Chapter 8
Assessing Soil Nutrients

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8 Assessing Soil Nutrients

8.1 Introduction

Before applying any fertiliser, farmers need to assess which nutrients and how much of each is to be applied to correct deficiencies or to balance what has been removed by the farming system. Many factors must be taken into account before making the final decision. These will be more fully discussed in Chapters 9 through to 15.

However, several tests and observations can be very useful, and even essential, in assisting to make more informed fertiliser decisions. An assessment of pasture nutrient requirements should include a program of soil testing and plant tissue analysis. Other tools, such as paddock history, visual paddock indicators and fertiliser test strips, are also useful indicators of nutrient requirements of pastures.

Learning outcomes

At the completion of this chapter, you should be able to:

- Correctly sample a paddock for soil testing.
- Correctly obtain a sample for plant tissue analysis.
- Assess possible nutrient deficiencies in conjunction with the visual appearance of the pasture.
- Set up fertiliser test strips to assist in identifying the fertility status of your pasture.

8.2 Soil testing

Soil testing is very useful for assessing:

- Fertiliser type and rate of nutrients required.
- Lime requirements.
- Gypsum requirements.
- Changes in soil nutrient levels over time.

A recent survey has shown that about 82% of dairy farmers use soil tests to determine the next season's fertiliser application, and 50 % of dairy farmers do this in consultation with independent consultants. A significant proportion (49%) are confident in the advice they receive which still leaves many dairy farmers that are only fairly confident to not confident in the advice, or are still basing their current fertiliser strategy on a soil test carried out 5 to 10 years ago or relying on past practices (Dairy Australia, 2012).

In order to know how much and where the nitrogen, phosphorus, potassium, etc. is in the soil and if it is plant available, you have to take a soil test. Essential plant nutrients in the soil are often in a dynamic state i.e. changing in terms of availability and form; nitrogen being the classic case. There are new soil tests being developed in different regions which allow more specific analysis. In some cases, soil tests are now able to give indications of soil health, in addition to a chemical analysis (See Chapter 5).

The accuracy of any soil test depends on:

- A truly representative sample being supplied to the laboratory. Many incorrect recommendations associated with soil test results occur due to poor sampling.

- The sample being packaged correctly and transported to an ASPAC or NATA accredited laboratory for a comprehensive and accurate analysis.
- Correct calibration of the chosen test methods against local or regional field trials to allow reliable interpretation.
- Basing the fertiliser, lime and gypsum recommendations on a broad range of other factors, such as pasture composition, homogeneous soil type, and stocking rate; in other words being site specific.

8.3 Suggested soil sampling guidelines

The standard sampling procedures outlined below are designed to minimise the effects of soil variation and to help you collect a representative sample.

8.3.1 Timing of soil sampling

As soil nutrient availability can vary throughout the year due to changes in temperature and moisture, it is best to:

- sample at the same time each year,
- sample at least 6 weeks prior to planting, and
- avoid sampling within 3 months of liming or 2 months of applying fertiliser.

There is not one particular time of the year to soil sample, as it will vary depending on location, seasonal conditions, the type of crop or pasture being planted, growth flushes, and the nutrient that it is intended to apply.

8.3.2 Selecting areas for sampling

In recent years, dairy farmers have been changing their choice of fertilisers, with an increasing use of organic and potassium fertilisers. Efficient use of fertilisers requires an awareness of environmental and soil conditions. In order to achieve increased nutrient use efficiency, dairy farmers are placing a greater reliance on independent consultants to assist with interpreting soil test results and prepare nutrient budgets. Deciding which field to sample for the nutrient budget should be carefully considered so as to:

- provide a strategy for the management of fields including future rotations, and
- deliver objectives and optimal soil fertility.

A common strategy is to sample a representative paddock from a **farm management zone (FMZ)** – see Chapter 15.4.1.

From these zones, select a number of representative ‘monitor’ paddocks to sample. These monitor paddocks can be sampled regularly over time, following the same transect, to determine if the farm soil fertility is changing. Initially, these areas may need to be sampled every 1 to 2 years while in the development stage of soil fertility. Once the maintenance stage is reached and you are confident that your fertiliser strategies are meeting the maintenance requirements of your farm, the sampling interval could increase to every 2 to 3 years (See Chapter 1.7). It may then be possible to rotate the areas tested each year so that the soil fertility is monitored on other parts of the farm.

Soil samples can vary greatly in their ability to truly represent the area being tested, even when taken and analysed correctly. For example, a very wide variation in nutrient levels can exist between

paddocks and within paddocks. Figure 8.1 shows the variation of Olsen P (estimated from Colwell P data) within one paddock that was soil tested on a gridline basis, with 20 samples taken randomly around each grid point. Each number in the figure indicates a grid point and the Olsen P around that grid point. As you can see, the Olsen P measurements ranged from 8 to 40 mg/kg.

