SPATIAL LIVESTOCK RESEARCH IN AUSTRALIA AND NEW ZEALAND: TOWARDS A COOPERATIVE RESEARCH MODEL

Yule, I.J.

New Zealand Centre for Precision Agriculture, Massey University, Palmerston North, New Zealand.

ABSTRACT

A number of researchers in Australia and New Zealand are working in the area of animal tracking as an important technological step to gaining a deeper understanding of animal behaviour in various farmed and natural environments. The ultimate goals of the research vary from simply trying to understand how animals can be farmed more effectively to how animals could be controlled without fences. There are a number of parallels with the development of conventional precision agriculture in terms of the stages of development and the research processes involved. Researchers have recognized that there is considerable advantage in working together to share experiences and avoid repeating similar mistakes, thereby shortening the development time and attacking the real research questions posed.

GPS is a good example where the technology had to be proved and the use of expensive specialist GPS tracking devices has given way to lighter, cheaper units which can be easily constructed. The research questions are different from conventional precision agriculture and so the research approaches must be adapted. It may be more effective to have a greater number of animals recorded within a herd or flock than achieving sub-meter accuracy, however where animal locomotion is considered then higher levels of accuracy are required.

Consideration is being given to methods of statistical and geo-statistical analysis in order to develop robust methods and models to describe behaviour and provide measurements of error of prediction around resource selection functions and distance travelled particularly when dealing with extended sampling intervals (>1 minute).

The research presently being undertaken in Australasia is reviewed, research goals and priorities are expressed.

Keywords: Animal Tracking, Animal behaviour, GPS collars,

INTRODUCTION

Currently, within this field of research and development, the use of animal tracking equipment in farmed environments could be placed under three main categories.

- High (temporal) frequency store-on-board systems.
  - Post-event analysis of behavioural (‘spatial-only) indicators of calving/lambing, forage status (quantity and quality), water point condition, animal-landscape interactions (eg. pasture utilisation, feed efficiency, parasite infection), animal to animal interactions (eg socialisation, joining, wild-dog predation).
  - Proved to be a great R&D tool, opens up new fields of activity.
  - Low cost, this has come down from US$2,000 in 2004 to US$100-200 in 2010.
  - Cheap to run (no data charges, no external infrastructure).

- Low (temporal) frequency, real time (remotely-accessible systems)
  - Again spatial only, will build on knowledge derived from high-frequency systems
  - Ideal for time critical decision making (trigger point/alarm-based)
  - Fence breaches, calving/lambing, water point failure, forage status
  - Convenience (data retrieval- www or mobile phone, SMS alarms)
  - But requires external infrastructure- eg. mobile network, triangulation towers, broadband communications.
  - Unit cost reducing and commercial application maybe 5-8 years away.

- Direct ‘activity’ sensors
  - Eg chewing, urination, dung, rumen and health.
  - Potential for integration with GNSS systems, many simply marry up data at the post processing stage at the moment. Communication challenges to integrating sensors on large animals, animals sometimes in close confinement, eg. cows in collection yard before being milked.
  - Advantage- direct measurement

- Disadvantage- adds to animal burden, ACE (animal care and ethics)
- Extra cost on top of GNSS.

REVIEW

There are two groups working on animal tracking in New Zealand. AgResearch Grasslands and Massey University, Centre for Precision Agriculture. There are a number of factors motivating this work, the main focus is to examine the impact of the animal on it's environment, especially the re-distribution of nutrients around the farm environment. Work by Betteridge (2008 , 2009, 2010a, 2010b) utilised GPS collars to track cattle, sheep and deer. The work was focused on nitrogen mitigation in the Taupo catchment in the central north island which is an area of high environmental sensitivity. Betteridge (2010b) developed a urine sensor that could be used to determine when a grazing animal was urinating, this was linked to the GPS collar worn by the animal and was able to locate urination events in the herd or flock. The cattle leached twice as much N per ha as sheep or deer after data were normalised to a common apparent intake of N, or a common stock unit grazing days, Hoogendoorn (in preparation).

Massey's first interest was to examine pasture utilisation and growth within a variety of landscapes. Simple trials were undertaken in 2004 and 2005 to examine the practicality of using GPS collars on cows to track their position and behaviour in hill country and dairy farm situations. The hill country study lasted for twelve months and the Sirtrack® collars used were found to work satisfactorily. Although the cows were tracked with a position read from GPS every 30 minutes, only two cows were used which meant that no real statistical data could be generated. Utilisation of pasture on land with varying slope and aspect was recorded as well as examining the effect of weather conditions. The initial dairy trial was used to check that the accuracy of the GPS was sufficient to continuously track the cows to calculate distance travelled and recognise grazing behaviour from standing and laying down.

The teams have conducted joint work as describe by Draganova (2010),in this conference. A total of 17 GPS collars were used and cows were also fitted with IceTag® activity sensors and the urine sensors developed by Betterridge,(2010b). The focus was to develop methodologies for analysing this type of data. As well as cow tracking, pasture availability was also mapped in some paddocks. The larger number of cows being tracked allowed factors such as the synchronicity of activity to be examined. A high level of synchronicity was found, this was also experienced in Betteridge's work with sheep and beef cattle.

Draganova's work was funded by the Fertiliser Manufacturers Research Association of New Zealand and the focus was to examine nutrient re-distribution around the farm as nitrogen leaching from dairy farms is recognised as a concern and urine spots are the major source of this leached nitrogen. To this end some of the statistical techniques developed are described by Draganova(2010).

