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OPTIMISE USE OF RESOURCES: CURRENT AND FUTURE APPROACHES

Rendel, J.M. and Mackay, A.D.

AgResearch
Email: john.rendel@agresearch.co.nz

Abstract

The NZ Government has set a goal to double the value of export earnings from the primary sector by 2025 to $64bn from $32bn. This requires earnings growth of 5.5%pa. This cannot be met by increased on-farm production alone, as there is growing pressure for this sector to reduce its current environmental footprint to protect our living environments for a rapidly expanding range of activities beyond just food and fibre production.

Farmers are well used to operating within boundaries. These, like for example financial and feed supply boundaries, are part of everyday life. Adding limits on emissions to receiving environments to that list is an emerging challenge, made doubly demanding if increasing production outputs remains the primary mechanism for lifting income and maintaining profitability. In this paper we will present findings, using a new farm systems modelling approach that has the capability to optimise the farms resources within ecological limits. We explore the rapidly growing interest in configuring the farm business in direct response to signals from the market in an effort to capture greater value for our produce and the country, and for more of that value to be retained behind the farm gate. Constructing the supply chain backwards from the market as part of paradigm shift from volume to value, will involve new supply chains, with the producer likely required to make significant changes to the current farm system. We will provide an example where the farm systems analysis is driven by the market's specifications, rather than just maximising the resource use of the farm.

Introduction

Farms are the starting point of any of our pastorally-based supply chains. We need to understand, and be able to paint pictures, of what these systems could look like when new boundaries or other changes are incorporated into the farm decision making process. This requires not only understanding the raw resources on-farm and their boundaries (e.g., soil type and its relationship with pasture growth, soil and pasture management through to animal performance) but also its relationship with the quadruple bottom line (people, profit, purpose and planet). It also involves understanding trade-offs that may exist (e.g., increased ewe lambing performance and stocking rate). With the NZ Governments goal of doubling primary exports to $65bn by 2025 (MPI, 2015), it is imperative that these trade-offs are understood and quantified within a systems context. Our current suite of farm systems tools (e.g., Farmax, Udder) in the pastoral agricultural area focus on operational and tactical decision making. This leaves a gap in our analytical capabilities for strategic decision making tools that can describe and conceptualise new farm systems when existing boundaries are changed or new ones introduced.

Development

As part of the Pasture 21 project (a partnership program involving MBIE, Beef+Lamb, AgResearch, DairyNZ, Fonterra, DECANZ) we set out to answer "Can greater wealth and a reduced footprint be created for the whole farm from understanding the contribution from each of the land management units (LMU's) that make up a farm?" and then how can the farm be re-configured to capture those benefits? A literature search identified the only tool available to us was MIDAS (Model of an Integrated Dryland Agricultural System), a bio-economic model of a dryland farm system, developed in Western Australia to understand how crop rotations and livestock enterprises could be better integrated in a whole farm system (Morrison, 1987). Adapting this model to New Zealand pastoral conditions would have taken considerable time, so we developed an integrated farm optimisation and resource allocation model (AgInform®). This model consists of multiple near contiguous areas LMUs, which have their own characteristics (e.g., pasture growth and energy content, response to nitrogen fertiliser, option to make supplementary feed or not, could support cattle at specified times of the year and potential for winter crops). AgInform® allocates livestock to LMUs and moves them between LMU's in order to maximise profitability, whilst meeting feed requirements within the constraints of pasture, crop and supplementary feed availability. A year is split into 26 fortnightly periods, and the model is constrained to be a steady-state single year model with pasture covers at the end of the year equal to opening covers at the beginning of the year and the same with stock numbers. The model was optimised as a Linear Programme (the objective was profit measured as Earnings before interest, tax, depreciation and amortisation, EBITDA, and the constraints were a feed budget and a stock reconciliation). The model chooses the type of capital stock to run on the farm (e.g. cattle, sheep) and the numbers and sale dates. This provides a strategic snapshot of the optimal configuration of the farm. This information could then be used to generate an investment analysis, which takes into account the purchase of capital stock and income flows over a number of years. A Net Present Value (NPV) is estimated, which can be converted into an annuity. The base system was modelled and then changes made. The annuity and NPVs are then compared between the two optimised systems. Further, a picture can be generated to show where animals are on the farm over the year. This provides a visual image of what the farm system may look like, and more importantly, how the farm system changes to incorporate new or changed boundaries. Several analyses were undertaken using this steady-state single year model. These included the impact of forestry on the farm system and the earnings from forestry required to break-even with remaining in pasture. Also included in that analysis was an investment analysis of a multiyear forage crop (Rendel *et al*., 2015). The capture of ecosystems services was also analysed in the single year steady state model (Dominati *et al*., 2016).