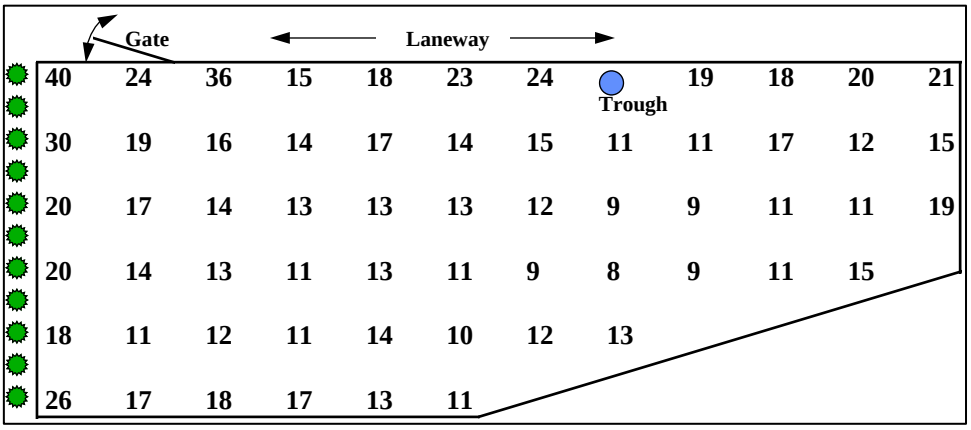

Figure 8.1 Variation of Olsen P (mg/kg) within one paddock.
Source: State Chemistry Laboratory (Macalister Research Farm)

To minimise variation within paddocks and between times of testing, **transect sampling** is recommended.

Transect sampling means sampling the same path through the paddock each time you do a soil test. Recent experiments have shown that this technique can substantially reduce the variation in the soil test results. Permanently mark the fence posts opposite the end of each path so that future sampling can be carried out along the same line, or use a GPS unit. In irregularly shaped paddocks or sections, a permanent landmark, such as a tree, fence corner or dam, can be used to identify where sampling lines cross - see Figure 8.2.

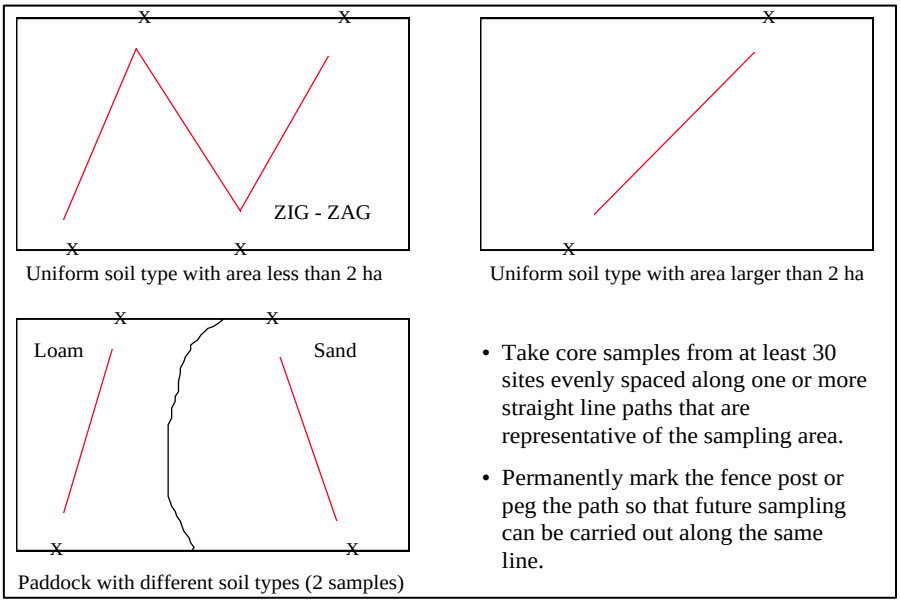

Figure 8.2 Recommended sampling sites for transect sampling

In addition to transect sampling of representative paddocks over time, soil testing is also used to investigate specific problem areas. In these cases, take the sample from the problem area or poor section of the paddock. This is referred to as **poor patch sampling.** It is extremely useful to take a sample from a nearby area that is representative of good pasture so that results can be compared to the 'poor patch' sample. If the soil test results are similar for both the poor area and the good area, then the problem may be related to some other factor, such as a trace element deficiency (which can be tested via a plant tissue analysis; see Section 8.4), disease or insect pests, lack of suitable pasture species or inadequate drainage or pugging.

