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Empowering producers with a national grassland biomass service

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Abstract

The Australian Feedbase Monitor (AFM) is a new grazing management tool that gives Australian land managers satellite insights into their feed capabilities. It is an online portal codeveloped between CiboLabs and Meat and Livestock Australia (MLA) to improve the understanding and management of Australia's pasture and fodder feed base. The portal is free to MLA members and supported through a broad-based extension program. We used over 5000 site-based total standing dry matter (TSDM) measurements from pasture cuts, rising plate meter transects and expert observation to build a satellite-based TSDM estimate with similar accuracy to the field observations.

This model produces national TSDM estimates every five days based on the previous 30 days of imagery. The coincident application of a fractional cover model allows the TSDM estimates to be partitioned into green and dry components, allowing additional applications such as pasture quality estimation, bushfire risk assessment and ground cover analysis. Based on the European space agency Sentinel-2 satellite, these products are available back to 2017. This enables producers to understand the trends in their farms' pasture production, including rainfall, ground cover, and biomass, to place this season in the context of previous years.

As part of this tool, training and extension programs have been developed to support producers using the data for feed budgeting and to improve planning to respond to seasonal changes. This data is also used to identify underperforming areas of the farm or areas that may benefit from management changes. Further enhancements are planned to support a greater range of visualisations, farm metrics, and comparisons, which will drive adoption and help producers understand this tool's benefits and limitations.

Introduction

The Australian red meat industry needs help meeting market demands due to fluctuating livestock availability, influenced by variable pasture resources. This variability stems from rainfall, grazing pressure, and land conditions. Innovative technologies are being developed to enhance feedbase and animal management for improved productivity and sustainability.

In partnership with Meat and Livestock Australia (MLA), Cibo Labs has developed the Australian Feedbase Monitor (AFM). This groundbreaking grazing management tool leverages satellite imagery to give land managers valuable insights into their feed capabilities. This online portal aims to enhance the understanding and management of Australia's pasture and fodder resources, ultimately supporting a more profitable and sustainable red meat industry.

Methods

The development of the Australian Feedbase Monitor (AFM) followed a comprehensive process to ensure its effectiveness and applicability.

Data Collection and Preprocessing:

We collected and curated 5,100 Total Standing Dry Matter (TSDM) measurements from diverse locations across Australia, including sites collected by Cibo Labs, clients and collaborators. These field data were guided by a dedicated field data collection app that assists the user in collecting field data along a 50m transect, suitable for calibrating Sentinel-2 10m spatial resolution imagery and aimed to capture variability within and between species, growth stages and land types in the grazing regions, ensuring the model's robustness. Measurements were obtained through multiple techniques, including pasture cuts (31%), rising plate meter transects (9%), and expert observations (60%), allowing for a broad analysis of measurement types and variability. We acquired the five closest cloud-free Sentinel-2 satellite images for each site, giving us an effective window of 20 days around the field date. Coincident photography and GPS locations enable Rigorous quality control to be applied to the field and satellite data to remove outliers and address inconsistencies, such as cloud contamination and location error.

Model Development:

We used a five-hidden-layer, multilayer perceptron regression model for TSDM prediction, known for its capacity to learn complex relationships between input (satellite features) and output (TSDM) variables. The dataset was split into 50% training and 50% validation subsets to prevent overfitting and ensure generalizability. We optimised parameters using the Adam optimiser coupled with 50% layer dropouts, a layer norm constraint of 1.0 and a robust Huber loss function to enhance accuracy and prevent over-prediction. The model's performance was evaluated using metrics such as Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE).

Model Validation and Refinement:

A 10-fold cross-validation method ensured robust validation, dividing the data into subsets to iteratively train and test the model. We generated 16 initial realisations of the model to assess hallucinations and used an adversarial method to select the four best candidate models for additional expert evaluation. We adopted a "living model" approach, using an ML Ops framework to continuously update the model with new field data to maintain accuracy and relevance as conditions evolve.

Extension and Training:

The extension program of Cibo Labs commenced in March 2022, with activities increasing following the formal launch of the Australian Feedbase Monitor in November 2022. As of December 2024, the Cibo Labs extension team had facilitated 236 engagement events, connecting with 16,700 producers and 3,486 consultants through various platforms like field days, conferences, and webinars to boost pasture assessment and grazing management awareness. These figures reflect program activities conducted over a 33-month period from March 2022 to December 2024. The team was crucial in industry initiatives such as NT TRM Rain Ready Rangelands and MLA EDGE Grazing Fundamentals. They also developed the

'Grazing for Growth' workshop to enhance producers' confidence using pasture assessment and forage budgeting tools.

