"We found that mature cows with calves lose even more bone density on low-P diets than heifers because they put more into their calves, particularly during lactation," she said.

The good news is that mature cows are able to regain their bone density, even when on moderate metabolisable energy diets, as long as there is adequate P available in the diet.

Lisa said the lift out message was the importance of P supplementation during lactation.

"Lactation is when heifers and cows lose the most bone density, and they can do it very quickly on low-P diets," she said.

Further developments

Lisa hopes to develop crush-side tools such as ultrasound for measuring bone density and advance the concept of a producer-usable blood test, validated by her biopsy method and other work.

Information derived from the new bone biopsy technique, similar to that used in human medicine, will also improve the existing P screen test and validate hormonal tests that measure P deficiency and other markers developed during the project.

Animals undergoing biopsies did so under surgical conditions, with local anaesthetics and follow-up veterinary care, and all animal work had animal ethics approval.

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Feedbase

Looking below the surface

Researchers were shocked when tests from across south-east Australia – home to 29 million hectares of sub-clover pasture – found more than 70% of samples suffered root disease.

Martin Barbetti, Professor of Plant Pathology at the University of Western Australia, said an Australian Wool Innovation-funded soil survey revealed widespread seedling death and root disease that was almost universally severe.

An MLA-funded research program run by Martin and Dr Ming Pei You is now underway to quantify the adverse impacts of soil-borne pathogens and assess and develop cultural and chemical means to minimise damage to sub-clover pastures. They aim to provide producers with flexible management options.

Field trials form the MLA research focused on using cultivation methods, fungicide sprays and seed treatments combined with altered pasture nutrition and clover variety tolerance to establish best management practices.

"We were shocked because we didn't expect to find such entrenched levels of severe disease across large swathes of pasture," Ming Pei said.

"No wonder clover pastures are unproductive and persist poorly, leaving a critical autumn-winter feed gap.

"In terms of the new MLA-funded research, we still need to collate the 2016 data and revisit the findings in 2017, but it is obvious the long-term solution is resistant varieties."

Critical analysis of the 2015 data revealed that productivity increases of up to four and five-fold were demonstrated for disease-resistant varieties where high levels of disease occurred.

"We already recognise the tremendous potential for disease resistance in naturally developed varieties that have been growing and adapting across Australia for up to 150 years," Martin said.

"We must now use these naturally selected disease-resistant clovers to develop new disease-resistant and disease-tolerant varieties that may potentially eliminate the losses from soil-borne clover diseases."

Dr Brett Nietschke, technical facilitator for the Barossa Improved Grazing Group (BIGG), which conducts on-farm root disease trials for the project, said root disease remained a "hidden" problem, because stunted plants and patchy germination were mistaken for other environmental or plant health issues.

Martin and Ming Pei said the challenges of

BIGG digs deep

The 2016 Barossa Improved Grazing Group (BIGG) trials, funded by MLA at Moculta and Craneford in South Australia, highlighted the complexities in managing root diseases.

The severity of root disease caused by pathogens Rhizoctonia, Pythium, Phytophthora and Aphanomyces is related to factors such as temperature, moisture, soil and nutrition.

Root diseases can be caused by a 'mix' of two to four pathogens, which makes fungicide management difficult because the fungicides registered for sub-clover do not have activity against all four pathogens. For example, Apron XL® (Metalaxyl-M) can control Pythium and Phytophthora at the seedling stage, but has no activity on Rhizoctonia.

According to University of Western Australia (UWA) researchers, Rhizoctonia is a particularly prevalent soil-borne pathogen in many pastures across South Australia. Research Fellow Dr Ming Pei You said despite the lack of a broad-spectrum fungicide treatment, fungicide seed or foliar spray treatments may still increase sub-clover germination and survival by up to 30%.

BIGG trials at Craneford in 2016 evaluated the effect of several fertilisers on sub-clover productivity and found the superphosphate treatment (autumn application at 150kg/ha) doubled late winter production. Given the Craneford trial site was low in phosphorous (17mg/kg, Colwell P), the results are a timely reminder of:

- → the importance of knowing the soil nutrition status of paddocks
- → the benefits of maintaining soil nutrients at adequate levels.

Getting to the root of the problem

Root disease is hard to diagnose, but the following signs may indicate its presence:

- → stunted plants
- → poor or patchy germination (see right)
- → sudden die-off for no apparent reason
- → little or no presence of subterranean clovers.

managing sub-clover seedling death and root disease should not be underestimated.

"For example, we found different types and combinations of soil-borne pathogens frequently occur at the same time," Martin said.

"However, these combinations depend particularly on the growing season, with pathogens like Pythium, Phytophthora and Aphanomyces causing the greatest problems in wetter locations while Rhizoctonia causes much more of a problem in dry periods.

"Furthermore, our findings not only highlight the complexity of managing root diseases, but have also led to the development of several tangible, practical options for pasture improvement."

The best long-term answer to the problem of disease-induced seedling death and root disease will come from identifying disease-resistant and tolerant sub-clover varieties. In the interim, it is best controlled through a variety of management approaches. These include:

- → cultivating soil to reduce pathogens and subsequent root disease impact on productivity
- → coating seeds prior to replanting or using fungicide sprays on regenerated pastures, particularly fungicides that boost plant immunity
- → improving soil and plant nutrition to enable better root and shoot growth even when disease is severe
- → choosing varieties that perform best in your area (e.g. two cultivars in South Australia that show resistance to root disease and persist well are Trikala and Clare)
- → sowing a mixture of clovers
- → using a rotational grazing system that allows more plant growth, which improves root development, even where disease is severe.

The PreDicta B soil test is another tool available to producers.

"While it can be cost-prohibitive in the short-term, PreDicta B may be useful for producers to establish the main causes of root disease on their property," Martin said.

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Resources: MLA's pasture improvement calculator and phosphorus tool are available at **www.mla.com.au/tools**

Good soils for good nodulation

A productive legume pasture above ground does not necessarily indicate effective nodulation and nitrogen fixation below ground.

A survey of NSW and WA pastures found more than 90% of the analysed pastures had inadequate nodulation, even though effective rhizobia strains were present.

A range of soil conditions affected legume pasture performance. According to researchers Dr Sofie De Meyer, Murdoch University, Dr Belinda Hackney, Charles Sturt University and Janelle Jenkins, NSW Local Land Services (LLS), soil pH, soil sulphur and molybdenum levels, and herbicide application were factors affecting rhizobia nodulation and nitrogen fixation.

The survey by the MLA and Riverina and Central West LLS-funded rhizobia team involved extensive producer interviews. It investigated a range of factors, including paddock history, herbicide and fertiliser applications, and plant and species diversity and management. Soil and sub-clover plant samples were also taken for analysis.

Of the paddocks analysed, 90% had inadequate rhizobia nodulation with an average nodulation score of 1.8. Within the nodulation scoring system, a score of four is considered average; a score of eight is high and rarely seen in paddocks.

"We were shocked by the result. Visually, the pastures did not indicate the situation was so bad, but below ground effective nodulation and nitrogen fixation was clearly not occurring," Sofie said.

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