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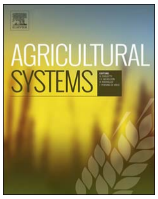

Feedbase intervention in a cow-calf system in the flooding pampas of Argentina: 2. Estimation of the marginal value of additional feed

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ABSTRACT

Temporal variability in the availability of forage reduces the production and economic performance of livestock systems. The marginal value of feed (MVF, the possible gross economic benefit of additional feed on offer during an annual cycle), was assessed under the expected variability of climate and prices in a cow-calf operation from the Flooding Pampas, Argentina. Herbage mass accumulation (HMA) was simulated on a daily basis over 20 different years with DairyMod, grouped by month and season and where the HMA was equal or below 50% of its long-term average, it was tagged as "Dry". Typical monthly pasture growth rates were synthetically depicted for average years (Average), or with dry autumn (D-Au), winter (D-Wi), spring (D-Sp) or summer (D-Su) conditions. These pasture growth curves were incorporated into whole-farm scenarios which were modelled with SIMUGAN, a bio-economic whole-farm model. Farm scenarios were baseline (unchanged HMA) or with additional 10% of the annual HMA. This additional feed was either evenly distributed across each month of the year (all year), or the full amount provided in one of the four seasons. These scenarios were repeated in a factorial design across a range of stocking rates (SR; 0.9–1.3 cows/ha) on an average year or years including one dry season (D-Au, D-Wi, D-Sp orD-Su). SIMUGAN results were fed to an ad-hoc built model to calculate production and market risk profiles. In years with average HMA, MVF were always below 0.05 US$/kg DM but the presence of a dry season caused significantly higher MVF. Years with dry autumn presented the highest economic responses when the extra feed was fed during autumn or winter. MVF analyses showed a positive impact of additional forage only above 1.1 head/ha and this increased with SR, whereas MVF at the low SR were mostly negative due to extra hay making costs. At 1.1 and 1.2 head/ha, allocating additional feed in autumn produced a higher return (0.04 and 0.08 US$/kg DM) than feed provided at other times of the year (averaging 0.02 and 0.05 US$/kg DM). Otherwise, at 1.3 SR extra feed in winter always had the highest MVF (up to 0.19 US$/kg DM). Bio-physical variables of livestock demand and seasonality of pasture growth were the main drivers of MVF variability. Overall, the framework developed by integrating forage, livestock and economic models "in a series" effectively identified the economic feasibility of changes to the farm feed-base under different climatic and livestock management conditions.

1. Introduction

In grazing-based livestock systems, fluctuations in feed supply induce periods with surpluses and feed shortages caused by seasonal and inter-annual variations in pasture growth (Moore et al., 2009). Management practices that can reduce the frequency or intensity of the major feed gaps can greatly improve the profitability of a livestock enterprise (Bell et al., 2016). Cow-calf systems breeding and producing weaner calves are the core of Argentina's significant national beef industry. These systems are characterized by low input and low labour management strategies where feeding depends almost entirely on grazing forages (Arelovich et al., 2011; Rearte and Pordomingo, 2014). Different forage management technologies have been evaluated to explore the potential to improve livestock productivity of such systems, such as haymaking (e.g. Romera et al., 2005), and strategic N application to pastures (e.g. Berger et al., unpublished companion paper). External feed sources may be an option in some circumstances, but they should meet the nutrient needs in a cost-effective manner to achieve

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profitability in the operation. Hence, the biology of pasture and animal production needs to be coupled with an economic evaluation (Moore et al., 2009). Estimating the likely financial return of implementing a change in feedbase of the grazing enterprise needs to take into account how this may impact on the whole-farm system (Bell et al., 2008).

Modelling approaches for analyzing feedbase alternatives in livestock systems are required which allow estimates of the possible gross economic benefit of additional home-grown feed (that is, feed over-and above the amount normally consumed during an annual cycle), and then allow farmers to judge whether or not they can produce the feed at sufficiently low cost to secure a profit margin (Chapman et al., 2011). A convenient integrative measure of the economics of additional feed available to the system is the marginal value of feed (MVF), which quantifies the value of an extra kg DM or MJ of metabolizable energy to whole-farm residual profit which will change according to the livestock enterprise analyzed (Bell et al., 2008). In the case of cow-calf systems, the efficiency with which extra feed can be used to improve calf-weaning rates and weaning weight is the main driver of economic performance (Morris et al., 1994). Furthermore, MVF is a function of several aspects of the system (climate, land resources, forages/feedbase available, livestock system, input and output prices), which means that for its estimation it is essential to adequately capture and explore the balance of livestock demand and forage supply within the whole-farm environment. Previous modelling assessments have involved pasture growth predictions (Berger et al., 2014) and bio-economic whole farm modelling for beef cattle systems that capture the system interactions and carryover effects (Machado et al., 2010b). These provide the basis for the estimate MVF for Argentinean beef farmers, which can be used as a strategic indicator for determining the value of extra feed for these systems. Moreover, most of the time farm decisions regarding growing extra forage are made depending on the current state of the farm with no attempt to predict the future, but probabilities of future events are embedded in the decision process (Behrendt et al., 2013). Combining MVF estimation with risk assessment under the expected variability of climate and input and output prices may facilitate valuable information to define better management strategies to overcome feed gaps in livestock systems. The development of such analysis in cow-calf farm operations in Argentina is the main aim of this work and provides an example of how systems analysis can be deployed to identify the economic value of interventions in the farm feed-base under different climatic and livestock management conditions.