In order to understand how farm systems may need to adapt to a nitrogen leaching boundary, and the impact this has on profitability, the option to include urinary N boundaries across the year was introduced. This approach was used to quantify the impact on an N limit on a farm system in the Taupō catchment. The old and new farm systems were then analysed in Overseer to estimate the N leaching.

The single-year steady state model was the first step in pastoral farm system design and analysis. The next step was the development of a multiyear version, where the pasture production, quality and crude protein content could vary across years. As the optimisation was across time, capital livestock purchases and sales were introduced into the model, as was discounting to allow for the time value of money. Analysis showed that the single-year steady state model overestimated profit by 30% and capital stock numbers by 20%, for a Whanganui hill country farm (updated analysis from Rendel *et al* 2016). A hogget lambing option has since been added that allows the modeller three choices for hogget lambing - no, yes, or model chooses. Legume content in the diet has also been added.

In order to better understand how dairy, and sheep and beef enterprises may work together, dairy livestock has been added, using AgResearch core funding. This will enable the design and evaluation of an integrated livestock system allowing the quantification of milking cows, dairy grazing (young stock and dry cows), and cull cow and bobby calf transfers, where the milking platform is only part of the overall land holding. At this stage a dairy option is running, however the transfers have not yet been integrated.

The Dream

In order for New Zealand pastoral agriculture to meet the Government's aim of doubling the value of exports by 2025, the industry needs to move from a commodity based platform, where volume is a key driver, to one where the supply chain is integrated from and including the farms to the delivery of products to the market, (i.e., to specification, on time). This will involve the integration of farms and the participants in the supply chain in order to maximise the value of the supply chain, over time to all participants. The role of AgInform® could be, at a strategic level, to paint a picture of what that supply chain might look like and its potential value. This may also include other boundaries (e.g., greenhouse gases, ecosystem services, cultural, etc.) and alternative enterprises (e.g., organic milk production, dairy sheep, once-a-day milking of dairy cows).

Conclusion

We have developed a new approach to farm systems modelling that has the capability to optimise farms resources within ecological limits. This and the ability to include other boundary conditions as well as increasing the ability to configure the farm business in direct response to signals from the market in an effort to capture greater value for our produce and the country will become capabilities required by the industry. This will replace the current concept of maximising resource use on-farm, probably resulting in more value being retained behind the farm gate,

References

Dominati, E.J. Mackay, A.D., Rendel, J.M. Smale, P.M. 2016. Looking to the future of land evaluation and farm planning. Journal of New Zealand Grasslands 78: 67-71

Morrison, D.A. 1987. Background to the development of MIDAS. In Kingwell, R.S., Pannell, D.J. (Eds). MIDAS, a bioeconomic model of a dryland farm system. Pudoc, Wageningen, 5-14

MPI 2015. The export goal. www.mpi.govt.nz/about-mpi/our-strategy-2030-growing-and-protecting-new-zealand/the-export-goal/. Accessed 1 March 2017.

Rendel, J.M., Mackay, A.D., Smale, P.M. 2015. Valuing on-farm investments. Journal of New Zealand Grasslands 77: 83-88

Rendel, J.M., Mackay, A.D., Smale, P.N., Vogeler, I. 2016. Moving from exploring on-farm opportunities with a single to a multi-year focus: Implications for decision making. Journal of New Zealand Grasslands 78: 57-66