8.3.3 Soil sampling depth

Soil nutrient levels vary with depth and usually reduce in concentration as you go deeper. It is critical that soil cores be collected to a standard sampling depth, if results are to be interpreted reliably.

The standard surface soil sample depth for pasture, cereal, oilseed, grain & legume crops is 10 cm, except Tasmania where the standard depth for pasture is 7.5cm and 15cm for field crops.

Optimum soil test values vary with depth due to a concentration of some nutrients such as phosphorus and potassium near the soil surface. Subsurface samples (taken from a depth of 10 to 60 cm below the soil surface, in 10 cm increments) may need to be taken for such problems as:

- Salinity.
- Poor structure.
- Sulphur deficiency.
- Subsoil pH.
- Aluminium toxicity.

Subsurface soils are usually sampled using an auger or hydraulic soil coring machine to remove soil at depth. For phosphorus in particular, it is essential to minimise contamination by the top 10 cm of soil, whilst inserting the auger to collect samples at the deeper profile depths. This is because phosphorus is concentrated in the surface soil where it is applied as fertiliser and dung. After the top 10 cm has been collected, a hole wider than the auger circumference can be dug before collecting the 10-20 cm profile depth with the auger, thereby minimising surface soil contamination. If required, this process can be repeated for subsequent depths.

Correct soil sampling equipment such as hand augers, foot probes, and hydraulic cores, or soil testing services are available from fertiliser companies, private consultants and dedicated soil testing services. Using other sampling tools, such as spades or galvanised pipe is not preferred due to possible contamination or inaccurate sampling methods. In the case of galvanised pipe, the galvanising can affect the soil test results.

8.3.4 Taking core samples

Take cores from **at least** 30 sites for surface tests and from at least 15 sites for subsoil tests.

The samples should be evenly spaced along one or more straight-line or zig-zag paths that are representative of the sampling area. Cores should be taken from spots of average or below-average growth. Bare ground should only be sampled if that constitutes a significant part of the paddock. Remember that you are trying to get an 'average' sample that is representative of the entire area.

Avoid waterlogged or pugged soil, obvious dung or urine patches, stock camps, stock tracks, fertiliser dump sites, recently grazed strips, and silage or hay storage or feedout areas. It is best not to sample within 20 metres of fencelines, gates, troughs or trees. Remember, if 3 or 4 cores in a 30-core sample are from urine patches, it can cause the potassium soil test result to be substantially higher than it should be. Take samples from sacrifice paddocks and those that are soon to be grazed before they are grazed, so you can avoid the urine and dung patches more easily as you can see the extra growth – See Figure 8.3.

Figure 8.3 Urine and dung patches should be avoided when sampling soils. The prevalence of these is a common indicator of nutrient deficiencies in other areas of the pasture.
Source: http://www.caes.uga.edu/Publications/pubDetail.cfm?pk_id=7780

When taking cores, avoid growing plant material by inserting the sampler tip between leaves and stems. Remove each core carefully from the sampler, using a clean tool or fingers, and place the core in a clean container such as a plastic bucket. Discard any partial cores and resample near that site.

If the 30 cores weigh more than about 1 kg, thoroughly mix the cores in clean containers and then take a subsample of about 0.5 kg for mailing to the laboratory.

Transfer the cores or the subsample to a clean sample bag and label the bag with the paddock (or area) name and the number of cores taken. Fill in as much detail as possible when completing the paddock information form to ensure that the best possible recommendation can be made. This information is crucial for the person who will interpret your soil test results and formulate a fertiliser strategy for a paddock or area. Labels should be written on paper or cardboard labels with an indelible pen and attached to the outside of the sample bag. Use a second bag to protect the label from being rubbed during transport to the lab. Never put a label in with the sample because it will quickly deteriorate and become unreadable. Your samples are now ready for posting to the laboratory.

Exercises 4, 5, and 6 will help you understand how to choose representative areas to sample and how to take transect samples. Download Exercises 4 to 6

8.4 Plant tissue testing

Plant tissue testing is the preferred method for diagnosing micronutrient (trace element) toxicities, deficiencies, and imbalances for plants.

Plant tissue testing:

- Checks on fertiliser management recommended from soil testing.
- Checks if nutrients not applied as fertiliser (such as calcium, magnesium, or trace elements) remain adequate.
- Can help to determine nutrient deficiencies in animals, if taken as mixed herbage sample - see Section 8.4.2).
- Is helpful in diagnosing nutrient levels in pasture or crop diets offered to animals.

Many field experiments have been used to verify the results of laboratory testing of soils and of plant tissue. Research has shown that using soil tests to indicate trace-element deficiencies can be less accurate, especially on acid soils.

