Use of Remote Sensing Satellite Images to Predict Pasture Biomass on Waikato Dairy Farms

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Introduction Efficient pasture management is a key component of profitable dairy farming in New Zealand (NZ), yet feed budgeting is only used on about 20% of dairy farms (Clark et al., 2006). Current methods of pasture biomass assessment by NZ dairy farmers using visual assessment, rising plate meter (RPM), pasture probe or rapid pasture meter are time-consuming. Satellite images can save time and labour by rapidly providing individual paddock yields to assist management decisions. Remote sensing by satellite images relies on the fact that different levels of plant biomass differentially reflect red and near infra-red (NIR) electromagnetic radiation. This information is used to calculate an index of plant greenness or 'Normalised Difference Vegetation Index' (NDVI). The relationship between NDVI and pasture biomass allows pasture biomass to be predicted at the paddock or regional scale (Mata et al., 2007). Fonterra and Dairy InSight contracted CSIRO and Dexcel to investigate this technology for use in NZ dairying, aiming for real-time delivery of paddock covers to farmers. The project is now in its third year, with further validation of the model continuing along with pilot delivery of satellite-derived estimates of pasture biomass to farmers involved in the project.

Materials and methods From August 2005 to December 2006, 22 images were sampled with pasture biomass data collected from 11 Waikato dairy farms (8 commercial, 2 research, 1 corporate) of flat contour (<10° slope), for calibration and validation of the relationship between satellite-derived NDVI and field estimated pasture biomass (Mata et al., 2007). Further validation and pilot delivery began in June 2007, with 3 more commercial farms and 1 research farm added to increase the number of cloud-free farms available to sample and to add more contour. A further 7 images were sampled from July to November 2007 with satellite predicted pasture biomass delivered to farmers for 2 of these images. Data collection was focussed on the winter-spring period (June to December), where pasture management to match feed supply with demand and maintain feed quality is critical in New Zealand dairy systems.

Paddock average pasture biomass values were collected using a RPM according to recommended industry practice (minimum of 50-80 readings per paddock), Thomson et al., 1997. Satellite images acquired from SPOT-4 (pixel size 20m) and SPOT-5 (pixel size 10m) satellites (*www.spotimage.fr*) were processed using standard remote sensing procedures. A model was developed using the ground measurements of pasture biomass and satellite-derived NDVI at the pixel level to enable pasture biomass predictions from the satellite imagery (Mata et al., 2007).

Results and discussion Validation studies from data collected in Year 2 (Mata et al., 2007) showed satellite estimates of paddock-average pasture biomass were highly correlated with RPM biomass estimates collected on the same day as image acquisition, with combined data giving a 10% error, or 260 kg DM/ha for a pasture biomass range of 1500 to 3400 kg DM/ha. This compares well with other NZ and Australian estimated errors of pasture biomass, using the RPM, of 311-610 kg DM/ha. However validation of the algorithm during 2007-2008 has revealed that between 20% and 30% of the data may exceed these limits and options for addressing issues are being considered.

Cloud-cover remains a constraint to obtaining weekly images, with up to 3 weeks between clear images obtained in late September and November 2007. Pasture growth modelling using interpolated weather data is being investigated to overcome this and may be used alongside satellite estimates to enable weekly data delivery. Long-term, radar satellite technology, which is not affected by cloud-cover, may prove to be a useful tool to link with. Other satellites may also provide more frequent coverage.

Delivery of reliable pasture biomass estimates at low cost would allow farmers to use the data in weekly feed budgets, or provide them with a feed wedge to help make management decisions.

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