



Best Management Practices for nitrogen (N) fertiliser use on dairy pastures

The following Best Management Practices were developed to ensure maximum nitrogen use efficiency (NUE), while also minimising avoidable environmental losses.

General guidelines for N management

- **Apply N strategically, rather than by fixed recipe:** Before each N application estimate the likely N response (i.e from lookup tables, experience, consultant) and compare the cost of the additional pasture produced to other purchased feed options.
- **Only apply N when pasture is actively growing and can utilise the N.** Ensure that soil moisture is adequate to sustain the regrowth, there likely to be rain in the regrowth period, temperatures are conducive to good pasture growth, good species composition, good basal fertility.
- **Apply N at rates of 20 to 50 kg N/ha per application, no closer than 21 to 28 days apart.** It can also be useful combine the rate by interval as **1.0 to 1.75 kg N/ha per day**. During the peak growth period, with newer cultivars, it may be justified to increase the upper rate to 2 kg N/ha per day.
- **Ensure that the extra pasture grown is utilised** either through grazing or as harvested forage, as utilisation has a big impact on the economics of using N.

Right Rate

- The most efficient pasture growth responses occur when N fertiliser is applied at rates of between 25-50 kg N/ha at any one time. This is because the steepest response to N occurs at lower rates and drops off as rates increase.
- Do not apply above 50 kg N/ha in any single application and do not apply N closer than 21 days (30 kg N/ha in spring), to 28 (50 kg N/ha) days apart, as this will increase N losses exponentially. The exception may be on highly productive pastures, through their peak growth period, with a newer cultivar, and where soil moisture is not limiting, then pastures may respond to rates of N fertiliser beyond 60 kg N/ha per application (above 2 kg N/ha/day).
- Applying less than 25 kg N/ha in any single application will often produce unpredictable N responses i.e. 20 kg N on 2 hectares may produce less than 40 kg N on 1 hectare. However, likewise 80 kg N/ha on 1 hectare is likely to produce less than 40 kg N on 2 hectares, due to decreasing N efficiency with increasing rate.

Right Place

- Apply N to pastures with a high density of desirable (i.e. sown) species. Applying N to pastures where weed species have invaded, will result in larger, healthier weeds and have no beneficial effect on feed supply for grazing cows.
- Apply N to pastures with a good ground cover. Gaps or bare areas in pastures will result in more N lost through leaching and/or volatilisation.
- Apply N to pastures that have no limitations to major soil nutrients. Regularly soil testing will establish the nutrient status of the soil and if other major nutrients or pH are limiting growth, these can be addressed before or at the same time as the N application.
- Do not apply N to pastures that are drought stressed, or where water is running off the surface, or grazed at less than 2-leaf regrowth stage for temperate grasses (e.g. ryegrass) and 3-leaf stage for tropical grasses (e.g. kikuyu and paspalum).
- Consider applying less N to the front half of a paddock than the back, as cows transfer N towards the gate.
- Avoid applying N to animal hot spots i.e. gateways, water troughs, shelter belts, stock camps.

Right Time

- Apply N as soon after grazing as possible, as this is when plants need access to N for maximum regrowth potential.
 - As a rule, for every day you delay applying N post-grazing, you can lose 1% of the potential N response.
- Avoid grazing until growth has reached at least the 2.5-leaf stage for temperate grasses (e.g. ryegrass), or the 3-leaf stage for tropical grasses (e.g. kikuyu, paspalum), to maximise the nitrogen use efficiency, the energy: protein ratio in the diet and therefore the amount of N excreted or lost.
- Temperate pasture grasses (e.g. ryegrass) generally respond to N fertiliser when soil temperatures are above 4°C, and subtropical pasture grasses (e.g. kikuyu) respond to N fertiliser when soil temperatures are above 10°C. Remember, this is the average soil temperature over the regrowth period, NOT just on the day of application.
- Autumn and summer N responses on dryland pastures are highly dependent on adequate soil moisture.
 - Don't apply N unless the soil moisture adequate, plus there is a good prospect of irrigation or rainfall to follow through



the regrowth period (e.g. summer and autumn in winter rainfall regions).

- If irrigating, ensure that your irrigation season starts well before deeper soil water levels drop into the dry period, as once the soil has started to dry out it is almost impossible to apply sufficient water to restore a full profile. This has serious implications for pasture growth and will limit the pasture response to N.