The same guidelines apply for plant tissue testing as for soil test sampling when doing simple problem diagnosis:

- Take representative plant samples from the area of interest. In the case of a problem diagnosis, make sure to take samples from both the affected and normal areas.
- Use transects.
- Take the samples in accordance with the physiological growth stage of the plant, when the plants are not stressed and at the same time of each day; generally in the morning between 6 – 10 am.
- Make sure that sufficient quantity of material is collected for testing. The number of tillers or plant parts stipulated has to account for high moisture content when dried in the lab before sampling.
- Do not take samples until about **8 weeks** after the last fertiliser application.

If plant tissue samples are being collected on an ongoing monitoring programme, collecting the sample from the right plant part and at the right time will be more crucial. This is due to the change in nutrient concentrations in plant parts as the season progresses. The results will be useful only if these sampling guidelines are followed carefully.

8.4.1 Testing for plant nutritional deficiency

Plants have different demands for nutrients, even for the same nutrient. If the availability of a nutrient becomes scarce in the soil not all plants display visible symptoms at the same time, i.e. different crop and pasture species have varying sensitivity to nutrient deficiencies. When sampling for plant nutritional deficiencies taking the sample from the legume component of a pasture (e.g. clover or lucerne**)** provides more accurate results than a sample from the grass component. This is more pronounced in the case of boron and potassium deficiencies. If no legumes are present however, the grass component can be sampled (e.g. ryegrass).

When clover is sampled it is best to select the most dominant species in the paddock. This may be white clover, sub clover, or strawberry clover. A mixture of clover species is not recommended because the various clover species have slightly different adequate levels for each nutrient and will be at different stages of maturity.

Collect the leaves and petioles (stems) from about 60 white clovers or 60 strawberry clovers or 80 to 100 sub clovers (around 2 hands cupped together and filled once with clovers).

Sample the youngest fully grown leaves and their petioles of the same species of clover – see Figure 8.4. Post the samples early in the week so that they are not left to deteriorate in a post office over the weekends, especially during the summer months. Always put samples into paper bags and avoid leaving the sample for too long before posting. Do not leave the sample in a hot tractor cabin, on the ute dashboard, etc.; and refrigerate the sample if there is a delay in sending. Samples can also be oven (preferably not a microwave) or air dried before sending to the laboratory. This is recommended for extended delivery periods, or to avoid the possibility of mould establishing on high moisture plant samples.

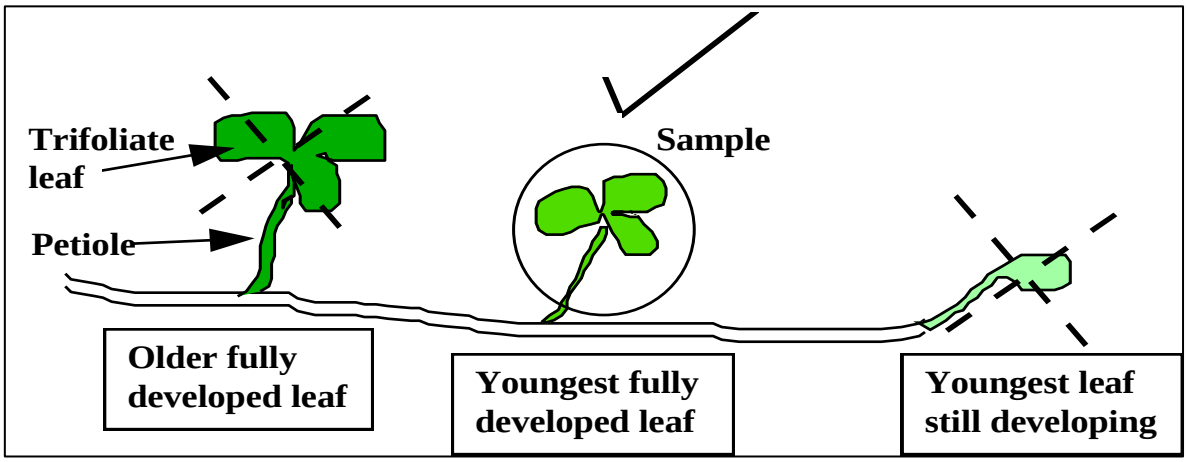

Figure 8.4 Section of clover to sample for plant tissue analysis

When taking tissue samples, it is vital to include as much information as possible. Describing the visual symptoms, noting which leaf is affected (youngest or oldest), and noting whether or not there is an effect on the edge (margin) of the leaf or between the veins are important. You should also outline the **paddock history** in terms of pasture type, soil type and previous nutrient applications.

When taking tissue samples, you should also ensure that the plant symptoms are not the result of other stresses such as, differing soil textures, seasonal changes, root disease, leaf disease, waterlogging, severe frost, insect attack or recent chemical application.