Results

Table 1 shows the cross-validated satellite TSDM error metrics for various ranges of TSDM values. Figure 1 shows the cross-validated results and associated confidence envelopes for the field data and the predictions. The median absolute percentage error of less than 30% over most of the model's range aligns closely with field measurement error and demonstrates its reliability in offering critical data to producers. There is still a significant error in the 0 to 1000kg/ha range, which reflects the variability of field estimates and difficulties associated with some soil colours when the estimation area is predominantly bare ground. Additional field sites are being collected to better sample these environments and update the model in early 2025. The model is used to supply rolling monthly pasture biomass estimates that are updated every five days. This enables producers to make informed decisions regarding grazing management, stock movements, and supplementary feeding, optimising their operations.

Table 1 - Cross-validation metrics for selected TSDM ranges.

TSDM range	Mean Error (kg/ha)	StDev (kg/ha)	RMSE (kg/ha)	MAE (kg/ha)	MAPE (%)
0 - 1000	287	543	618	184	90.5
1000 - 2000	35	563	564	235	25.7
2000 - 3000	268	735	783	453	24.0
3000 - 4000	618	892	1085	637	24.3
4000 - 6000	1218	1193	1705	1073	27.9
6000 - 10000	2404	1915	3074	2263	35.1

Producers who have participated in extension activities were surveyed before and after the event, focusing on their confidence in developing forage budgets. Participants, particularly those attending Grazing for Growth, showed significant increases in their understanding and confidence in forage budgeting, specifically in accessing and applying data provided by the AFM or PastureKey.

Additionally, the AFM enriches producers' understanding of pasture trends by providing historical data since 2017. This allows for a comprehensive analysis of factors such as rainfall, ground cover, and biomass, helping producers make informed decisions for the current season while also planning for the future. The tool's broad industry adoption reflects its perceived value, with over 4,400 registered users managing more than 52 million hectares as of December 2024.

Furthermore, extension activities have equipped producers with practical tools and knowledge to integrate this data effectively into their strategies, leading to a measurable 58% increase in confidence in forage budgeting. This increase is benchmarked against pre-event survey responses, where participants rated their confidence in key areas such as estimating available feed, calculating livestock demand, and making stocking decisions based on AFM or PastureKey data. Post-event surveys substantially improved

participants' ability to apply these skills independently. These efforts have heightened awareness and enabled actionable improvements in grazing management practices, enhancing efficiency, resource utilisation, and resilience against climate variability across diverse production systems

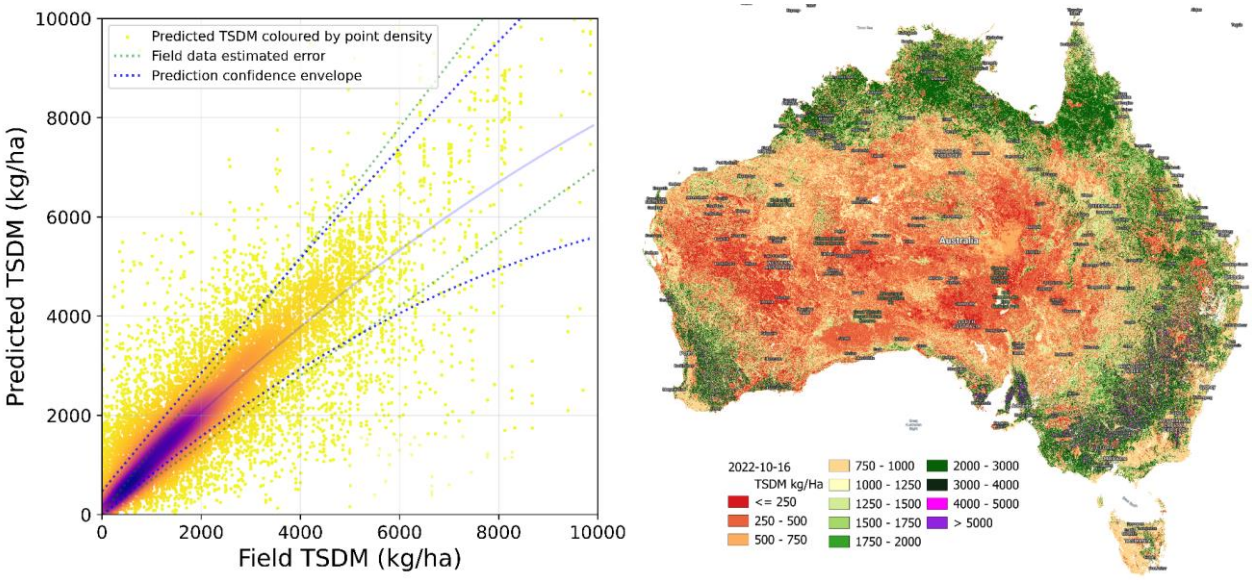

Figure 1 - Australian feed base monitor predictions vs field-based estimates (left) and example model output for 16 October 2022 (right).

Implications

The Australian Feedbase Monitor represents a significant step forward in grazing management. It gives producers powerful data-driven insights to optimise their operations and contribute to a more sustainable and profitable red meat industry. Continued research, development, and ongoing producer engagement will further enhance the AFM's capabilities and accuracy and ensure its long-term impact.

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