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SEASONAL FLUCTUATION OF LIVESTOCK NUMBERS ON EQUINE STUD FARMS AND THE IMPACT ON MODELLING OF FARM LEVEL NITROGEN LEACHING

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Abstract

Overseer® is the primary software tool used to estimate farm level nutrient cycle and management for regulatory purposes in New Zealand. On Thoroughbred breeding farms, livestock numbers fluctuate seasonally, with an approximate doubling of the number of mares on the farm during the breeding season due to influx of non-resident breeding mares. At farm level this results in substantial fluctuation of feed demand and livestock numbers across the year. Currently, this fluctuation is not considered within Overseer® due to the inability for user to allocate equine stock class to grazing months, which can impact the feed demand estimations within the model. Previous modelling has demonstrated that even small over estimation of feed demand can significantly impact the nutrient intake estimation. Therefore, there is a need to identify simple correction factors for equine livestock numbers to account for seasonal variation associated with the thoroughbred breeding production system. Prospective data on livestock number and management were captured on a commercial Thoroughbred stud farm. The annual ME requirement of the farm was estimated using the livestock data captured and published data on equine energy requirement. To reflect Overseer input data, whole farm annual ME requirement was also estimated using the *equine*RSU (revised stock unit modelled using equine specific model) with and without adjustment for the seasonal fluctuation in broodmares numbers. To adjust for the seasonal fluctuation of broodmare and other livestock numbers, an annual stock total was generated using the weighted average of the monthly stock numbers. The model farm consisted of 116ha with 120 resident mares and 22-37 non-resident mares on farm between September – December thus a total of 140-155 mares on the farm during the breeding season (September – December). Twenty-four resident dry mares (non-pregnant mares) were grazed off farm between March – July. The total number of horses increased 1.8-fold from July-September. The estimated annual farm ME demand for equine livestock was 9490499 MJ ME. Failure to account for the seasonal fluctuation of broodmares resulted in the estimated ME being 29% greater than the true ME requirement. Use of the weighted average monthly stock numbers reduced the over estimation of ME demand to 6%. This modelling demonstrated that the seasonal fluctuation of horse numbers on commercial thoroughbred breeding farms can heavily impact the ME estimations which would result in overestimation of nutrient leaching and may provide unfair regulatory constraints on equine livestock management for this sector of the equine industry. This seasonal fluctuation could be easily accounted for in an Overseer® model by use of the weighted average of the monthly stock numbers in conjunction with the *equine*RSU. The horse number fluctuation over the breeding season observed on this farm reflected the 2-fold increase in mare stocking density reported

previously within the literature. However, the magnitude of the mare number fluctuations is expected to decrease with increasing farm size. Further data collection are required across farms of different sizes in order to determine whether a standard or a bespoke correction should be applied when the modelling nitrogen leaching on Thoroughbred breeding farms.

Introduction

In New Zealand, the majority of commercial Thoroughbred breeding farms and broodmares are located in the catchment under control of the Waikato Regional Council (WRC) (Rogers et al., 2016). It has been signaled that the WRC will require Thoroughbred breeding farms to calculate nitrogen loss using Overseer® by 2029. Early work by our group has identified potential overestimation of nitrogen loss by horses at a *per animal* and *per farm* basis with the current Overseer® input values (Chin et al., 2023)

Recent modelling has provided refinement of the revised stock units allocated to the different equine livestock classes (*equineRSU*) which should minimize the over estimation of nitrogen loss from equine properties at a *per animal* basis (Chin et al., 2023). However, there remains a difficulty in modelling the seasonal variation in stock classes and stock density on Thoroughbred breeding farms, particularly in association with the breeding season. Currently, this fluctuation is not considered within Overseer® as there is no feature available for users to allocate equine stock class to specific grazing months, which can impact the feed demand estimations within the model. Previous modelling has demonstrated that even a small over estimation of feed demand can significantly impact the nutrient intake estimation which can have subsequent effect on the nutrient excretion and leaching estimates within Overseer® (Chin et al., 2023). This is because the nutrient excreted is estimated based on nutrient intake and requirement, and nutrient excretion is a key input value for the nutrient leaching sub-model (Wheeler, 2018).

Therefore, the objectives of this study were to utilize historical Thoroughbred breeding farm production data (stock reconciliation and feed budgets) to deterministically test the biological plausibility of the *equineRSU* and application of simple stock number moderators within Overseer® to reflect typical stock fluctuations.

Methods

Livestock numbers and whole farm energy demand

Data on livestock numbers and management were captured on a commercial Thoroughbred breeding farm (116 ha) during the 2017/18 farming year (1st July -30th June). Data were captured prospectively with quarterly stock reconciliations and assessments of feed supply and demand via whole farm pasture plating and feed budgets. Where liveweights were not available, liveweight averages reported and the equations and methods for calculating daily energy requirement proposed in Chin et al., (2023) were used.