Tissue samples should not be taken when the plant is under a major stress, such as lack of moisture, waterlogging, frost or recent herbicide application.

Another key point is to note the amount of dry matter the plant is producing relative to what is considered adequate. In other words, is the plant growing slowly and producing very little dry matter, or is it producing close to maximum production. This will help the person interpreting the results.

Sampling the correct plant part is also vital, as described above. However, no matter which plant part is taken, ensure you tell the laboratory which plant part you have taken. In most cases, the youngest fully open leaf is the best plant part to take, regardless of the plant type, and the sample should be taken preflowering if possible. If there is a good and bad section in a paddock or farm, take a sample from each area as this is very useful for comparison.

Supplying the species of plant, plant part and stage of growth will allow the person interpreting the results to put the correct nutrient standards in for your sample. Actual adequate levels for any nutrient vary depending on species, plant part and stage of growth, so this information is critical.

For more information on soil, plant and water sampling refer to the link: http://www.incitecpivot.com.au/sampling_instructions.cfm

8.4.2 Testing for animal health problems

When sampling for animal health issues, collect a mixture of the plants that the stock are eating. Include weeds if relevant. Collect at least 20 handfuls across the pasture, using scissors to cut the sample off so as to avoid soil contamination from pulling. This is referred to as a **mixed herbage** sample.

8.5 Soil and plant tissue testing laboratories

A number of laboratories throughout Australia offer a soil and plant testing service. Many laboratories have membership in the **Australasian Soil and Plant Analysis Council (ASPAC)**, but only a limited number have membership of the **National Association of Testing Authorities (NATA).**

ASPAC conducts regular National Quality Assurance Programs to enhance standards of analysis and to provide standardisation of soil and plant analytical methods across laboratories. Those laboratories that produce analysis results that meet certain criteria are provided a 'Certificate of Proficiency' for each test in which they successfully participated. It is important to remember that ASPAC provides a proficiency certificate for individual tests, not on a whole-of-laboratory basis. Other tests that a laboratory carries out may not have been deemed sufficiently accurate to be worthy of a proficiency certificate. It is recommended that you ask the lab if they are certified for the tests that you require, or check on the ASPAC website (www.aspac-australasia.com).

ASPAC offers assistance to improve laboratory procedures. It also encourages laboratories to:

- Use standard units for reporting so that results are comparable between laboratories.
- Regularly check their testing techniques by testing samples with known values.
- Use accredited methods that have been calibrated against field trials under local conditions.

NATA is an association that, among other duties, sets and maintains the high standard for the methodology of laboratory practices and technical advice and accredits laboratories. Laboratories with NATA accreditation are also required to participate in a quality assurance testing program such as ASPAC. More information about NATA is available at www.nata.asn.au.

Using a NATA accredited laboratory, or a laboratory with ASPAC proficiency certificates for the tests required, provides the best assurance of consistent and accurate test results. These laboratories are recommended over those that do not participate in recognised quality assurance programs.

Check the soil test methods offered have been calibrated for crops and pastures in your region or state. Test methods that haven't been calibrated with research and trials are meaningless and should not be used.

Cost of analysis is also an important consideration but only laboratories with quality assurance should be considered when comparing costs.

Using the same quality assured laboratory for future analysis should provide greater consistency, and more comparable results.

Soil test results require interpretation. Check you are receiving quality advice. Fertcare provide quality assurance programs for advisors. For more information on Fertcare Accredited Advisors visit the Fertilizer Australia website: www.fertilizer.org.au.

8.6 Visual symptoms of nutrient deficiencies in pastures

To help determine your fertiliser needs, an important step to take in conjunction with soil testing, is to visually assess the pastures. The main features to look for are overall colour, the presence of weeds and poor pasture species, and if applicable, legume density and leaf size. If symptoms are apparent on individual plants, then pasture production will have been below its maximum potential well before this stage. In fact, visual symptoms will not become apparent until the reduced growth has exceeded 30%. This is referred to as 'hidden hunger'.

8.6.1 Identifying plant disorders from visual symptoms

The visual symptoms plants exhibit in response to nutritional disorders can be a useful guide for identifying the cause of a disorder. Common plant responses include unusual colours or patterns in the leaves, burns, distortion of individual plant parts, stunting or abnormal growth.

Several non-nutritional disorders (Table 8.1) can also produce similar symptoms, so careful observation is needed to ensure the diagnosis is reliable.

