronated fertiliser	—	Recom-mended fertiliser rates	Deficiency occurs in swedes and turnips. Not to be applied to cereals or potatoes
	Borax ($Na_2B_4O_7.10H_2O$)		20 kg/ha (18 lb/ac)	
	'Solubor'	10 kg/400-1000 litre water/ha (9lb in 40-100 gal/ac)	—	Foliar spraying is best carried out immediately after singling and before deficiency symptoms appear.
Manganese	Manganese sulphate ($MnSO_4.4H_2O$)	4-6 kg/200-500 litre water/ha (4-5lb in 20-50 gal/ac)	—	Oats, barley and to a lesser extent wheat may suffer from deficiency. Manganese chelates can also be used. Repeated spraying may be necessary.
	($MnSO_4$)	3-4½ kg/200 500 litre water/ha		
Copper	Copper sulphate ($CuSO_4.5H_2O$)	—	10-50kg/ha (9-45lb/ac)	Deficiencies occur both in cereals and ruminants. **POISONOUS**-keep stock off treated ground until washed in. Note that sheep are particularly susceptible to copper poisoning. Treatment should be effective for four or five years/
	Copper oxychoride ($CuC1_2$ $3Cu(OH)_2$	3-5kg/200-500 litre water/ha (3-5lb in 20-50gal/ac)	4-20kg/ha (3-18lb/ac)	For cereals. Obtainable as a colloidal solution and as certain brands of potato-blight spray. Copper chelates can also be used.
Cobalt	Cobalt sulphate ($CoSO_4.7H_2O$)	—	6 kg/ha to ¼ of field (5lb/ac to ¼ of field)	Deficiency occurs mainly in sheep. Cobalt 'bullets' may be used as a preventive measure. Alternatively apply to land as a cobalt sulphate spray or as cobaltised super phosphate. Treatment should be effective for four or five years.
Molybdenum	Sodium molybdate ($Na_2MoO_4.2H_2O$)	9g/30 litre water/100 m^2 (0.25oz in 5 gal/100yd^2)	1kg/ha (1lb/ac)	Deficiency occurs mainly in cauliflower. Spraying is best carried out on seedbed or on plants in seedbed before planting out. **POISONOUS**-molybdenum is toxic to grazing animals and spraying should not be carried out on pasture.

***Uptake by plants** is improved by the addition of a wetting agent to the spray

TRACE ELEMENTS IN EXCESS CAN BE TOXIC TO CROPS AND STOCK

INTENSIVE CASH CROPPING FARMS, OR WHERE ROTATIONAL GRASS

Recommendations in kg/ha and (units/acre) are based on rainfall of 710mm (28 inches)

CEREALS		Winter Wheat		
Placed in rotation		N	P_2O_5	K_2O
After cereals, roots	A	25(20)	50(40)	50(40)
harvested or grass cut	S	160(128)	—	—
After oil seed rape,	A	—	50(40)	50(40)
peas, beans or 1 yr grass grazed	S	130(104)	—	—
After potatoes	A	—	—	—
	S	130(104)	—	—
After roots eaten on	A	—	50(40)	50(40)
	S	100(80)	—	—

A = Autumn S = Spring

NB—spring N top-dressing of winter wheat and winter barley should be split e.g. — ⅓ at start of spring growth and ⅔ at advanced tillerage stage.

OIL SEED RAPE	Winter sown			Spring sown		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Autumn	60(48)	60(48)	60(48)	—	—	—
Spring	200(160)	—	—	150(120)	60(48)	60(48)

SWEDES and TURNIPS	110(88)	110(88)	110(88)
STUBBLE TURNIPS	80(64)	40(32)	40(32)
KALE			
Early sown (split N: ⅔ seedbed, ⅓ top dressing)	175(140)	110(88)	110(88)
Sown after mid-June	135(108)	70(56)	70(56)
FODDER BEET and MANGOLDS	150(120)	70(56)	210(168)
SPRING BEANS (Horse and Tick)	30(24)	70(56)	70(56)
COMBINING PEAS	—	25(20)	25(20)

per year.