Right source

- **Urea** is currently the cheapest pure source of N.
 - Assuming soil moisture is adequate for pasture growth, ammonia losses from urea fertiliser are usually not large enough to justify the unit price of other N sources.
 - If applying N to waterlogged soils, an ammoniated source (e.g. urea, ammonium sulphate) is better than using a nitrate source (e.g. UAN).
- **Phosphorus:** Di-Ammonium Phosphate (DAP) is potentially the cheapest source of N, if the P is needed at the same time.
 - When using DAP, calculate the N rate applied and consider 'topping up' with urea to ensure an adequate N fertiliser rate i.e. 100 kg of DAP/ha will only apply 18 kg N/ha, which may not produce a predictable N response.
 - When applying N and P fertiliser together, defer to the best management practices as applicable for minimising overland flow losses of P.
- **Sulphur:** Low soil available sulphur (S) can reduce the response to N. Ammonium sulphate or sulphur blends can be a useful source of both N and replacing soil S, particularly where single-superphosphate has not been applied for a few years.
 - Ammonium sulphate is an expensive form of N and it will acidify the soil rapidly with regular use.
 - Sulphate can also leach out from free draining soils during high rainfall or irrigation, so only apply the sulphate when needed and at the recommended rate.
 - If sulphur is applied in elemental form (S) this form needs to be oxidised to sulphate before plants can use it, so apply this form well before the sulphur is needed e.g. in autumn.
- **Lime:** Where annual N application rates exceed 250 kg N/ha per year, a proactive strategy of soil testing and liming may be required to prevent soil acidification. Usually 2.5 tonnes of lime per hectare will be required every 2 to 3 years.

Managing ammonia losses

- Ammonia loss is highest under hot, dry, windy, and therefore high evaporation, conditions. Urea losses are also highest during the first 48 hours after application, while the urea granule is breaking down to ammonia (called hydrolysis).
- As a general principle, ammonia volatilisation losses from urea should be small, if best practice is followed i.e. do not apply urea where soil moisture is limiting, on hot and windy days with low pasture cover.
- Between the cooler, wetter months (May to November in south eastern Australia), ammonia volatilisation losses from urea fertiliser are too small to justify switching to higher-cost N fertiliser sources. During this period, urea does not need to be watered into the soil – if there is enough soil moisture and rainfall to justify the urea, the urea will be able to absorb enough moisture to dissolve itself.
- Ammonia volatilisation losses in summer, under dryland conditions, average around 14%, which still does not economically justify switching to other more expensive sources of N. Where soils are dry and temperature and evaporation is high, avoid applying urea fertiliser after a rainfall event, as this may increase volatilisation losses above 22%. Under these conditions, irrigating after urea application will greatly reduce ammonia loss.
- If urea fertiliser is applied in the drier months (November to March in south eastern Australia) without irrigation, you can apply fertiliser 2 to 3 days prior to grazing to minimise wind speed at ground level and reduce ammonia volatilisation during the critical loss period (first 48 hours). Care must be taken to avoid cows ingesting lumps of fertiliser as this could lead to ammonia toxicity.

Managing ammonia losses - spray irrigated pastures

- Apply N fertiliser within 24 hours prior to spray irrigation.
- In summer, where evaporation is high, avoid applying urea fertiliser after a spray irrigation as this is likely to increase volatilisation losses.

Managing ammonia losses - flood irrigation

- Urea is best applied just before irrigation but minimise run off into drains, as this will carry dissolved urea. In some cases, not fertilising the last few metres of the irrigation bay, will capture the urea dissolved in the irrigation head water.
- If urea fertiliser is applied after flood irrigation, soil moisture should be adequate to dissolve the urea and minimise volatilisation, but avoid wheel damage to the wet soils.

More Profit from Nitrogen



Minimising nitrate leaching and denitrification

- Avoid applying N fertiliser to warm (>10°C) waterlogged soils, as this increases the rate of denitrification.
- If applying N to cold, wet soils use urea or ammonium based fertilisers and avoid nitrate based fertilizers such as UAN.
- Avoid applying N fertiliser near streams/riparian zones and over drainage lines within a paddock.
- If irrigating, take care to avoid overwatering, as this may result in nitrate leaching.

Minimising surface runoff losses

- The volume of water lost as runoff determines the N lost in runoff - avoid overwatering and surface runoff.
 - Use a weather forecast to minimise runoff after N application. When soils are full, wait at least 2 days after rainfall for excess run-off water to drain, before applying N.
 - Where possible, re-use drainage water.
- Do not apply N fertiliser near drains, channels, dams, lakes or riparian areas. In a hump and hollow, avoiding applying N to the hollow as this is likely to receive N through surface movement anyway.

Dung and urine management

- Minimise the time that cows spend in the laneways and ensure that runoff from laneways, feedpads, sacrifice paddocks or other standoff areas drain to pastures and not directly into waterways.
- Effluent should be viewed as a valuable fertiliser resource, and nutrient testing should be used to ensure that no more than 50 kg N is applied to a pasture at a time.
- High stocking rates and stocking intensity will result in high losses of N from hot spots in the farm.



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