Table 8.1 Major causes of visual symptoms in plants

TYPE OF DISORDER	CAUSES
Nutritional	Nutrient deficiencies
	Nutrient toxicities
Non-nutritional	Infectious diseases: fungal, bacterial or viral
	Insect damage
	Physiological: environmental stresses
	Mechanical injury
	Chemical injury: pesticide, air pollution, spray burn

In pasture plants, nutrients move from the roots to other parts of the plant through a network of cells called the vascular system (veins). These cells specialise in moving water, nutrients and metabolic products throughout the plant. The arrangement of veins and the ease with which individual elements move within the plant (in other words, their mobility) have a strong influence on the way symptoms develop.

Symptoms that show patterns that align with the plant's veins usually indicate a nutritional disorder. Non-nutritional disorders usually show no relationship to vein pattern.

8.6.2 Characteristics of nutritional disorder symptoms on leaves

Nutritional disorders produce characteristic symptoms in leaves. These include:

- Symptoms are restricted initially to a single leaf-age class, that is, young, old or intermediate-aged leaves.
- Patterns are symmetrical and closely related to leaf venation.
- Changes in leaf colour and tissue death develop gradually (rarely overnight).
- The boundaries between green and chlorotic (yellow) or necrotic (dead) areas on a symptom leaf tend to be fuzzy or blurred. Strong, definite boundaries are often produced by herbicides or viruses.

- Leaf symptom patterns due to a nutrient deficiency are rarely blocky or angular. Such patterns can be caused by a pathogen or occasionally by nematodes.
- Nutritional problems impair cell function and rarely cause mechanical disruption of the cuticle (outer layer) of the leaf. Thus, damage to the surface of a symptom leaf is not likely to be caused by a nutritional disorder.
- Symptoms develop first in tissues most distant from the major veins of the leaf, such as the interveinal regions and the tips and edges of the leaf blade.

Visible changes in a crop, such as yellowing, small leaves and poor seedset, all begin as a breakdown in cell functioning and tell us that a nutritional disorder exists. For example, the distortion of new tissues or flowers or the death of growing points is typical of boron deficiency. These visual symptoms occur because boron is necessary for the proper regulation of cell division. Similarly, the leaves of nitrogen or magnesium deficient plants are pale because nitrogen and magnesium are components of the green plant pigment, chlorophyll.

Such links between an element's function and a specific abnormality that results when it is deficient are common in plants. For this reason, the nature of the symptom can provide a useful guide to the identity of a nutritional disorder even in unfamiliar crops.

The two most important diagnostic features of a nutritional disorder symptom are:
- Where the symptom is found on the plant (location).
- Its appearance (colour and pattern).

8.6.2.1 Location

Nutritional symptoms generally develop irregularly over a plant but show first in specific organs, such as the leaves, roots, shoots or growing points. Depending on the mobility of the element, leaf symptoms can occur in the upper, middle or lower sections of a plant.

Mobile elements like nitrogen, magnesium or potassium (see Table 8.2) are moved about the plant relatively easily to satisfy local shortages, particularly in new shoots or developing seeds. When one of these mobile elements is deficient, the **older leaves** are the first to be depleted and the first to show symptoms.

Less mobile elements, such as iron, copper, boron or calcium, do not move readily from older to younger tissues; so when these elements are deficient, the symptoms appear in the **newer or upper leaves** or in the flowers or the seed.

Symptoms of nutrient toxicity generally show first in the **oldest leaves**. These leaves have the highest transpiration rates and receive most of the nutrients absorbed by roots as the nutrients move in the transpiration stream.

Table 8.2 The difference in mobility of nutrients within the plant

MOBILE	VARIABLY MOBILE	IMMOBILE
Nitrogen (N)	Sulphur (S)	Calcium (Ca)
Phosphorus (P)	Copper (Cu)	Manganese (Mn)
Potassium (K)	Zinc (Zn)	Boron (B)
Magnesium (Mg)	Molybdenum (Mo)	Iron (Fe)

8.6.2.2 Pattern

Observe the size and shape of the plant, the overall foliage colour, the colour of symptom leaves and the pattern of chlorotic (pale or yellow) or necrotic (burnt, appears dead) areas in relation to vein pattern. Also note any irregular shape, splitting, cracking or corkiness of affected organs. All of these may help to establish the identity of the disorder.

8.6.3 Deficiency and toxicity

Are the symptoms indicative of a deficiency or a toxicity?

Deficiency symptoms typically occur on a single leaf-age class unless more than one problem exists.
Toxicity symptoms often develop rapidly. When this happens, the affected leaf tissue may change from healthy green to grey-green or dark brown without a transitional yellow phase.

Symptoms that appear on old and new leaves at the same time may indicate a toxicity. For example, when an excess of one element causes a nutrient imbalance, deficiency symptoms may be seen in the young leaves while older leaves may show burn or other symptoms of toxicity. Excess phosphorus, manganese or zinc can cause iron deficiency chlorosis in young leaves as well as symptoms of nutrient excess (toxicity) in the old leaves.