Winter Barley			Spring Barley			Spring Oats		
N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
25(20)	50(40)	50(40)						
150(120)	—	—	130(104)	50(40)	50(40)	120(96)	50(40)	50(40)
—	50(40)	50(40)						
120(96)	—	—	110(88)	50(40)	50(40)	100(80)	50(40)	50(40)
—	—	—						
120(96)	—	—	110(88)	—	—	100(80)	—	—
—	50(40)	50(40)						
90(72)	—	—	80(64)	50(40)	50(40)	70(56)	50(40)	50(40)

POTATOES	Fertiliser placed or broadcast over open ridges			Fertiliser broadcast on flat before ridging		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Maincrop ware	160(128)	130(104)	190(152)	200(160)	160(128)	240(192)
Early and maincrop seed	140(112)	130(104)	190(152)	180(144)	160(128)	240(192)
First earlies-ware	180(144)	150(120)	150(120)	220(176)	190(152)	190(152)

After 3rd successive cereal add 25 kg (20 units) N to recommendation.

ADJUSTMENTS—SEE BACK FOLD OUT PAGE

ARABLE FARMS WITH APPROXIMATELY ¼ OF THE CROPPING AREA

Recommendations in kg/ha and (units/acre) are based on rainfall of 810mm (32 inches)

CEREALS		Winter Wheat		
Place in rotation		N	P_2O_5	K_2O
After 2 or more cereals	A	25(20)	50(40)	50(40)
	S	140(112)	—	—
After 1 cereal, roots harvested or grass cut	A	—	50(40)	50(40)
	S	130(104)	—	—
After oil seed rape, peas or beans	A	—	50(40)	50(40)
	S	120(96)	—	—
After potatoes	A	—	—	—
	S	120(96)	—	—
After roots eaten on or grass grazed	A	—	50(40)	50(40)
	S	90(72)	—	—

A = Autumn S = Spring
NB—spring N top-dressing of winter wheat and winter barley should be split e.g. —⅓ at start of spring growth and ⅔ at advanced tillerage stage.

OIL SEED RAPE	Winter sown			Spring sown		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Autumn	50(40)	50(40)	50(40)	—	—	—
Spring	175(140)	—	—	125(100)	50(40)	50(40)

	N	P_2O_5	K_2O
SWEDES and TURNIPS	100(80)	100(80)	100(80)
STUBBLE TURNIPS	70(56)	35(28)	35(28)
KALE			
Early sown (split N: ⅔ seedbed, ⅓ top dressing)	165(132)	110(88)	110(88)
Sown after mid-June	125(100)	70(56)	70(56)
FODDER BEET and MANGOLDS	110(88)	70(56)	210(168)
FORAGE RAPE	120(96)	60(48)	60(48)
Late sown catch crop of rape—treat as for STUBBLE TURNIPS			
SPRING BEANS (Horse and Tick)	30(24)	70(56)	70(56)
COMBINING PEAS	—	25(20)	25(20)

per year.

Winter Barley			Spring Barley			Spring Oats		
N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
25(20)	50(40)	50(40)						
130(104)	—	—	120(96)	50(40)	50(40)	110(88)	50(40)	50(40)
—	50(40)	50(40)						
120(96)	—	—	110(88)	50(40)	50(40)	100(80)	50(40)	50(40)
—	50(40)	50(40)						
110(88)	—	—	100(80)	50(40)	50(40)	90(72)	50(40)	50(40)
—	—	—						
110(88)	—	—	100(80)	—	—	90(72)	—	—
—	50(40)	50(40)						
80(64)	—	—	70(56)	50(40)	50(40)	60(48)	50(40)	50(40)

POTATOES	Fertiliser placed or broadcast over open ridges			Fertiliser broadcast on flat before ridging		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Maincrop ware						
After 2 years grass	120(96)	100(80)	150(120)	160(128)	130(104)	200(160)
After other crops	150(120)	130(104)	190(152)	190(152)	160(128)	240(192)
Early and maincrop seed						
After 2 years grass	100(80)	100(80)	150(120)	120(96)	120(96)	190(152)
After other crops	130(104)	130(104)	190(152)	160(128)	160(128)	240(192)
First earlies-ware	170(136)	150(120)	150(120)	210(168)	190(152)	190(152)
After 3rd successive cereal add 25 kg (20 units) N to recommendation.						