The continuing focus is likely to be the integration of further sensors, either mounted on the animal or used to describe the environment which can assist in describing the interaction between the two. This information will assist in designing livestock farming systems which will minimise the nutrient loss and assist in greenhouse gag mitigation strategies. Production objectives are being investigated, such as increasing pasture utilisation and improving pasture quality through better control of grazing strategies. This is similar to many other precision agriculture applications where increasing production efficiency has also reduced environmental impacts.

Although the environments experienced in Australia are very different to that of New Zealand similar objective have been expressed and techniques developed. Trotter(2009a) completed work on analysing the behaviour of grazing steers, mapping the density of grazing behaviour indicated large differences in grazing intensity, Trotter used Livestock Hour Index (LHI) and Dry Stock Equivalents (DSE) to indicate these levels. Trotter (2009b) mapped pasture mass using VIS/NIR sensors, ME content was also measured and a tendency to graze in high biomass areas in the morning was followed by higher ME areas in the afternoon. A strong diurnal variation as observed and in common with most other trials the herd activity was strongly synchronised.

Swain (2008) investigated the GPS requirements needed to achieve robust resource selection functions, RSF's. In this case position accuracy required to monitor speed of movement and describe the minimum spatial resolution an animal could be placed in was calculated. Further probability density functions were used to describe speed profiles, again used to calculate the minimum unit area when using a range of sampling intervals. Swain recommended that when wishing to study behaviour down to the 10m and $100m^2$ then a sampling interval less than 10 seconds should be used. When GPS position measurement is only carried out at 1 hr intervals then the probability of accurately predicting position within a $10,000m^2$ area is 30%.

GPS collars on cattle have also been used to identify differences in animal behaviour, Thomas (2009) used this technology to compare the behaviour of range-raised cattle, moved to a temperate grazing environment, compared to cattle of a similar age which had been raised in the temperate environment. The weight gain of the range-raised cattle was one third of the other group, use of GPS collars allowed information to be gathered the time budgets of various activities, These cattle travelled 23% further, were active for 16% more of the time available and spent 21% more time exploring the paddocks in the . The study concluded that the cattle exhibited more exploratory behaviour, less grazing activity and reduced weight gain.

Taylor (2009) investigated the possibility of training sheep to visual and auditory stimulus to assist in improving utilisation of shelter and shade in the Northern Tablelands of New South Wales (NSW) by grazing animals. Techniques to train sheep to lead naive mob members to shelter were investigated. Taylor also used techniques described as change point analysis to identify changes in behaviour. This technique was used to successfully identify lambing in ewes. If this technique could be adopted by some rangeland farmers who's cattle have a high birth mortality (up to 30%) then it could allow them to identify the location where a cow calved. In remote areas this could help to identify if a calf had survived and if not the body would be available for post mortem. This initially would be part of a study attempting to find the cause of early mortality.

Other unique environmental challenges offered by Australia have been investigated. Ballard(2009) investigated predation of stock by wild dogs and foxes. Large dogs used to protect stock are to be fitted with GPS tracking in order to better understand the dynamics and management requirements involved in this situation. Berney(2009) used GPS tracking to investigate grazing behaviour of cattle in the floodplain wetlands in the northern Murray-Darling Basin.

CONCLUSIONS

The utility of GPS collars appears to be proven for animal tracking for a number of applications in a range of environments. The movement and behaviour of animals in sometimes remote and difficult environments can be closely monitored. Statistical analysis of positional data allows individual and herd behaviour to be analysed and modelled in relation to their environment. Having an enabling GNSS technology has given researchers the opportunity to develop further sensors that allow some aspects of behaviour to be examined or controlled. Examples include; urine sensors, activity sensors and collars which attempt to control where the animals graze through the concept of fenceless farms. A better understanding of cow behaviour can assist in the design of dairy farms which allow the smooth flow of animal traffic and avoid unnecessary concentrations of animal excreta especially urine. A great deal of concern has been expressed about environmental impacts. Work by Betteridge is to be extended to examine sensing technologies that can measure the duration and concentration of urination events thereby refining studies to further quantify the distribution of nutrients from farm animals .

The use of animal tracking technology could potentially be linked with existing work on identifying pasture quality and mass (Pastoral 21 Project) which involves, AgResearch, Massey University, Dairy NZ and Landcare Research, to form a highly integrated project studying precision dairying, one aspect is to study the effectiveness of our current dairy systems and design improved farms taking land resources and animal interactions (with landscape and peers) into account.

Increasing demand that these technologies move from research to commercial use will require instantaneous data transfer from the unit to the management system in order to track animal position and behaviour. This is likely to remain challenging in remote locations where the present limitation on battery power required to transmit information may be limiting. In applications such as dairying the twice daily visit to the milking platform may create the opportunity to re-charge battery power.

The language around this technology is developing as is the need for indices which allow ready comparison between different situations and provide measurable outputs. Simple concepts such as DSE and LHI allow the relationship between the animal and its environment to be expressed. When used alone or with other sensors it is feasible to detect changes in behaviour over time or sudden events that may require action on the part of the farmer. Basic statistics such as changes in distance walked or time spent grazing may indicate the animals are ready to be moved to a new grazing area or that water troughs are not functioning. Deviations from daily routine may signal problems with individual animals

Geostatistical interpolation and kernel modelling techniques have been developed and it is again important that these develop common meaning between researchers if the field is to develop rapidly. As commercial applications develop it is important that robust statistical processes are adopted in order to accurately describe position and behaviour.

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