SOIL NUTRIENTS

Soil is the major source of nutrients needed by plants for growth. The four main nutrients are nitrogen (N), phosphorus (P), potassium (K) and sulphur (S). Together they make up what is known as NPKS. Other important nutrients are calcium and magnesium. Plants also need small quantities of iron, manganese, zinc, copper, boron and molybdenum, known as trace elements because only traces are needed by the plant.

In nature there are 17 nutrients necessary for plants to thrive and 14 of these come from the soil. To grow healthy crops and pasture full of nutrients, farmers need to ensure they have healthy soil. Without fertilizers, nature struggles to replenish the nutrients that are removed via harvesting (crops, meat, milk, wool etc). Different crop and pasture systems remove different amounts of nutrients from the soil. If the soil is not replenished with essential nutrients through fertilising, yields will decrease over time.

CONCEPT OF MOST LIMITING NUTRIENT

Just as the capacity of a wooden bucket (above) to hold water is determined by the height of the short panel, crop yields are restricted by the soil nutrient in shortest supply. Increasing the height of the nitrogen (N) panel in the bucket does not increase the bucket's capacity. Unless the sulphur fertility is improved, the value of other fertiliser nutrients is reduced. Soil testing discovers the limiting nutrients (the short panels) and maximizes fertiliser returns.

KNOWING WHAT TO APPLY

What kind of fertiliser you need, depends on what production system you are carrying out and the nutrient deficits that are specific to the soil you are working with. Regular soil testing gives valuable insight into your soils natural limitations and how your production system is impacting this valuable resource. Soils are not all the same and getting to know the soil types on your property is a major step towards understanding how it will behave and keeping it replenished for the work you are asking it to perform.

Knowing the exact amounts of nutrients in the mineral fertilizer also makes it easier to plan the farming process.

AB LIME
PROUDLY DOWN TO EARTH

Fertiliser	Nitrogen %	Acidifying Action	Amount of N applied	Lime needed to correct acidity
Urea	46	Slight	1kg N	2 kg Lime
Ammonium nitrate	34	Slight	1kg N	2 kg Lime
DAP	18	Moderate	1kg N	3.5 kg Lime
Sulphate of Ammonia	21	Severe	1kg N	5.5 kg Lime
MAP	11.3	Severe	1kg N	5.5 kg Lime

MAIN NUTRIENTS FOR PASTURE PRODUCTION - NPKS

NITROGEN (N)

Nitrogen (N) is a key element in plant growth, and plants need plenty of it in the growing season. Nitrogen must be taken up by plant roots from the dissolved nitrogen pool found in soil water. Legume plants (clover, lupin, lucerne etc.) form relationships with beneficial bacteria to create a direct source of Nitrogen from the air. These plants are less reliant on Nitrogen provided by the soil but nitrogen released this way varies through the seasons.

Soil nitrogen levels are generally deficient in early spring and autumn when fertiliser responses can be obtained. Applying more nitrogen than plants can take up leads to a loss of Nitrogen from the soil mainly through leaching. Leaching is a well-known potential contaminant pathway for N loss down through the soil and into freshwater resources. It can also leave your soil acidic making it less productive.

To prevent this happening:

- use the recommended rate of nitrogen for your crop or pasture
- apply a little nitrogen often so that it is all taken up by the plants
- use the least acidifying nitrogen fertiliser you can afford, and
- apply lime.

Nitrogen is available in different fertiliser forms such as urea, ammonium sulphate, and ammonium nitrate. Some of these fertilisers leave the soil more acidic than others, so they need different amounts of lime to counteract the acidity.

Source (modified from): *www.dpi.nsw.gov.au/agriculture/soils/acidity/publications/n-acidify*

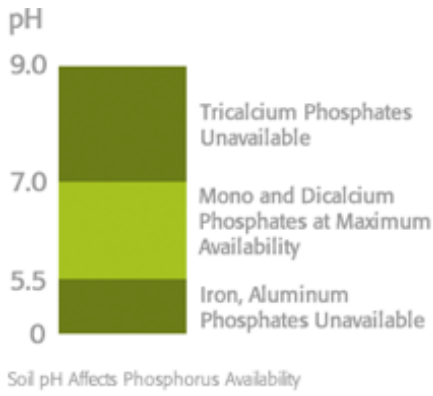
PHOSPHORUS (P)

Phosphorus promotes early plant growth and root formation through its role in the division and organization of cells. Phosphorus is essential to flowering and fruiting.

Phosphorus is found in soil organic compounds and in minerals. The amount of readily available phosphorus is very low compared with the total amount of phosphorus in the soil.