ADJUSTMENTS—SEE BACK FOLD OUT PAGE

GRASS ARABLE FARMS WITH AT LEAST ONE HALF OF THE CROPPING

Recommendations in kg/ha and (units/acre) are based on rainfall of about 890mm

CEREALS		**Winter Wheat**		
Place in rotation		N	P_2O_5	K_2O
After 2 or more cereals	A	—	50(40)	50(40)
	S	120(96)	—	—
1st cereal after grass cut or roots harvested; 2nd cereal after 3 yr or older grass mainly grazed	A	—	50(40)	50(40)
	S	110(88)	—	—
After potatoes	A	—	—	—
	S	100(80)	—	—
1st cereal after 3 yr or older grass mainly grazed; or after roots eaten on	A	—	50(40)	50(40)
	S	80(64)	—	—

A = Autumn S = Spring

NB—spring N top-dressing of winter wheat and winter barley should be split e.g.— ¾ at start of spring growth and ⅞ at advanced tillerage stage.

	N	P_2O_5	K_2O
SWEDES and TURNIPS	90(72)	120(96)	90(72)
STUBBLE TURNIPS	60(48)	30(24)	30(24)
FORAGE RAPE			
Undersown	75(60)	75(60)	75(60)
Not undersown	100(80)	50(40)	50(40)
Late catch crop	60(48)	30(24)	30(24)
KALE			
Early sown (split N: ⅔ seedbed, ⅓ top dressing)	150(120)	110(88)	110(88)
Sown after mid-June	110(88)	70(56)	70(56)

35 inches per year.

Winter Barley			Spring Barley			Spring Oats		
N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
—	50(40)	50(40)						
110(88)	—	—	100(80)	50(40)	50(40)	80(64)	50(40)	50(40)
—	50(40)	50(40)						
100(80)	—	—	90(72)	50(40)	50(40)	70(56)	50(40)	50(40)
—	—	—						
90(72)	—	—	80(64)	—	—	60(48)	—	—
—	50(40)	50(40)						
70(56)	—	—	60(48)	50(40)	50(40)	50(40)	50(40)	50(40)

POTATOES	Fertiliser placed or broadcast over open ridges			Fertiliser broadcast on flat before ridging		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Maincrop ware						
After 3 years or older grass	80(64)	80(64)	110(88)	110(88)	110(88)	150(120)
After other crops	110(88)	110(88)	150(120)	140(112)	140(112)	190(152)
Early and maincrop seed						
After 3 years or older grass	60(48)	80(64)	110(88)	80(64)	110(88)	150(120)
After other crops	80(64)	110(88)	150(120)	100(80)	140(112)	190(152)

ADJUSTMENTS—SEE BACK FOLD OUT PAGE

VEGETABLE AND BULB CROPS

Fertiliser recommendations in kg per hectare (units per acre)

	Base N Dressing
Brussels sprouts (field drilled)	100(80)
Brussels sprouts (transplanted)	150(120)
Summer, autumn and winter cabbage (field drilled)	100(80)
Summer, autumn and winter cabbage (transplanted)	150(120)
Spring cabbage	50-75(40-60)
Cauliflower (field drilled)	100(80)
Cauliflower (transplanted)	150(120)
Cauliflower (winter hardy)	50-75(40-60)
Calabrese	100(80)
Beetroot	100(80)
Carrot	25-60(20-48)
Turnip (early bunching)	100(80)
Broad bean	Nil
Peas	Nil
Onions Spring (spring sown)	75-125(60-100)
Onions Spring (autumn sown)	25(20)
Onion bulbs (spring sown)	60-90(48-72)
Leek	100(80)
Lettuce	150-200(120-160)
Shopping Swedes	50-100(40-80)
Rhubarb (established)	
(planting year)	125-175(100-140)
Narcissus	100(80)
Tulip	75(60)

1. Where a range of top dressings is given, the amount to be applied depends on the appearance of the crop and the amount of N lost by leaching.

