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Space-age farming

Western Australian wool-growers are testing the use of satellite imagery to assist pasture management. **Wendy Pyper** reports.

Satellite images could soon be helping graziers in Western Australia to better manage their pastures and improve productivity.

The images are generated by three satellites during the growing season (winter to spring) and show the amount of 'greenness' across south-west Western Australia. Using software developed by CSIRO, this 'greenness index' can be converted to 'food on offer' (FOO) – the amount of pasture available for animals to eat, in kg / ha – and pasture growth rates (PGR), in kg / ha / day.

By 2002, farmers will be able to download maps from the internet, showing the FOO and PGR in their own paddocks. According to Dr David Henry from CSIRO Livestock Industries, this information will assist management decisions such as grazing rotations, feed budgeting, fertiliser application and other 'precision agriculture' techniques.

The technology is being piloted by about 50 wool-growers in Western Australia, with assistance from CSIRO, the Department of Agriculture of Western Australia and the Department of Land Administration. The pilot studies are designed to test both the delivery of information to farmers and how successfully the information can be used to improve management decisions that effect wool quality.

'The pilot studies are specifically targeted to sheep farmers, although the technology can be applied to other forms of grazing such as beef and dairy cattle,' Henry says.

'At the moment, we're trying to show farmers that they can use the satellite information to improve the way they manage their farm and achieve greater profits. We're also looking at the preferred format for the information – maps, tables and so on – and how often and how quickly the information can be delivered. At the same time, we're gathering on-ground measurements of pastures, which we can use to test the accuracy of our satellite images.'

The French 'spot' satellite, used to measure food on offer.

Precision wool production

To show how satellite imagery can improve pasture management, CSIRO has introduced the technology into an existing study on precision wool production being conducted by the Department of Agriculture.

The study, which began in 2000, saw farmers alter their grazing practices to assess whether wool quality and wool income could be improved on a predetermined 'feed budget'.

'Feed budgeting looks at food on offer and pasture growth rates, and enables farmers to work out how many animals can be put in a paddock and how long they can stay there before they need to be moved,' Dr Chris Oldham from the Department of Agriculture says.

'We're working with wool-growers to determine the level of feed restriction sheep can tolerate and still remain healthy, as fit, healthy sheep grow more and better wool than fat sheep. So a better controlled system should produce more wool income per hectare.'

On today's market wool value depends on its fibre diameter, and the finer the wool, the higher the price paid. According to Oldham, the more a sheep eats, the broader the fibre diameter, while the less a sheep eats, the finer the wool.

During the growing season in Western Australia, sheep have access to a lot of food, and if left unchecked, will grow

Great Southern Herald, Katanning

Roger Bilney: ' . . . when I saw the satellite images, I thought that for grazing management strategies, it was the most exciting bit of technology I'd seen.'

wool with a fibre diameter of about 23 microns. In summer and autumn, however, when the feed dries up and animals start to lose weight, fibre diameter can drop to about 18 microns. This means that at shearing, the thickness of a wool fibre can vary by up to five microns along its length or 'staple'.

One farmer keen to reduce staple variation and fibre diameter among his flock is grazier and crop producer, Roger Bilney. Bilney runs about 25 000 head of fine wool sheep, and a large-scale cropping operation, at Kojonup, two hours drive south-west of Perth.

Bilney's role in the precision wool production project required that he monitor the fibre diameter of ewe weaners every month, and restrict feed intake to avoid 'fibre diameter blowout' over spring.

To do this, Bilney, with assistance from the Department of Agriculture, made visual assessments of FOO and PGR on his property, and then worked out a feed budget that would limit his sheep to about 700 g/day. He then took wool samples from 20 sheep every month and sent them to the Department of Agriculture, where

Eye in the sky

CSIRO Livestock Industries has developed technology to measure the growth rate and biomass of pastures, using satellite images.

Two satellites are routinely used to measure biomass or 'feed on offer' every fortnight, while a third satellite measures pasture growth rate on a daily basis.

Instruments on board the satellites measure the reflectance of visible and invisible light from the earth's surface. This produces an image of the earth's surface, which can be converted to a 'normalised difference vegetation index'. In other words, a measure of how green the surface is.

'We then use an algorithm to turn the green index into a figure. For biomass we convert greenness into kilograms per hectare. So the more intense the green, the more grass there is,' CSIRO's Dr David Henry says.

'For pasture growth rates, the green index is combined with climate information to provide an estimate in kilograms per hectare per day.'

The biomass satellites can measure the greenness of the earth's surface at a resolution of about 20–305 m^2, while the PGR satellite has a resolution of 1.1 km^2. In 2002, the AVHRR PGR resolution will be increased to 250 m^2 (6.25 ha), after a new receiving station is built in Western Australia.