Diagnostic keys (Table 8.3) provide a framework for a visual diagnosis of deficiencies, but there are two major weaknesses:

- A disorder is usually quite advanced before clear visual symptoms appear, and some loss of yield or quality will have occurred. Also, the absence of symptoms in a crop or pasture does not mean that nutrition is adequate. ‘Hidden hunger’ is the condition in which performance is limited, but no symptoms have been expressed.
- Visual symptoms can be unreliable when more than one element is limiting or when some environmental stress has modified the normal pattern.

Table 8.3 Quick guide to nutrient deficiencies: What to look for. *Source*: Adapted from Weir and Cresswell (1994).

LOCATION	PATTERN
Symptoms first seen in *older* leaves	*Leaf colouration even over whole leaf* **Nitrogen:** Pale-green to yellow leaves. **Phosphorus:** Leaves dull, lacking lustre, bluish-green or purple colours. Poor growth.
	Leaf colouration forms a definite pattern **Potassium:** Scorching and yellowing, commonly around the edges of leaves, which may become cupped. **Magnesium:** Patchy yellowing often with a triangle of green remaining at the leaf base. Sometimes brilliant red to orange patterns or scorching.
Symptoms first seen in *young* leaves	*Leaf colouration forms a pattern* **Sulphur:** Small, pale, yellow-green leaves with lighter-coloured veins. **Iron**: Almost total loss of green between veins, leaving faint green 'skeleton' of veins on leaf. **Zinc:** Severe restriction of leaf size or stem length, or both (hence the terms 'little leaf' or 'rosetting'). Distinct interveinal creamy yellow patches on leaves in many species. **Copper:** Tip leaves cupped, narrow, distorted or scorched. Defoliation from tip. Chlorosis interveinal or irregular.
Symptoms first seen in either *old* or *young* leaves	*Leaf colouration forms a pattern* **Manganese:** Mottled diffuse pale-green to yellow patches between veins. No restriction of leaf size (unlike zinc).
Symptoms usually most prominent in other tissues; seen first in *youngest tissues* and *fruit*	**Calcium:** Breakdown of parts of fruit in some species. Collapse of flower stalk (flax, rapeseed) or leaf petiole (clover). **Boron**: Internal cracking or breakdown of root or stem tissues. Irregular shaped tissues, corkiness or surface cracking of stems. Irregular flower development or poor seed set.

Chapter 3 covers all the nutrient disorder symptoms of individual nutrients in more detail.

8.6.4 General paddock symptoms

As soil fertility declines, the grasses and legumes (clovers and Lucerne) become patchy and stunted. Gradually, weeds start to fill the gaps.

Dandelion, rib weed, white daisy, etc. are collectively called ‘flat’ weeds. They are regularly associated with a reduction in soil fertility, usually potassium deficiency but also phosphorus and molybdenum. This is especially evident in regular silage and hay paddocks or where insufficient fertiliser has been applied in the past.

Onion weed is an indicator of soils that are deficient in phosphorus.

Sorrel and moss are usually associated with low-pH (strongly acidic) soils but can also be acting as a filler species like those mentioned above. That is, coming into a pasture to fill in the areas vacated by the more productive grasses and clovers.

A good indicator of whether a pasture may respond to extra fertiliser is to examine the areas around the dung and urine patches – see Figure 8.3. If there are healthy pasture plants within these areas, but such plants are sparse or less healthy in the areas between the patches, then this pasture is indicating that ‘If you feed me (N, P, or K), then I’ll grow.’

Soils becoming saline undergo a change of species as the level of salinity increases over time – See Chapter 7.5.5. In temperate regions, the initial changes are a decline in white clover and an increase in strawberry clover. Then buck's horn plantain, toad rush, and windmill grass begin to invade. Yellow buttons, sea barley grass and annual beard grass indicate advanced stages of salinity.

Damage may also be caused by insects, such as lucerne flea and red-legged earth mite, and by various viruses.

8.7 Fertiliser test strips

Fertiliser test strips are useful for determining what nutrients to apply but are less useful for determining the appropriate application rate.

Test strips may be used to check results of soil tests or as a cheap way to test soil fertility. They may be of limited use on high-fertility pastures where there are no obvious nutrient limitations to plant growth. To determine the application rate, it is often more useful to prepare a budget and evaluate the costs of nutrients (discussed in Chapters 14 and Chapter 15).

There are basically two ways to set up test strips:

- small hand-spread strips (20 m x 2 m), or
- longer more commercial tractor/machine-spread strips the length of a paddock.

