

Lesson 9: You are what you eat = Nitrogen Leaching.

Teaching notes are provided.

Starter	Nitrogen Problem Google “Fixing Nitrogen - Managing Earth's nitrogen problem” made by the UN Environment Programme to watch the clip they have made introducing nitrogen. Or click the following links... Website = https://www.unep.org/news-and-stories/story/bittersweet-nature-nitrogen-calls-better-management-practices YouTube = https://www.youtube.com/watch?v=lkAhI7nzi6A
Activity	Picture Dictation of the Nitrogen Cycle (basic version). An activity that gets students to practice listening and visualising what is occurring in the environment. You can then see if they can come up with some solutions. Read the sentences from ‘L9_PicDic_Teachers Version’ and ensure that each student has a copy of ‘L9_PicDic_Student Handout’ that has diagrams that they can draw on and questions they need to answer.
Exit Pass	As students exit the classroom get them to list the source of nitrogen and two solutions.

Nitrate Leaching and Feed

Clover and Lucerne are part of the legume family and have the ability to fix nitrogen from the atmosphere into the soil which results in high nitrogen levels. This can be good as it acts as a natural fertiliser helping itself and other plants to grow. Most dairy pastures composition is ryegrass (75%) and clover (25%). Clover also has positive impacts on milk production and growth rates of pasture but it does mean the cows end up consuming a lot of clover and hence a lot of nitrogen.

When an animal consumes more nitrogen than its body needs, the excess is extricated from the body. Some of the nitrogen is in the dung, and due to its solid nature it takes a while for it to break down and release the nitrogen. This gives the plants in close proximity to the dung time to absorb the nitrogen.

A lot of the nitrogen is extracted through urine making it the primary source of nitrate leaching. The levels of nitrogen in urine (700kg N/ha) are immediately available and significantly higher than fertilisers (30kg N/ha). The plants that the urine lands on/ near cannot absorb all the nitrogen within the time period so the rest is leached through when it rains.

Most of the nitrogen entering the soil system is ammonium (NH_4^+) but within the soil there is a bacteria that breaks it down into nitrates (NO_2^-). These nitrates leach through the soil easily due to the negative charge, since soil has a negative charge. When it is in the form of ammonium it is more stable and less likely to leach due the positive charge.

Riparian plantings do help with run-off, stream habitat and stabilising the bank but the majority of leaching is downwards through the water table. There is slow plant growth in winter so less nitrogen is used and it rains more often so the rate of leaching is significantly increased. The rate of leaching can also be affected by soil type and in some cases there could be more than a 20 year lag time between when a farming operation improves their practice to when a decrease in nitrogen leaching is measured.

The integration of plantain, which is a herb, with other pasture species has led to a 30% reduction of nitrogen leaching. This is because plantain has a slightly higher percentage of water, so cows are consuming more liquid which helps dilute the nitrogen concentration in their urine. It is also a diuretic so cows will urinate more frequently. The increase in frequency of urination and dilatation of nitrogen concentrations results in a 30% reduction in leaching. However, management practices are still being developed so the plantain plants remains in the paddock past two years. After two years number of plantain plants drops significantly due to completion from other and the cows are no longer consuming enough of it to decrease their nitrogen consumption or the leaching rate. Plantain is outcompeted by dock (a weed) because the timing of its breeding cycle is similar to dock (a weed).

Bare ground with no plants to absorb the nitrogen increases nitrogen leaching and uneven ground that pools the runoff/ urine to one place also increases nitrogen leaching. Feed crops have a higher opportunity for these circumstances occurring which is why they must be carefully managed. Management includes limiting cow's time on the crop so they urinate on pasture where it can be absorbed or a feed/ standing pad where it can be collected and stored. It could involve cutting and carrying the crop to the feed pad so animals do urinate on the paddock and not damage the soil. Replanting after the crop as soon as possible allows new plants to capture and use the nitrogen which is called a catch crop. When re-planting there is the opportunity to re-contour the soil to minimise the ponding of run-off or urine.