'The key to this technology is quantitative measurement at the high resolution, as it allows us to produce maps of individual paddocks, farms, districts or regions, and to show the distribution of different pasture characteristics,' Henry says.

As well as helping farmers to improve pasture management decisions (see main story), Henry says the satellite images will benefit regional shires, government, agribusiness, banking and finance.

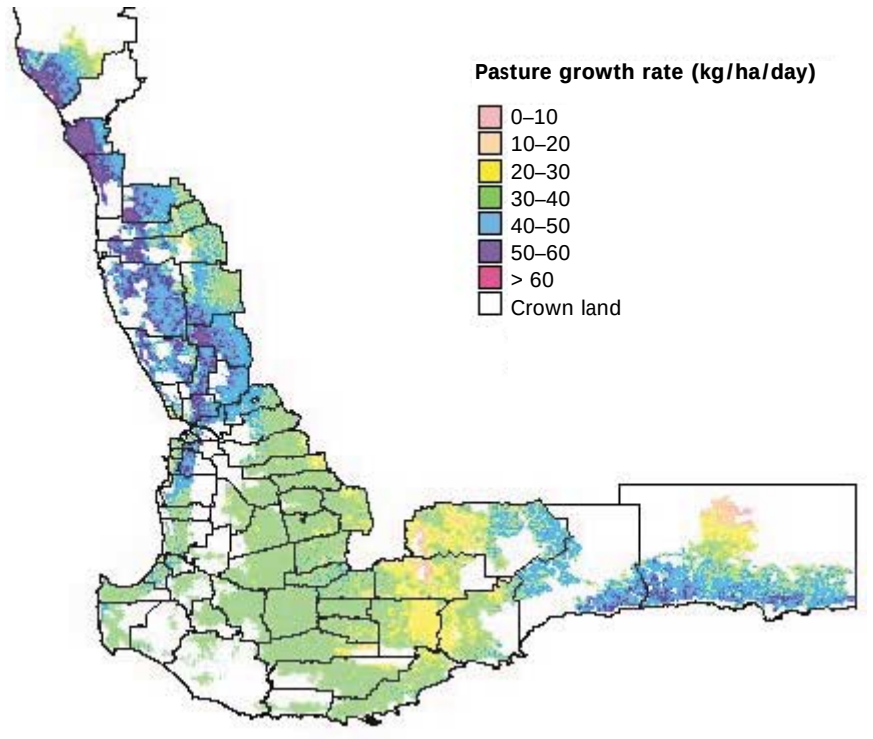
For example, land valuations can be made by looking at the productivity of a farm. Or, by comparing images over a number of years, banks and insurance groups can assess the productivity risk of a property.

the average fibre diameters of 2 mm snippets were plotted against the average staple length. The weight of each sheep and their condition were also recorded, to keep track of their health and help determine the minimum feed intake required.

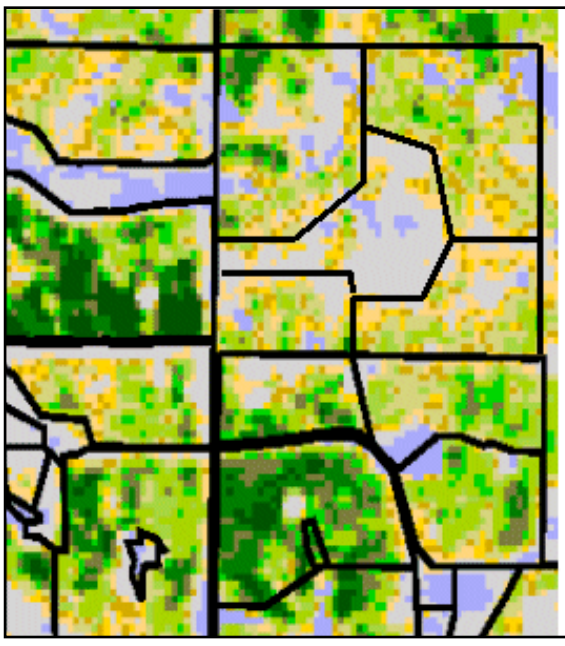
At shearing, Bilney found that the fibre diameter of his wool had decreased from 17.7 microns to 16.6 microns, and although the fleece weight had decreased by 200 g per head, the overall fleece value had increased by $16.30 a head.

'We had a bad growing season in 2000 and the sheep were quite restricted,' Bilney recalls.

'I felt uncomfortable because I didn't think they had enough to eat. But their body weight and condition were good, and in the end, it turned out to be a very profitable exercise.'



Pasture growth rates and food on offer calculations can be superimposed over farm maps provided by the farmer or the state Department of Agriculture. Both the farm map and satellite image is 'geo-referenced' so that the exact location of the farm can be pinpointed on the satellite image.