Plants can only take up phosphorus dissolved in the soil solution, and only a small amount of phosphorus is available to the plant at any given time. The types of phosphorus compounds that exist in the soil are heavily influenced by soil pH.

If soils are too acidic, phosphorus reacts with iron and aluminium. That makes it unavailable to plants. But if soils are too alkaline, phosphorus reacts with calcium and also becomes inaccessible. Maximum availability of phosphorus generally occurs in a pH range of 6.0 to 7.0. This is one of the beneficial effects of liming acid soils.



Soil pH Affects Phosphorus Availability

POTASSIUM (K)

Potassium is necessary to plants for translocation of sugars and for starch formation. It is important for efficient use of water through its role in opening and closing small openings on the surface of leaves. Phosphorus increases plant resistance to diseases and assists in enzyme activation and photosynthesis. It also increases the size and quality of fruits and improves winter hardiness.

Plants take up potassium in the form of potassium ions (K^+). It is relatively immobile in soils but can leach in sandy soils.

SULPHUR (S)

Sulphur is a constituent of 3 amino acids that play an essential role in protein synthesis. It is also essential for nodule formation on legumes.

Plants take up sulphur in the form of sulphate (SO_4^{-2}) ions. Sulphur is susceptible to leaching, and sulphur deficiencies can occur in sandy soils low in organic matter.

TRACE ELEMENTS

Trace elements play an essential role in the soil, plant and animal system. Even slight deficiencies can affect production. High producing farms in particular need to look after their trace elements.

COPPER (Cu)

Copper is essential for plants and animals and is an activator of several enzymes in plants. Copper deficiencies are not common in soils. It has a narrow concentration range for deficiency (<5-20ppm plants, 10 ppm animals) and toxicity (> 20-300 ppm). At high pasture concentration it is toxic to both plants and animals

For animals, Cu concentration is also dependant on the uptake of other elements from the plant, particularly Mo (Molybdenum). Excessive intake of Mo will seriously deplete Cu reserves (decrease liver Cu stores and blood concentration)

BORON (B)

Boron regulates the metabolism of carbohydrates in plants. It is essential for the process where cells that divide and differentiate to form specific tissues. With boron deficiency, plant cells may continue to divide, but structural components are not differentiated.

Boron is taken up by plants as the borate ion (BO_3^-). Plants differ in their boron needs. Plants with high boron requirements are cauliflower, broccoli, turnip, brussel sprouts, apples, celery and lucerne.

MOLYBDENUM (Mo)

Most pastures in Southland are a blend of clovers and grass. Clovers are legumes and can fix Nitrogen from the atmosphere but Molybdenum (Mo) is essential for this to happen. Without molybdenum, plants cannot transform nitrate nitrogen to amino acids and legumes cannot fix atmospheric nitrogen. Molybdenum levels are strongly related to pH, and in many cases raising the soil pH to 6 will provides adequate amounts of Mo, though deficient soils will need Mo applied as fertiliser.

Effects of pH on the concentration of Mo (mg/kg) in grass and clover in a mixed sward

	pH					
	5.0	**5.5**	**6.0**	**6.5**	**7.0**	**7.5**
Grass	1.1	1.6	2.7	4.0	4.3	5.2
Clover	0.9	1.3	2.7	3.9	5.7	5.9

Source: Mills, D.F & Davis, G.K 1987. Trace Elements in human and animal nutrition. Ed Mertz, W.

ZINC (Zn)

Zinc is an essential component of several enzymes in plants and is involved in the production of chlorophyll and protein. Zinc deficiencies are more likely to occur in sandy soils that are low in organic matter. In soils with high pH the solubility of zinc decreases and it becomes less available.

Zinc and phosphorus have antagonistic effects in the soil. Therefore zinc also becomes available in soils that are high in phosphorus. Wet and cold soil conditions can cause zinc deficiency because of slow root growth and slow release of zinc from organic matter.

TRACE NUTRIENTS REQUIRED FOR ANIMAL HEALTH

SELENIUM (Se)

Selenium is essential for animals and humans, but not for plants. Diets deficient in selenium can limit animal production and performance. It acts as an antioxidant protecting biological membranes from oxidative degeneration. As soil pH increases Se uptake by plants also increases.

COBALT (Co)

Cobalt is essential for animals and legumes (for rhizobium bacteria) and adequate pasture levels of cobalt are essential to meet the needs of grazing stock. Young stock are most susceptible to deficiency. Cobalt is used for the synthesis of Vitamin B12 by rumen microorganisms.