2. Materials and methods

The study was made on a cow-calf farm from the Laprida region (37°33′00″S 60°49′00″W) located within the Flooding Pampas, Argentina. The area is a vast flat plain which constitutes part of the high basins of the Salado and Quequen rivers, covering approximately 2 million ha. At the landscape scale, there is a matrix of lowlands, with alkaline and poorly drained soils, interspersed with small uplands, with better drained soils. It is characterized by cool, wet winters and warm, dry summers. Mean and standard deviation of annual rainfall and potential evapotranspiration were 856 ± 225 and 1147 ± 45 mm/year respectively. Lowest and highest daily mean temperatures occurred in July (7.4 °C) and in January (22.2 °C), respectively. Historical monthly rainfalls and potential evapotranspiration for the period 1993–2013 are shown in Fig. 1.

Beef finishing and cropping systems are located in the uplands areas but cow-calf systems based on temperate perennial pastures of tall fescue and/or tall wheat grass are found in the lowlands. Stocking rate of cow-calf systems average 0.5 cows/ha, but can reach 1.1 cows/ha in the more intensified beef calf producers, and weaning rate ranges between 70 and 85% (Mosciaro et al., 2012).

The basic approach used in this study was to feed a dynamic whole-farm model with simulation outputs from a biophysical pasture model and afterwards results were analyzed introducing variability in prices and costs in order to estimate a distribution of the economic gain that might be achieved from addition of extra forage into the system (i.e. marginal value of feed). The analysis examined the provision of extra feed at different times of the year under a factorial of different system stocking rates and seasons defined as either ‘average’ or ‘dry’. The sequence of procedures and model integration “in a series”, where simulated results from one model were used to build the scenarios in the next one, is described below.

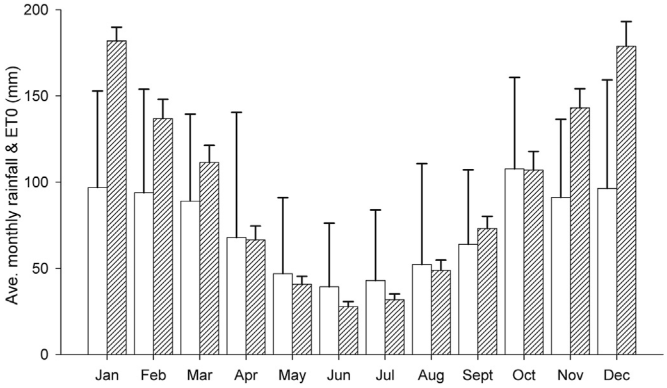

Fig. 1. Average monthly rainfall (open bars), and potential evapotranspiration (ET0, cross lined bars), at Laprida Basin (1993–2013). Vertical lines show standard deviations.

2.1. Pasture growth herbage mass accumulation data

Long term (1993–2013) mean monthly herbage mass accumulations [HMA, expressed as the mean daily net pasture accumulation (growth minus senescence) after adjusting days with net negative pasture accumulation rate to equal zero] and frequency of dry seasons were simulated for tall fescue pastures in the ‘DairyMod’ model (Johnson et al., 2008). A cutting treatment where pasture was harvested at the two leaf stage leaving a residual pasture mass of 700 kg DM/ha was implemented. Removed nutrients were returned as dung and urine evenly across the paddock at each cutting, to approximate intensive rotational grazing system consistent with livestock management in the whole farm model. Soil parameters were set to represent a Petrocalcic Paleudolls soil type (Staff, 2010), having a loamy-clay profile (4.7% OM, pH 6.2). Each year for the period 1993–2013 was run separately using local daily data for maximum and minimum daily temperatures (°C), rainfall, relative humidity, total global solar radiation and wind speed. Mean annual HMA and its standard deviation (SD) were 7364 ± 2061 kg DM/ha year respectively (Fig. 2). Chapman et al. (2008) suggested a method to classify multi-year pasture data in whole farm assessments, and this strategy is followed here. Pasture daily net accumulation was analyzed for each year and season (winter, summer, spring, autumn) and years in which HMA was equal or below 50% of its long term average (the 25th percentile of the long term data), were identified as “Dry” (Fig. 2). In order to examine the effect of these dry seasonal conditions, synthetic HMA for each year was generated by replacing long-term average monthly mean daily net pasture accumulation with the average HMAs in ‘dry’ seasons so that only one of the seasons was replaced at a time and the others drew upon the long-term simulated pasture daily accumulation data. Therefore, typical monthly HMAs were depicted for average years (Average), or with dry autumn (D-Au), winter (D-Wi), spring (D-Sp) or summer (D-Su) conditions. Analysis of the pasture growth series showed that HMA during dry autumn and winter seasons were slightly correlated ($r^2 = 0.38$), but the correlations amongst other combinations of seasons was weak ($r^2 = 0.05$ for D-Wi/D-Sp, $r^2 = 0.07$ for D-Sp/D-Su and $r^2 = 0.14$ for D-Su/D-Au). Hence, it was felt that dry seasons could be implemented independently in the analysis.