Feed on offer (FOO) or biomass in each paddock as determined by the French spot satellite. Paddock boundaries are indicated by the black lines.

Maps made to measure

Bilney says the hardest part of the project was the visual assessment of FOO and PGR. Programs such as Woolpro, run by the Department of Agriculture and the Woolmark Company, have given farmers more experience in estimating these pasture characteristics, but it remains a difficult and time-consuming process that is subject to a variety of errors.

'Working out how much food is in each paddock is the most difficult and important part of precision wool production. But at the end of the day, the variation in our ability to visually assess FOO and PGR is too great to make the concept feasible,' Bilney says.

The impending availability of satellite imagery showing FOO and PGR in individual paddocks, however, could make precision wool production a lot easier.

'My visual assessment of the FOO on my property indicated that there was a tonne of feed on offer per hectare. But the satellite imagery showed there was less than 500 kg,' Bilney says. 'That difference is not such an issue if it's between two and 2.5 tonnes, because there's a lot of feed there. But at less than 500 kg, the sheep's intake would have been very limited.

'So when I saw the satellite images, I thought that for grazing management strategies, it was the most exciting bit of technology I'd seen.'

The images are being delivered to participating farmers via CD-ROM, although eventually farmers will be able to access information on their individual farms via the internet.

'At the moment we have a web site that shows pasture growth rates over the south-west region of Western Australia. But eventually we envisage that farmers will be able to log on to the internet and pull up maps of their own farms. We're looking for a commercial partner to help us deliver this to farmers now,' Henry says.

Income boost

Farmers using the satellite maps to help maximise the use of their pastures for grazing will also free up land, which can be used to generate further income. For example, Bilney has planted more lucerne. And, in addition to hand-feeding his sheep during the dry summer months, he has planted forage sorghum to get them over the lean period.

'We've got so much green feed this year that we've decided to kill some of the pastures and plant forage sorghum. When things dry up, we'll be able to feed our sheep and carry over some of that excess spring feed into summer,' he says.

'So instead of letting our sheep eat all the pasture and have their microns blow out, we're managing the wool fibre to produce a fine wool product.'

Bilney says the satellite imagery will also enable him to assess variations amongst different paddocks.

'We will see areas of our farm that are very productive and others that are less productive. So if I take the input, such as fertilisers or sprays, away from the poorer areas and put them into the more productive areas, I may be able to lift production in the good paddocks by 20 or 30%,' he says.

'Eventually we may take the poor areas out of production altogether and turn them into something else, like trees.'

Similarly, Bilney predicts that variation in crop growth from one week to the next could be assessed, allowing farmers to pick up on any problems and react quickly. While the technology is yet to be adapted to measuring crop growth, the greenness index of the images gives farmers a rough idea of how well their crops are growing.

Bilney hopes to receive the satellite information every fortnight during the growing period, to correspond with the movement of his sheep. As PGR and FOO can vary within individual paddocks over the course of a fortnight, this will ensure his sheep get a consistent and correct amount of feed.

David Henry and Marion Barnes from CSIRO Livestock Industries examine pasture growth rates across the south-west region of Western Australia.

Interstate applications

Farmers in New South Wales, Victoria and South Australia are now testing the satellite technology to see if it applies in areas with different pasture types and rainfall.

'We're very confident it will be easy to extend they technology into other states, but we have to make sure it is accurate,' Henry says.

While the satellite imagery can only be used in the green growing season, CSIRO is developing a satellite based radar system that can measure FOO in green or dry pastures. A 'near infra-red reflectance spectroscopy' (NIR) system is also being developed to measure the quality of feed in the dry season.

'When feed dries, the digestibility and crude protein content goes down and animals can no longer eat enough to maintain their weight,' Oldham says.

'The advantage of NIR is that it can measure the quality of feed over summer when it is the critical factor for animal performance and grazing management.'

Graziers such as Bilney will then know how much to hand feed their sheep in order to maintain wool quality.

Farmers using the satellite maps to help maximise the use of their pastures and to free up land for other enterprises.

Abstract: Satellite images could soon help graziers in Western Australia improve pasture management. Using CSIRO technology, the amount of 'greenness' measured by satellites across the state's south-west, is converted to biomass or 'food on offer' (FOO), and 'pasture growth rates' (PGR). By 2002, farmers will be able to download weekly or monthly images from the internet, showing FOO and PGR for their whole farm or individual paddocks. The technology is being piloted by wool-growers undertaking a precision wool-growing experiment. Using the pasture measurements, growers can determine feed budgets for their sheep, aimed at maximising pasture use and improving wool value. The technology is now being tested in other states to determine its accuracy in areas with different pasture types and rainfall.

Keywords: satellite imagery, remote sensing, pasture management, pasture growth rates, food on offer, sheep feeds, grazing practices.