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The economic value of replacement breeding ewes attaining puberty within their first year of life on New Zealand sheep farms

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ABSTRACT

The economic value of increasing the reproductive performance of a breeding-ewe flock through selecting replacement ewes that attain puberty (AP) in their first year of life was quantified using bio-economic farm system modelling. In all of the scenarios modelled, the breeding-ewes were first presented for mating as yearlings (18–19 months of age) to enable them to start lambing at 2 years of age. For a New Zealand hill country sheep farm initially weaning 1.4 lambs per ewe mated, farm profit was improved by 6% when the percentage of breeding ewes that attained puberty in their first year of life was increased from 25% to 100%. However, if current sheep-industry target liveweight recommendations for rearing ewe lambs are met then between 70 and 95% of breeding-ewes should already attain puberty in their first year of life, and under these circumstances any further gains in farm profitability through specifically using this selection policy will be small (< 2%). Countering the reproductive performance benefits of this selection policy was: (1) ewe liveweight increased with a higher AP%, which increased the individual feed requirements of the ewes; and (2) ewe mortality increased as multiple-bearing ewes became increasingly prevalent. The economic cost of using additional resources to further increase the farm's feed supply outweighed the benefits, resulting in the need to reduce farm breeding ewe numbers. The methodology and farm system model used for this study can be readily applied to other sheep farming systems. This can identify components of the reproductive process which should be targeted for further research to maximise on-farm benefits, and provide information on how a farm system will need to change for this to be successfully achieved.

1. Introduction

The New Zealand sheep industry has made considerable productivity gains over the last two decades, enabling export sheep-meat volumes to be maintained, despite a 40% reduction in the national flock size (B + LNZ, 2016a; Geenty, 2013). These productivity gains have been achieved through a combination of improved sheep and forage genetics and farm management practices (Byrne et al., 2012; Robertson, 2010). In particular, emphasis has been placed on increasing the reproductive performance of the national breeding-ewe flock through making ewe prolificacy traits a major focus of maternal-flock breeding programmes (Amer et al., 1999; Byrne et al., 2012). There has also been significant farmer-uptake of new technologies and management practices helping to fully realise a ewe's reproductive potential. These practices include ultrasound pregnancy scanning, body condition scoring, stimulating ovulation with nutrition or vaccines (e.g. Androvax®) prior to mating, and differentially feeding single- and multiple-bearing ewes (Corner-Thomas et al., 2013, 2015a; Morris and Kenyon, 2014). Overall, this has led to a 22% increase in the national breeding-ewe flock lambing percentage from 105% in 1995 to 127% in 2015. Over the same period of time the average export lamb carcass weight increased from 14.8 kg/lamb to 18.1 kg/lamb (B + LNZ, 2016a).

While considerable productivity gains have occurred, research to further improve sheep reproductive performance is continuing and there are several ways this can be achieved. This includes: increasing the number of lambs conceived, by increasing ovulation or reducing early embryo mortality; improving lamb survival from birth to slaughter; and improving the transition of young ewes into the breeding flock by improved preparation of the ewe before first mating and/or mating them younger (Young et al., 2014). Recently, Edwards et al. (2015) showed that ewe lambs which attain puberty (AP) in their first year of life had increased reproductive performance when first bred at 2 years of age compared with those that did not attain puberty (NAP) in their first year. This increased performance was observed in terms of

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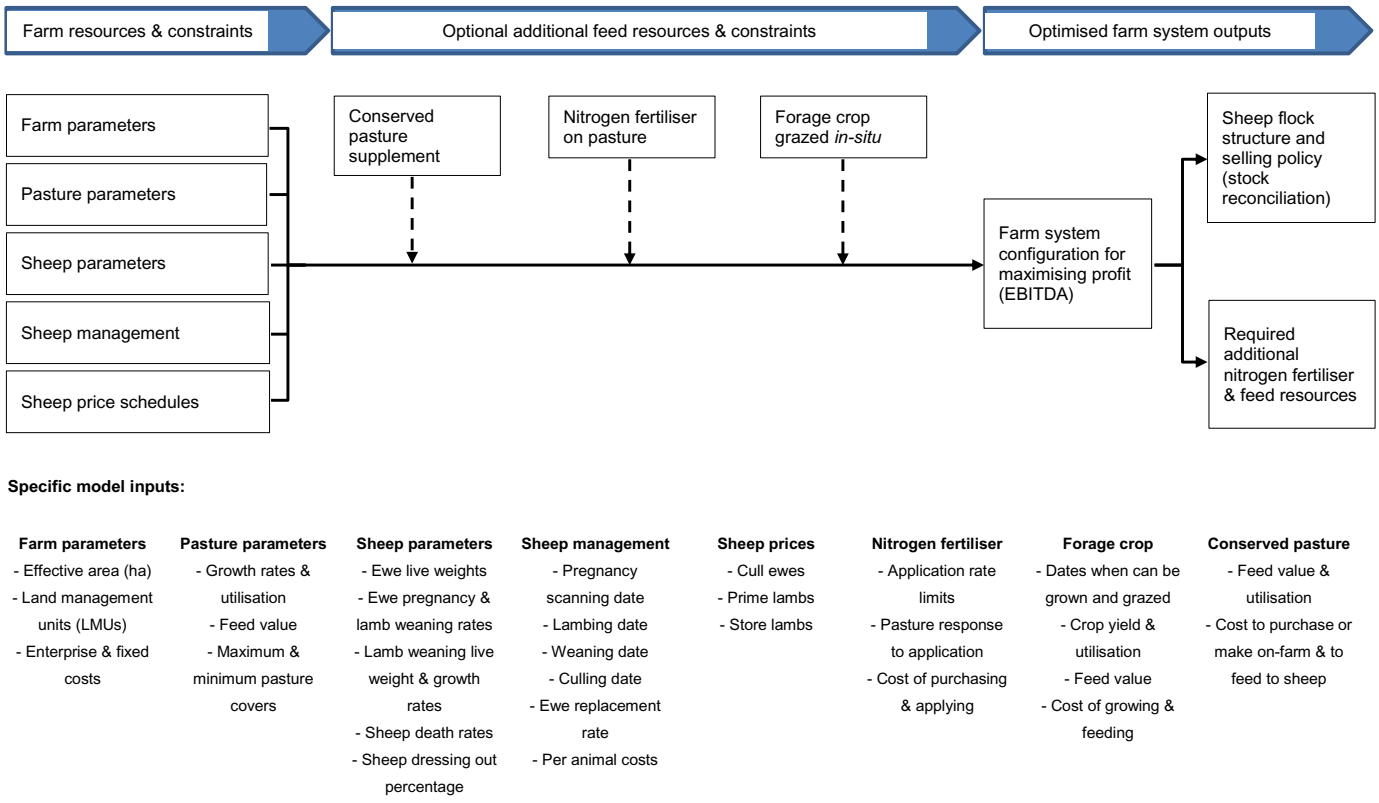