Whichever system is used, stock need to be kept off the strips for a period of time (at least 4 to 8 weeks, depending on the season) to allow the effects of the fertilisers to be seen.

A 20-m x 2-m test strip is equal to 1/250th of a hectare. Therefore, to apply the equivalent of 250 kg/ha, you need to weigh out 1 kg of the product to be applied. To ensure an even spread over the hand-spread strips, split the required amount of fertiliser in half and go over the plots twice. It can be helpful to apply the selected rate/ha to half of the plots and double the selected rate to the remaining plots in order to establish where the response finishes.

Small hand-spread or 4-wheeler spread strips are easier and less costly to set up and, provided they are around 20 m in length, will cover sufficient good and bad areas of pasture to allow a comparison to be made. Several sets of test strips may be needed around the farm to help in determining the final fertiliser strategy.

8.7.1 Site selection

- Test strips are best sited towards the centre of a paddock or at least 3 metres from a fence line. Run the strips at right angles to the fence line.
- Choose an area in the paddock that is typical of the diagnosed problem or where the change of fertiliser practise is to be and, if possible, a pasture with some clover or other legume present.
- Avoid fence lines, trees, gates, stock troughs, haystacks, old firebreaks, corners of paddocks, stock camps or poorly drained areas.
- Test strips will be of more use if they are put on an area that has not been top-dressed that year. Alternatively, top-dress the strips after the paddock has been top dressed and evaluate the potential for additional response above what is to be gained from the paddock topdressing.

- Run strips up and down a slope, rather than across it. Surface runoff immediately after topdressing can shift fertiliser from one strip to another.

8.7.2 Assessment of the strips

The control (no fertiliser) strip is the most important. Without this, it is impossible to compare treatments to determine whether the fertiliser has had any effect or not.

When comparing the strips consider:

- Pasture height and density.
- Size and colour of clover leaves.
- Botanical composition.
- Evenness of pasture.

The strips should be regularly checked throughout the year and observations recorded, such as regrowth after grazing. The final assessment of the site will be made before the grass seed-heads emerge. If the paddock is going to be grazed, then the test strips will need to be fenced off. To see the effects of the fertiliser, it is important to keep stock off because they will preferentially eat the good strips where there is a response, giving the observer the incorrect answer for responses on the site.

Sometimes it may be preferable to graze the strips off and allow them to grow again to evaluate the regrowth, when the best response is visible.

If nitrogen is applied to any strip, then evaluate it regularly from 2 weeks after topdressing.

The strips can be inspected in the following years to observe carryover effects on pasture production and changes to botanical composition. In longer term trials the accurate marking of strips will be essential. The benefits of some fertilisers may not appear until the clover or legume content of the pasture has increased, so sometimes responses are not evident until the second year. If the strips are to be observed in the second year, make sure that the test site is grazed down similarly to the rest of the paddock in between seasons. Remove the fences to allow better grazing and to reduce the likelihood of stock camping on the plots.

8.7.3 Interpreting the results

If there are clear differences in pasture growth between strips, you will be able to assess which nutrient or nutrients you require to improve pasture production.

A 20% or greater difference in growth rate can be visually detected, whereas a pasture meter can detect about a 10% difference.

If there is poor growth on all strips, it may be due to other factors, such as poor soil structure, soil acidity, plant diseases, pests, waterlogging, salinity or lack of productive pasture species (see Exercise 1). Usually these factors have all become evident before the test strips were even established.

In areas of reasonable soil fertility, fertiliser test strips may indicate that no fertiliser is needed or be used to evaluate a range of selected fertilisers. In fact, even though a test strip has shown nil response, paddocks may actually respond to fertiliser application. An experiment at DPI Ellinbank compared paddock application versus strip application of superphosphate. Although the test strips indicated that fertiliser was not required, the whole-paddock application did result in an increase in

pasture production and animal gain! The reasons for response in the paddock as against this lack of visible response in the test strip paddocks are probably due to:

- The greater availability of recycled P.
- An interaction between recycled N and K with higher soil P levels.
- Selective grazing of test strips, thereby retarding regrowth due to lower pasture height.

8.8 Summary

- A pasture's nutrient requirements should be assessed using a number of methods, including soil and plant tissue testing, visual paddock indicators, and soil test strips.
- Soil and plant tissue sampling guidelines should be followed carefully to achieve the most accurate results from your tests.
- Plant tissue testing should be used to determine the need for trace elements.
- Visual assessment of pasture condition can be used in conjunction with soil testing to help determine fertiliser needs.
- Fertiliser test strips are useful for determining which fertilisers to apply and can also be of value for determining the appropriate application rate if application rates are accurately calibrated and varied e.g. 1x and 2x application rate.

8.9 References

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