2. Reduce by 30 per cent when soil analysis is high, omit when very high. Add 50 kg (40 units) when analysis is low.

3. 125 kg (100 units) in March, 125 kg (100 units) after pulling.

4. Apply early in the second cropping year.

WEATHER: see page 9.

TABLE 4

Top[1] Dressing	P_2O_5[2]	K_2O[2]
150-200(120-160)	75(60)	125(100)
100-150(80-120)		
100-200(80-100)		
50-150(40-120)	75(60)	175(140)
150-250(120-200)		
100-150(80-120)		
50-100(40-80)	75(60)	125(100)
125-200(100-160)		
80-150(64-120)	60(42)	75(60)
150(120)	100(80)	200(160)
Nil	125(100)	125(100)
50(40)	50(40)	150(120)
Nil	150(120)	100(80)
Nil	25(20)	25(20)
Nil	150(120)	75(60)
50(40)	125(100)	125(100)
50-100(40-80)	150(120)	125(100)
50-150(40-120)	150(120)	125(100)
Nil	250(200)	100(80)
Nil	50(40)	125(100)
250(200)[3]	75(60)	155(124)
120(96)	125(100)	190(152)
50(40)[4]	75(60)	150(120)
Nil	75(60)	150(120)

TIMING OF P AND K APPLICATION: Where large amounts of phosphate and potassium are required they are best applied in the autumn, especially where crops are to be field drilled.

DUNG APPLIED: Reduce recommendations by 30 kg (24 units) N. 30 kg (24 units) P_2O_5 and 50 kg (40 units K_2O).

IRRIGATION: Where irrigation is applied on a routine basis manurial practice should be discussed with your local horticultural adviser.

SOFT FRUIT CROPS

Fertiliser recommendations in kg per hectare (units per acre)

RASPBERRY	Approx. date of fertiliser applic.	Maiden year N	Maiden year P_2O_5	Maiden year K_2O
1. Glen Clova and other over-vigorous varieties	End March	75(60)	40(32)	75(60)
	End June	50(40)	—	—
2. Varieties of average vigour	End March	75(60)	40(32)	75(60)
	End June	50(40)	—	—
3. Jewel and other varieties of similar vigour	End March	75(60)	40(32)	75(60)
	End June	50(40)	—	—

STRAWBERRY	N	P_2O_5	K_2O
Before planting or in March	40(32)	40(32)	60(48)
In 3rd and 4th cropping years if growth is poor			

GOOSEBERRY	N	P_2O_5	K_2O
At end of March (broad-cast over the root-run in maiden and second year)	40(32)	40(32)	60(48)

BLACKCURRANTS	N	P_2O_5	K_2O
At end of March (broadcast over the root-run in maiden and second year)	140(112)	40(32)	120(96)

ADJUSTMENTS

The recommendations are for average conditions; nitrogen rates for all crops should be adjusted according to the actual vegetative growth. *Where cane vigour control is being practised, routine applications of nitrogen may be required.

DUNG APPLIED: Reduce recommendations by 30 kg (25 units) N, 30 kg (25 units) P_2O_5 and 50 kg (40 units) K_2O.

