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Precision Pastoralism-Advanced Systems for Management and Integration of Livestock and Forage Resources in the Semi-Arid Rangelands in South Eastern Australia

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Precision pastoralism-advanced systems for management and integration of livestock and forage resources in the semi-arid rangelands in south eastern Australia

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Key points: Precision pastoralism involves the application of new technology to manage animals according to individual requirements and to assist the management of rangeland resources by matching forage supply with forage demand.

Individual animal management is achieved through the capacity to identify and weigh individual animals as they enter a watering enclosure, telemeter the data to a remote computer, and remotely activate drafting gates based on analysis of a quality assured data set. Alternatively, any other individual attribute (e.g. reproductive status) may be used as basis for remote drafting.

Improved management of forage resources is achieved through a capacity to provide probabilistic estimates of future sustainable stocking rates, and ground cover under the current stocking rate, by forward projection of pasture growth from current conditions. Projections are derived from a pasture growth model parameterised for individual vegetation types within a specific property, and applied at the paddock level. Decisions to increase or decrease stocking rate can then be considered in an objective risk management context.

Key words: stocking, risk, ground cover, liveweight

Introduction Extensive pastoral production systems in Australia have traditionally managed animals, at best, according to overall flock or herd requirements. Attempts to match forage demand with forage availability have often been restricted to stocking rate adjustments only at times of major animal husbandry events (e.g. shearing) although more frequent tactical adjustments have become more common in recent years. Attempts to objectively forecast livestock productivity in relation to forage and animal factors have been virtually non-existent in the pastoral context.

However, technologies are now available to facilitate the management of individual animals, or animal groups, according to their specific requirements, and to address more effectively the central issue of matching forage supply and demand to achieve both optimum animal production and sustainable resource use. Objective forecasting of expected animal production is feasible though less well developed. Collectively, these technologies constitute precision pastoralism. Its application will provide livestock producers with opportunities to improve profitability and enhance sustainability not previously feasible in extensive management systems.

Components of precision pastoralism

Individual animal management Precision management of livestock requires a capacity to uniquely identify individual animals, monitor their performance and apply husbandry measures accordingly. Some aspects of this approach have been available for some time e.g. pregnancy diagnosis, with individual females assigned to groups managed according to their pregnancy status. However, such applications require physical separation of groups. The capacity is now available to electronically record the weight of individually identified animals, telemeter this information to a remote office and activate automatic drafting gates on the basis of specified criteria. This allows the timely application of husbandry practices to individual animals without the need for on-going physical separation. Husbandry practices can also be changed as required on the basis of monitored performance.

Physically, this system involves:
- Access facilities at watering points (spear gates and a race) that force animals to enter the watering enclosure in single file, while passing over a weighing platform; design of the system ensures that animals cannot be excluded from water;
- RFID (Radio Frequency Identification) tags applied to each animal;
- A tag reader installed in the race in parallel with the weighing platform;
- A scales indicator/computer that accepts input from both the tag reader and the weighing platform;
- A connection or other wireless data transfer system that allows downloading of tag number-weight pairs to a remote office computer;
- Software that cleans up the data stream by eliminating spurious data points and calculates an average weight for each animal from the remaining set of accepted weights (Richards *et al*. 2006)
- An automatic drafting race that can be remotely programmed, via the indicator, to draft animals according to tag number once performance data has been analysed and management requirements identified.

This walk-over-weighing system is now operated by one of the authors (TJT) in an extensive grazing operation near Bourke, NSW , to manage an opportunistic livestock trading and fattening enterprise (Figure 1) . The system is portable and the intention is to use it , or its component parts , as required throughout the property . Remote weighing and drafting is used primarily to allocate specified animals to supplementary feed based on their monitored weight gain , and to identity those that have reached a marketable weight . Other applications for the systems include :

- monitoring stock remotely to minimise need for physical checking , particularly when used in conjunction with water level sensors at artificial watering points ;
- monitoring animal performance in relation to individual animal thresholds or targets such as joining weights or market contract specifications ;
- drafting of animals on the basis of other individualistic information (e .g . reproductive status , age or classer assessment) ;
- drafting out animals without tags (e .g . ferals) .

Future applications could include :

- individual application of preventative veterinary treatments ;
- mothering up of ewes and lambs , if this is important in breeding programs , based on the observation that lambs tend to follow ewes over the weighing platform and tag sequences can therefore be related to pedigree (Richards and Atkins , 2007) .

