NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Establishing pastures - Readers' Note

This document is part of a larger publication. The remaining parts and full version of the publication can be found at:

http://www.dpi.nsw.gov.au/agriculture/livestock/dairy-cattle/feed/publications/establishing-pastures

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Fertilisers

Nitrogen

Nitrogen (N) is important for leaf growth and is one of the essential building blocks of all proteins. It has an important effect on the quantity and quality of pastures.

Nitrogen is found in the soil as nitrogen gas, oxides of nitrogen (nitrate, nitrite, nitrous oxide and nitric oxide), ammonia, ammonium and organic nitrogen. Nitrate is the form required by most plants. Soil water content, pH, temperature, organic matter and microorganisms determine its rate of formation.

There are many different forms of nitrogen fertiliser:

Organic: Dairy manure, poultry manure, urea. Chicken manure is often used to increase pasture production. In cool climates it is applied in early autumn to provide winter feed. However, because of its high NPK content and because it's an organic fertiliser, it is best applied in spring.

Inorganic: Sulphate of ammonia, ammonium nitrate (Nitram), potassium nitrate, sodium nitrate, monoammonium phosphate (MAP), diammonium phosphate (DAP).

There are several NP (nitrogen and phosphorus) fertilisers; for example, DAP, Starter 15, Starter 18 and DAP Sulphur. The choice will depend on the phosphorus status of the soil and the amount of nitrogen required. As a general rule, sow 20 kg N/ha with the seedA hundred kilograms per hectare of DAP with an analysis of 18:20:0 will provide 18kgN/ha.

Heavy rain at or just after sowing will cause leaching and thus loss of nitrogen. Some dairy farmers prefer to sow with molybdenum and phosphorus and then broadcast nitrogen as urea or nitram after germination.

Urea and ammonium nitrate will last only 6–8 weeks in the soil. It is important to observe the pasture to determine its nitrogen status. Blanket applications of nitrogen fertilisers every 6–8 weeks are not recommended for perennial ryegrass – clover pastures because they will alter the balance between grasses and clovers. For other pastures, a small dose of 30–60kgN/ha every 6 weeks is ideal.

Choosing between urea and ammonium nitrate will be determined mainly by the price. Compare the cost of 1kg of nitrogen from both. Ammonium nitrate is more suited to drier conditions and provides a slightly quicker response.

For every 1kg of nitrogen applied to a pasture, approximately 10kg dry matter results. For a ryegrass pasture, 1kgN will produce the following amounts of dry matter (kg/ha):

Climate	Dry matter produced, by season (kg/ha)		
	Autumn	Winter	Spring
Cool	10–12	5–8	20
Moderate	15	10–12	23
Warm	20	15	25

Phosphorus

Phosphorus (P) fertiliser will be required each year to sustain a healthy and productive pasture. P deficiency can be one of the greatest constraints on pasture production. As stocking rate and intensity of production increase, the demand for P fertiliser will also increase.

The availability of phosphorus to pastures is reduced by:

- formation of sparingly soluble iron and aluminium phosphates in acidic soils
- formation of sparingly soluble calcium phosphates in alkaline soils
- adsorption* on soil particles
- transfer in dung to the unproductive areas on the farm such as laneways
- immobilisation in plant residues
- immobilisation in dung
- incorporation into the organic matter in slowly available forms
- run-off.

We can budget the annual phosphorus gains and losses:

Phosphorus budget for a model farm with a stocking rate on milking area of 2.5 cows/ha and milk production of 5000 L per head per lactation

		kg P
Inputs:	Concentrate	10.6
Losses:	Product	17.0
	Transfer	2.9
	Dung unavailable	9.6
	Run-off	2.0
	Residue unavailable	11.6
	Soil P sorption	See next
	Total	43.1+
Deficit (equivalent to 369 kg/ha of single super)		32.5+

* Adsorption is attachment by chemical reaction to a surface. Absorption is soaking into something. Together these are referred to as sorption.

This phosphorus budget does not take into account losses through reactions between the soil and the freshly applied fertiliser because the amount of P sorbed varies markedly between soil types. Soils with a high iron content, such as the red krasnozems, have a high capacity to sorb P and will have a higher requirement for P fertiliser than a low sorbing sandy soil. Organic matter in the soil also reduces P availability. Therefore more P than this budget indicates must be applied. The total fertiliser P required then could vary from 43 to 73 kg P/ha/year at the production levels used in this P budget.

Note that the capacity of the soil to sorb P reduces as more P is applied, so the annual requirement could approach the amount in the budget.