TABLE 5

Second Year			Cropping Years		
N	P_2O_5	K_2O	N	P_2O_5	K_2O
40(32)	40(32)	75(60)	—	40(32)	75(60)
40(32)	40(32)	75(60)	20(16)	40(32)	75(60)
75(60)	40(32)	75(60)	40(32)	40(32)	75(60)

—	40(32)	60(48)	—	40(32)	60(48)
—	—	—	25(20)	40(32)	60(48)

40(32)	40(32)	120(96)	75(60)	40(32)	120(96)

140(112)	40(32)	75-100(60-80)	140(112)	40(32)	75-100(60-80)

SOIL ANALYSIS:

WHERE SOIL P_2O_5 and K_2O are high, halve the P_2O_5 and K_2O application; where very high—omit.

where soil P_2O_5 and K_2O are low, add 50 kg (40 units) P_2O_5 and K_2O.

GRASSLAND MANURING

ESTABLISHMENT

Undersowing in a cereal

Reduce recommended rate of N for cereal by 25 kg/ha (20 units per acre) and broadcast extra P_2O_5 and K_2O each at 40 kg/ha (32 units per acre).

Direct sow-out	kg/ha			units/ac		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Grass	60	60	60	48	48	48
Grass/clover	40	80	80	32	64	64

If autumn sown, halve the N input.

ESTABLISHED GRASSLAND

Recommendations are based on nitrogen policy;

High Nitrogen policy: 300-400 kg N/ha (240-320 units N per acre).

This range produces a high yield of grass and is appropriate for most dairy farms and intensively stocked beef farms. The best response to N occurs in areas with adequate summer rainfall and on medium to heavy textured soils.

Moderate nitrogen policy: 125-250 kg N/ha (100-200 units N per acre)

This range is appropriate for most beef and sheep farms. A flexible approach to N use depending on the needs of the stock and clover content of the sward, will often pay best. Reliance on clover requires careful management, avoiding prolonged over-and undergrazing, to achieve a good clover content of at least 50% ground cover in mid-summer. Clover is weakened by shading in silage and hay crops and will only thrive in grazing fields.

Low nitrogen policy: 50-100 kg N/ha (40-80 units per acre)

This range is appropriate for hill and upland farms, or on other farms where reliance can be placed on clover N.

A guideline for N use for grazing on beef and sheep farms can be based on stocking rate in spring:

Beef— 12 kg N/100 kg LW/ha (12 units N/cwt/ac)

e.g. 10 beef cattle/ha at 200 kg liveweight would require 240 kg N/ha (4 beef cattle/ac at 4 cwt LW = 192 units N/ac)

Sheep— 12 kg N/ewe/ha (24 units N/ewe/ac)

e.g. 10 ewes/ha would require 120 kg N/ha (4 ewes/ac = 96 units N/ac)

TIME OF NITROGEN APPLICATIONS

The greatest response to fertiliser N occurs in the period up to mid-June when growth rates are highest. The recommendations are designed to exploit this and allow for nitrogen returned by grazing animals.

A timely application of N in spring is important to provide early growth.

A guideline for the time of spring N application is as follows:

Farms up to 100 m (300 ft)	—early March
Farms at 100-200 m (300-600 ft)	—mid March
Farms above 200 m (600 ft)	—late March

A more precise guide to allow for seasonal differences is provided by accumulated soil temperatures. Nitrogen should be applied when T 80° is reached, i.e. when the total of positive daily 10 cm (4 in) soil temperatures from 1st February, reaches 80°C.

Consult your adviser for recommended dates of spring N application.

HIGH NITROGEN POLICY: 300-400 kg N/ha (240-320 units N/acre)

GRAZING

	Approx. date of application	N
1st application	Early March	80
2nd application	Early May	65
3rd application	Early June	65
4th application	Early July	65
5th application	Early August	50
		325†

† Total N split ¼: ⅕: ⅕: ⅕: ⅙

CUTTING AND GRAZING

Silage		
1st cut	Late March	120
2nd cut	Early June	100
3rd cut or aftermath grazing	Late July	80
		300
Hay		
1st cut	Early April	80*
2nd cut or aftermath grazing	Early July	60*
2nd grazing (no 2nd cut)	Early August	60
		200

* Increase by 20 kg N/ha (16 units N/ac) in dry area.