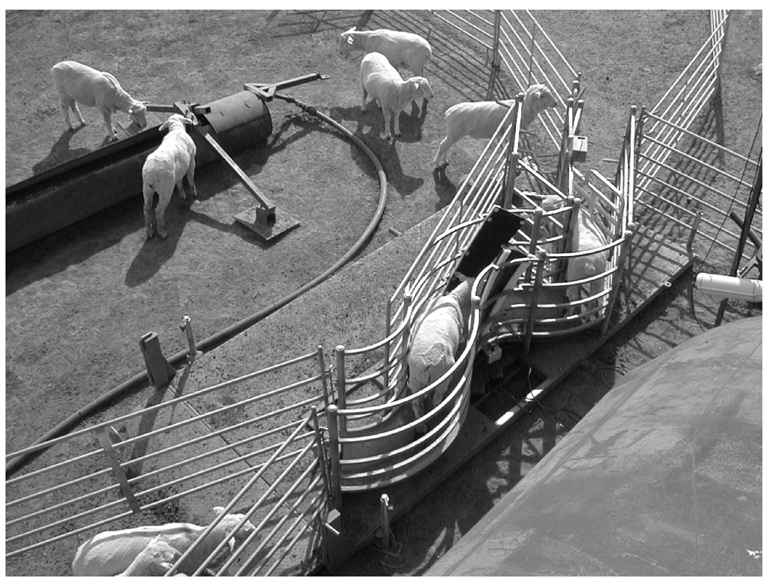

Figure1 *Remote weighing and automatic drafting facility showing the curved race which encourages animals to pass slowly over the weighing platform while entering a watering enclosure , tag reader (located in the race) and drafting gates .*

Precision pasture management Matching forage supply and demand through tactical adjustment of stock density is a fundamental challenge for all grazing systems . Spatial modelling of pasture growth offers a new tool to address this issue in the context of precision pastoralism . Calibration of pasture growth models for individual vegetation types within pastoral properties , combined with mapping of theses units at paddock scale allows probabilistic forecasts of future pasture growth on a paddock basis to be generated from historical climate data . Several generic calibrations of the pasture growth model GRASP (Littleboy and McKeon 1997) are available for western NSW (Richards *et al* . 2001) and can be relatively easily refined for more specific vegetation types by rapid assessment techniques to determine soil water holding capacity in the appropriate depth increments and tree basal area , a key driver of ground storey biomass production , for mapped vegetation types (Alemseged *et al* . 2006) .

We have used this rapid calibration approach to develop a prototype version of the package PaddockGRASP for two extensive properties in western NSW . Once supplied with an updated file of daily climate date in the appropriate format from the SILO data base (http ://www .nrw .qld .gov .au/silo/ppd/index .html) , and initialised for current standing biomass levels based on field observations , the model provides :

- pasture growth estimates , for paddocks and vegetation types within paddocks , for the next 3-12 months at the 20th , 50th and 80th percentile levels ;

Preliminary input screens allow specification of unique characteristics for vegetation types within individual paddocks such as the allowable utilisation percentage, proportion of biomass produced that is palatable (a surrogate for range condition) and proportion accessible to grazing. Stocking history for each paddock is also entered. While alternative probability levels could be chosen, the output of 20th, 50th and 80th values is considered to provide a reasonable representation of pasture growth and ground cover expectations for poor, reasonable and good seasonal conditions respectively.

Given the general acceptance of 40% ground cover as the minimum desirable in the semi-arid rangelands of western NSW (e.g. Campbell and Hacker, 2000; Western Catchment Management Authority, 2005) these data allow the natural resource implications of the current stocking regime to be appreciated in a risk management framework and the same perspective to be brought to tactical decisions regarding sale, purchase or agistment of stock.

The rapid calibration approach outlined above is thought to capture most of the unique characteristics of particular vegetation types (Hacker *et al*. 2007). However, further refinement may be justified but will require a period of least 12 months field observation of standing biomass, using rapid assessment techniques, for validation and finer parameterisation using the GRASP Calibrator (G. McKeon, pers. comm.).

While seasonal risk assessments for pasture growth can be based simply on the historical record, analogue years could also be used for outlook periods when seasonal climate indicators such as the SOI Phase (Stone, 1996) are known to have useful skill. In western NSW this indicator has useful skill in estimating the probability of exceeding median pasture growth for three-month periods beginning June-September inclusive (Hacker *et. al*., 2006).

Forecasting of animal performance Estimation of animal performance based on pasture production estimates from the GRASP model have to date been successful only at the level of annual liveweight change (Hall 1996). Calibration of the model to estimate live weight change over shorter period should be feasible given the capacity now available to obtain frequent liveweights of individual animals. The objective is to produce probabilistic estimates of liveweight change to complement the corresponding estimates of forage growth, sustainable stock densities and ground cover.

Implementation and adoption The walk-over-weighing system is now operational based on off-the-shelf components for animal identification, weighing and telemetry. Software to clean up the data stream has been developed by NSW Department of Primary Industries and is currently in the process of commercialisation.

Without considerable further development, or extensive support, it is unlikely that the PaddockGRASP software could be made available to individual producers. The best means of achieving the widespread adoption of this technology will be by development of web-based access for registered subscribers who would be able to contract the mapping of their properties to commercial companies and who would either draw on an existing library of vegetation type parameter sets, or would again contract the rapid parameterisation of their specific vegetation types to similar companies. Support for the extraction of climate files and maintenance of the software could then be cost-effectively localised in organisation.

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