The amount of P lost will vary with stocking rate and milk production. The table on the next page shows this.

Frequency of application

P fertiliser must be applied every year to sustain the high level of production that dairy farming systems demand.

Pasture plants take up P early in the growth cycle. Seedlings in particular take up large amounts. Freshly applied fertiliser can supply seedlings effectively with their P requirements. This P is more readily available than the P already in the soil. Apply the P near the seed so that the seedling can extract it efficiently from the soil.

The P taken up by the plant can be mobilised rapidly to supply the growing parts of the plant. P is moved from old leaves to new leaves very efficiently. Therefore, if the plant can take up large amounts of P early in its life then it can mobilise the P when soil moisture stress (too little or too much moisture) makes it hard for it to get P from the soil.

Application of P is required close to

P losses at different stocking rates, and rates of superphosphate required to replace the P for different soils

Stocking rate (cows/ha)	P loss (kg/ha)	P fertiliser required					
		High sorbing soils		Medium sorbing soils		Low sorbing soils	
		P (kg/ha)	Super (kg/ha)	P (kg/ha)	Super (kg/ha)	P (kg/ha)	Super (kg/ha)
1.5	25	65	740	50	568	35	398
2.0	29	69	784	54	614	39	443
2.5	33	73	830	58	659	43	489
3.0	43	83	943	68	772	53	602
3.5	52	92	1050	77	875	62	705
4.0	61	101	1148	86	977	71	807

periods of rapid pasture growth. Applications in autumn are essential to stimulate autumn growth and to start the perennial ryegrass – white clover growth cycle. Spring applications also supply readily available P just before rapid growth starts in spring. Early summer applications can also ensure that the clover and ryegrass have enough P to help them survive before they enter a period of stress during summer.

Phosphorus can be applied in association with frequent dressings of nitrogen or potassium. However, it might not always be possible to apply all the smaller dressings in some years because of unfavourable weather, and pasture productivity could suffer through P deficiency. Therefore the main autumn and early spring applications will still be essential to ensure that the plants can take up large amounts of P at these times. The P can then be mobilised when the plant needs it in the future.

Sulphur

Superphosphate contains 11% sulphur, which is mainly as immediately available sulphate. Rates of superphosphate sufficient to meet the P requirements of pastures in most districts will also meet the S requirements on moderately S-deficient soils. However, concentrated forms of P fertiliser, such as triple super and DAP, often cannot meet the S requirements in some soils. These fertilisers can be fortified with S by mixing in elemental (yellow) sulphur. This form of S has to be converted to sulphate by organisms in the soil before it can be used by pasture plants; this can delay the availability of sulphur to the plants.

Timing the application of fertiliser containing elemental S can be important. Because the S has to be converted by microorganisms, it should be applied well before periods of rapid growth when S deficiency in plants is likely to occur. When the S is required quickly after application, particularly after cold periods, which slow the rate of conversion, use fertilisers with sulphate S.

Which source of P should I apply?

This will be influenced by various factors:

- The relative price of the N, P and K components from the various fertiliser sources.
- The number of applications required to deliver the total fertiliser.
- The cost (bag fertiliser is dearer than bulk fertiliser).

Forms of P for application of annual dressings *(N = nitrogen, P = phosphorus, K = potassium, S = sulphur)*

P fertilisers	N:**P**:K:**S**	Comments
Superphosphate		
Single superphosphate	0:**8.8**:0:**11**	Sulphur content valuable in soils with S deficiency
Double superphosphate	0:**18**:0:**4**	Will require additional S in S-deficient soils
Triple superphosphate	0:**21**:0:**1**	
Compounds		
Monammonium phosphate (MAP)	10:**22**:0:**1.5**	These supply N but very little S
Diammonium phosphate (DAP)	18:**20**:0:**1.6**	
Mixtures		
Super Potash 1 + 1, Pasture 25	0:**4.5**:25:**5**	Superphosphate + potash
Super Potash 2 + 1, Pasture 16	0:**6**:16:**7**	
Super Potash 3 + 1, Pasture 13	0:**7**:13:**8**	
NPK mixtures		Wide range available from all the major fertiliser companies. Many developed for specialised situations in pasture development. Specialised mixtures can be made to suit individual needs.
Hay Booster®	12:**5**:24:**5**	Examples from Pivot
Pasturebooster®	24:**4**:13:**4**	
Poultry manure	~2% P	Variable product. 7.5 m^3/ha will supply ~50 kg P/ha. Soils that have had frequent applications of poultry manure can have very high soil test values for P, but how effective this P is in supplying pasture plants is unclear.