TABLE 6

kg/ha P_2O_5	kg/ha K_2O	Units/ac N	Units/ac P_2O_5	Units/ac K_2O
—	—	64	—	—
33	33	52	26	26
32	32	52	26	26
—	—	52	—	—
—	—	40	—	—
65	65	260	52	52

60	60	96	48	48
25	50	80	20	40
20	40	64	16	32
105	150	240	84	120
55	55	64	44	44
15	30	48	12	24
20	20	48	16	16
90	105	160	72	84

MODERATE NITROGEN POLICY: 125-250 kg N/ha (100-200 units N/ac)

GRAZING

	Approx. date of application	N
1st application	Early March	70
2nd application	Mid May	50
3rd application	Mid June	50
4th application	Late July	50
		220

CUTTING AND GRAZING

Silage		
1st cut†	Late March	100
2nd cut	Early June	80
Aftermath grazing	Early August	40
		220
Hay		
Hay†	Early April	80
Aftermath grazing	Early July	50
Autumn grazing	Early August	50
		180

† Where fields are grazed first by sheep in the spring, apply 50 kg N/ha (40 units/ac) in March; follow with a compound supplying 80 kg N for silage and 60 kg N for hay (64 and 48 units/ac).

TABLE 7

kg/ha		units/ac		
P_2O_5	K_2O	N	P_2O_5	K_2O
—	—	56	—	—
25	25	40	20	20
25	25	40	20	20
—	—	40	—	—
50	50	176	40	40

50	50	80	40	40
25	50	64	20	40
—	—	32	—	—
75	100	176	60	80
55	55	64	44	44
15	30	40	12	24
—	—	40	—	—
70	85	144	56	68

LOW NITROGEN POLICY: 50-120 kg N/ha. Reliance on clover nitrogen (40-96

GRAZING		
	Approx date of application	N
1st application	Early March	50
2nd application	July	40
		90

CUTTING AND GRAZING		
Silage		
1st cut	Early April	80
Aftermath grazing	June	40
		120
Hay		
Hay†	Early April	60
Aftermath grazing	July	40
		100

† Where fields are grazed first by sheep, apply 40 kg N/ha (32 units/ac) in March; follow with a compound supplying 40 kg N/ha (32 units/ac)

TABLE 8

kg/ha		units/ac		
P_2O_5	K_2O	N	P_2O_5	K_2O
—	—	40	—	—
60	60	32	48	48
60	60	72	48	48

40	40	64	32	32
20	20	32	16	16
60	60	96	48	48
40	40	48	32	32
20	40	32	16	32
60	80	80	48	64

HILL SWARD IMPROVEMENT

Most hill soils in the East of Scotland are acid and deficient in phosphate. Generally, the potash status is satisfactory with the exception of the peaty soils. **Have the soil tested before commencing any improvement and consult your local adviser.** Remember that the use of fencing, with or without fertiliser use, is a major factor in land improvement.

1. FOR TYPICALLY ACID AND PHOSPHATE DEFICIENT HILL SOILS TO BE DIRECT RESEEDED BEHIND A FENCE

Apply to seedbed:

5 tonnes/ha (2 ton/acre) magnesium limestone.
190 kg/ha (152 units/acre) P_2O_5; see pages 14-15 for types of phosphate fertiliser.

Apply at sowing time:

100 kg N/ha (80 units/acre); 50 kg/ha (40 units/acre) soluble P_2O_5 and 50 kg/ha (40 units/acre) K_2O.

NOTE: Where there is poor growth in the seeding year apply a further 50 kg/ha (40 units/acre) N.

Maintenance:
Apply limestone when necessary to maintain pH around 5.8 and 150 kg/ha (120 units/acre) P_2O_5 every 4-5 years.