Fig. 1. Schematic diagram of AgInform® including key resources and constraints used in the bio-economic farm system model.

greater numbers of lambs born (NLB) per ewe lambing and a lower incidence of non-pregnant (barren) ewes. As 2 year olds, AP ewes gave birth to 20 extra lambs per 100 ewes, compared to NAP ewes, but this difference was not maintained in older ewes (Edwards et al., 2015). Other researchers such as Hulet et al. (1969) and Moore and Hockey (1982) found a similar effect and it has been suggested based on these results that attainment of puberty in the first breeding season of life could be a useful criterion to use when selecting replacements for a breeding-ewe flock to maximise reproductive efficiency and farm productivity (Edwards et al., 2015). In New Zealand, the vast majority (66–85%) of breeding ewes are mated for the first time at 17–20 months of age (Stevens, 2010; Morris and Kenyon, 2014), and thus for such farming systems the use of crayon-harnessed vasectomised (teaser) rams or other technologies such as blood sampling (Kenyon et al., 2012) would be required for identifying puberty attainment and is usually assessed when the ewe lambs are 7–9 months of age (Kenyon et al., 2014). A wide range of factors affect the timing of puberty onset including lamb age, live weight, nutrition, and genotype, and it is generally accepted that a ewe lamb will not attain puberty until it reaches approximately 40–60% of their mature body weight (Kenyon et al., 2014).

However, increases in reproductive performance do not always directly and linearly translate into increases in farm profitability (Amer et al., 1999; Byrne et al., 2012; Conington et al., 2004; Ludemann, 2009; Morel and Kenyon, 2006). Many interacting factors contribute to the profitability of sheep farms, which may counter the economic benefits of a change in any one factor (Morel and Kenyon, 2006; Young et al., 2010). The main benefits of selecting AP ewe lambs as flock replacements would be to produce more lambs for sale per ewe and requiring fewer breeding-ewe replacements as a result of culling of fewer barren ewes. Potentially countering these benefits, is that as the pregnancy rate of a flock increases so too does the incidence of multiple-bearing ewes (Amer et al., 1999; Davis et al., 1983), which exhibit higher mortality rates compared to single-bearing ewes (Byrne et al., 2012; Thomson et al., 2004). Additionally, Edwards et al. (2015) found that AP ewes in their first year of life were heavier than their NAP contemporaries and remained so throughout their lives. Heavier ewes producing more lambs require greater quantities of feed for maintenance and production (Nicol and Brookes, 2007), which imposes an additional cost on the whole farm-system (Morel and Kenyon, 2006). All of these interacting factors must simultaneously be taken into account when assessing the economic value of selecting AP ewe lambs as breeding-ewe replacements for a flock, which can be efficiently examined using bio-economic modelling of the whole farm system (Janssen and Van Ittersum, 2007; Young et al., 2014).

The objective of this study was to use bio-economic farm system modelling to assess: (1) the economic value of selecting AP ewe lambs as replacements for a breeding-ewe flock, and (2) the farm system changes required to maximise the economic value generated through adopting this breeding-ewe selection policy. This information will enable farmers and farm management consultants to evaluate whether adopting such a selection policy is economically worthwhile for a sheep farming business and demonstrates the changes to the farm system needed for extracting the most value when adopting this management practice.

The present study was based on a New Zealand sheep-breeding farm system, with sheep grazed outdoors all year round on temperate mixed-species pastures and forage crops, lambing occurred seasonally once a year in spring, and all young replacement breeding-ewes were first presented for mating as yearlings at 18–19 months of age. New Zealand sheep farms typically carry between 1 and 14 breeding-ewes per hectare, and have lambing percentages ranging from 86% (lambs tailed/100 ewes mated) on some extensive high country farms to > 140% on some intensive lowland farms (B + LNZ, 2016b). Annual ewe death rates are approximately 5% (B + LNZ, 2016b) and pre-weaning lamb mortality rates range between 10 and 15%, 15–20%, and 25–35% for single-, twin-, and triplet-born lambs, respectively (Morris and Kenyon, 2014). Fine (low-micron) wool is the primary product of many