To decide which source to use, you need to determine the amount of nutrients inkg/ha that you plan to use over a year:

- Estimate thekg/ha of N, P and K required for each paddock for the whole year.
- Adjust for other nutrients such as sulphur, molybdenum and trace elements.
- Decide the timing of application for each nutrient.

A combination of the price of the fertiliser types that can supply the required nutrient amount and the cost of applying it will decide the most efficient combination of fertiliser types to use.

Potassium

Potassium (K) is usually deficient in dairy pastures. This is because cows transfer K in their urine and manure to unproductive parts of the farm, dairy farmers remove it in hay and silage, and the milk leaving the farm takes the K with it.

Keep the following points in mind when applying K:

- Potassium will burn seedlings if it is applied at more than 62kgK/ha. Broadcast the K before sowing and work it in, or sow a maximum of 30kgK/ha with the seed.
- Potassium has a big effect on the ultimate population of clover and lucerne stands. Application of K before

sowing will produce a good plant population. Application of K when clover and lucerne populations decline gives a poor response because the reduced plant population cannot compensate.

- Lighter or sandy soils are more prone to K deficiency.
- Dairy wastewater is high in K.
- Pasture can take up excess applied K; this can cause milk fever in freshly calved cows.
- Excess applied K can be leached out of the soil and wasted on sandy soils.
- Calcium and magnesium compete with K for entry into plants. A soil high in one or both of these will require extra K for satisfactory crop nutrition.
- Conversely, high amounts of K can reduce the uptake of magnesium and thus cause grass tetany, particularly when K fertiliser is applied with N fertiliser in early spring.
- Responses to K can be disappointing if N and P are deficient.

Recommended potassium rates at sowing

Soil test result (meq K/100 g)	Potassium needed (kg/ha)	Rate of muriate of potash (kg/ha)
> 1	0	0
1–0.5	15	30
0.5–0.3	30	60
< 0.3	60	120

Using fertiliser blends

Fertiliser blends can be useful for applying small amounts of K regularly:

N+P+K: Used mainly for summer crops. Can be used for pastures where K is deficient and N is required.

P+K: Very good for pastures that have a high clover component.

N+K: Ideal for topdressing a pasture. Maintains a balance of N and K and ensures that the grasses do not dominate the clovers.

The balance of K and P is critical if a blended fertiliser is to be sown with the seed. The balance will depend on soil concentrations and paddock history. The most important consideration is that excess K will burn seedlings.

Nutrient deficiencies

In the early stages nutrient deficiencies might be evident.

Nitrogen deficiency

If clovers and lucerne are growing actively but grasses are light green to yellow then nitrogen is deficient. Heavy rain at sowing can leach nitrogen below the root zone. Topdress with urea at 125kg/ha or nitram at 187kg/ha.

Forms of potassium fertilisers

Form	% K	Salt index*	Comments
Potassium chloride (KCl)	52	2.1	Sold as muriate of potash. By far the most widely used K fertiliser.
Potassium sulphate (K_2SO_4)	54	0.85	17% S
Potassium magnesium sulphate (K_2SO_4, $MgSO_4$)	18	1.97	11% Mg, 22% S. Frequently included in mixed fertilisers.
Potassium nitrate (KNO_3)	37	1.58	13% N

* Salt index is the ratio of the increase in osmotic pressure produced by the fertiliser to that produced by the same weight of sodium nitrate.

Phosphorus deficiency

Clovers are slow to establish. In extreme phosphorus deficiency grass leaves become purple. Apply any P fertiliser at 30kgP/ha.

Potassium deficiency

Hard to detect in the early stages. Clover and lucerne plants die out in the first 12 months. Apply potassium chloride before sowing or at 125kg/ha when symptoms first appear.

Molybdenum deficiency

Often seen on lighter soils. The young clover and lucerne seedlings have red stems. The plants remain stunted, the reddening affects the leaves and the young plants die.

Molybdenum deficiency causes nitrogen deficiency. Because molybdenum is necessary for nodulation of the roots, the plant is unable to produce nitrogen. Spray with sodium molybdate at 100g/100L applied at 70L/ha, or apply either urea at 125kg/ha or nitram at 187kg/ha with either Mo single superphosphate at 250kg/ha or Mo Goldphos at 125 kg/ha.

Fertilisers and the environment

There is concern that fertiliser use in intensive farming systems could pollute surface water and groundwater. The Agfact *Fertilisers and the Environment* (AC.21) discusses this problem. A copy was included in this manual.