1a. REDUCED INPUTS BEHIND A FENCE

2½ tonnes/ha (1 ton/acre) limestone with 90 kg/ha (72 units/acre) P_2O_5 are able to establish or support a hill grass/white clover association. Where potash status is low apply 80 kg/ha (64 units/acre) K_2O. For maintenance repeat initial fertiliser dressings every 4-5 years and limestone as required to maintain pH between 5.0 and 5.5.

1b. MOSAIC IMPROVEMENT OF OPEN HILL WITHOUT THE FENCE

Selected dry areas of the open hill can be treated to give clovery swards with or without oversown or introduced clover.

Apply:
5 tonnes/ha (2 ton/acre) limeston
180 kg/ha (144 units/acre) insoluble P_2O_5
with potash if required at 80 kg/ha (64 units/acre)

Nitrogen Use

In the hill situation N should only be used when the stocking pressure is able to keep the grass down to safeguard clover stands. With this proviso, a very useful source of N and K_2O is slurry, of benefit to grass and clover alike. Smooth stalked meadow grass (*Poa pratensis)* responds to N even in fairly acid conditions.

2. pH INFLUENCE ON SWARD COMPOSITION ON FREELY DRAINED HILL BROWN EARTH (EAST SCOTLAND)	
4.5 and below	**Wavy hair grass** strong with bent and sheep's fescue
4.5 - 5.0	**Bent/sheeps fescue** with red fescue, smooth stalked meadow-grass, Yorkshire Fog and a little wavy hair grass **White clover** present naturally (weak)
5.0 - 5.5	**Bent/sheeps fescue/red fescue** with smooth stalked meadow-grass, Yorkshire Fog and a little rough stalked meadow-grass and wavy hair grass **White clover** vigorous
5.5 - 6.0	**Bent/red fescue/red fescue/with smooth stalked meadow-grass,/Yorkshire Fog/rough stalked meadow-grass** **White clover** vigorous Suports **ryegrass, cocksfoot and timothy**

Bent and smooth stalked meadow grass are not greatly affected by pH in the range 4.5 - 6.5. Red fescue, Yorkshire Fog and particularly rough stalked meadow grass favour the higher part of this pH range. Sheep's fescue and wavy hair grass weaken with higher pH levels. Increased N availability can lessen the effect of acidity on the vigour of the sown grasses and smooth stalked meadow grass will respond to N to a greater degree than to pH.

White clover occurs naturally on a brown earth at pH 4.5, but requires pH 5.0 and above to grow vigorously.

ADJUSTMENTS TO TABLES 1, 2, and 3

CEREALS

Undersowing

Reduce N by 25 kg (20 units) and broadcast extra 40 kg (32 units) each of P_2O_5 and K_2O.

Straw ploughed in

Add 25 kg (20 units) N to following crop.

Intensive wheat

Where wheat is grown frequently, the effect of take-all disease can be alleviated by applying 30 - 40 kg/ha (24 - 32 units/acre) extra N. Part of the N top dressing should be applied in early spring.

CEREALS AND POTATOES

High yield situation

Cereals: P_2O_5 and K_2O recommendations in the tables are for average yields e.g. 5 t/ha (40 cwt/acre). Where high yield, e.g. 7 t/ha (56 cwt/acre) is anticipated, increase by 20 kg (16 units).

Potatoes: Where expected yield is in excess of 55 tonnes/ha (22 tons/acre) recommendations should be increased by 40 kg (32 units) N, 20 kg (16 units) P_2O_5 and 60 kg (48 units) K_2O.

ALL CROPS

Organic manures

Dung applied: reduce recommendation by 30 kg (24 units) N, 30 kg (24 units) P_2O_5 and 50 kg (40 units) K_2O.

Slurry applied: refer to pages 22-24.

Soil Analysis

Recommendations in the tables are based on moderate levels of phosphate and potash. Adjustments are given for use when soil analysis shows low available P_2O_5 and K_2O on page 8.

Rainfall

Recommendations in tables 1 - 3 are based on average rainfall associated with the various farm types. Adjustments for N are given for atypical areas and for seasonal variations in leaching on page 9.