The farm aimed to maintain wet mares at 560 kg with approximately 10% increase in BW associated with fetal growth in the third trimester. Dry mares were kept at an average of 540 kg, and then had a rising plane of nutrition during the breeding season (August to November) to an average target weight of approximately 560 kg. Foals born between August and December and were weaned (minimum age of 4.5 months starting in March) at an average weight of 216 kg with target average daily gain (ADG) of 0.7 kg / day. Feed supply was

altered in October (at average target weight 295 kg) as management changed to increase condition of the yearlings for the yearling sales. During yearling preparation (October – January), target ADG was 0.24 kg/day.

Overseer® estimated feed demand.

To reflect Overseer® estimations, whole farm annual energy demand was estimated using the *equine*RSU (Chin et al., 2023) and the average liveweights presented in Table 1. The energy demand of a stallion is similar to a Sport horse (NRC, 2007).

Table 1. The *equine*RSU for Thoroughbred broodmares and young horses Chin et al (2023).

Stock class	***Liveweight (kg)***	***equine*RSU**
TB Dry mare	576±32.65	4.87
TB Broodmare and foal	576±32.65	9.21
Working horse		
Recreational horse light work	547±67	6.29
Racing TB	454±35.13	8.46
Sport horse	533±62.85	7.34
Growing TB 6-12 months	248±54.3 (6 months)	6.12
	365±54.3 (12 months)	

Initial calculations within Overseer® were based on the maximal number of horses on the breeding farm during the year (peak numbers during the breeding season). To adjust for the seasonal fluctuations the weighted average of the monthly stock numbers for each equine livestock class was calculated and tested within the Overseer® model.

Results

Stock numbers

The seasonal fluctuations in equine livestock numbers during the season are presented in Table 2. There were distinct seasonal fluctuations in the livestock class numbers, reflecting the increase in mare numbers during the breeding season (September to December), due to the return of dry mares (non-pregnant mares) wintered off the stud farm at a run-off and the arrival of outside mares to be bred to the stallions. Of the 65 foals born to mares owned by the stud (resident mares) 25 were sold at or just after weaning, 20 were sold as yearlings (in January) and the remaining 20 were carried over and sold the following season as 2-year-olds. These seasonal fluctuations effectively meant that the total number of horses on the property increased by 1.8-fold from July to November. Data from the stock reconciliation were then used to derive the weighted average seasonal stock numbers presented in Table 3.

Cattle and trading lambs were used to maintain pasture quality and consume the 30% of pasture on offer not utilized by horses due to selective grazing behavior (roughs).

Approximately 55 R2 steers were routinely fattened from February through to the start of the breeding season (August), with all steers sold by November. Approximately 800 trading lambs were carried over from December to May. These variables were held constant in all models testing the equine numbers in Overseer®.

Table 2. Typical equine livestock reconciliation table for a medium sized Thoroughbred breeding farm.

	Aug	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**
Broodmares (DRY)	22	22	22	22	24	24	24					
Resident Broodmares (in-foal/foal-at foot)	96	96	96	96	95	95	95	95	95	95	95	95
Non-resident Broodmares (in-foal/foal-at-foot)	2	22	37	37	21	6	6	5	2	0	0	1
All Foals	10	42	94	127	116	65	65					
Foals--Weanling								65	65	65	60	55
Yearlings	55	50	40	40	40	40	24	24	20	20	20	15
Race horses	9	9	9	9	9	9	9	9	9	9	9	9
Stallions	4	4	4	4	4	3	3	3	3	3	3	3
TOTAL horses	**198**	**245**	**302**	**335**	**309**	**242**	**226**	**201**	**194**	**192**	**187**	**178**

Table 3 Monthly weighted approach to adjust for seasonal fluctuation in stock numbers on commercial equine breeding farms.

Livestock class	**Peak monthly number of livestock class**	**(Number of months*stock number)/12**	**Weighted stock number**
Resident broodmares with foals	96	(96x4) + (95 x 8)/12	95

Resident broodmares (DRY)	24	[(22x4)+(24x3)+(0x5)]/12	14
Non-resident Broodmares (WET)	35	(35*4)/12	12
Weanlings	65	[(65x4)+(60x1)+(55x2)]/7	59
Yearlings	40	[(40*4)+(24*2)+(20*3)+15]/10	28

Impact of stock number on feed demand and models

The estimated annual energy demand for the horses on the breeding farm during the year was 9,490,499 MJ ME. The annual energy demand for the horses on the breeding farm based on the *equineRSU*, assuming maximal number of mares and that mare numbers remain constant during the year was 12,260,100 MJ ME, 29% greater than estimated from the feed budget. In contrasts, use of the weighted average monthly numbers for each class of equine stock was 10,073,565 MJ ME, only 6% greater than the feed budget values.

Discussion

The seasonal fluctuation of equine stock numbers, particularly the broodmare numbers, is an important factor for model accuracy when estimating ME and therefore feed demand (DM). At present in Overseer® Thoroughbred breeding farms cannot utilize monthly stock numbers, as would be the method of choice to model a trading farm, which is the closest farm model representing the seasonal fluctuations. The data presented indicate that simple moderators of annual stock numbers using the weighted average stock numbers could provide a simple and easily implemented moderator for Thoroughbred breeding farms to obtain realistic equine values.

The difference between the values derived from the weighted average stock numbers and actual feed budget is within the bounds of biological plausibility due to less precision with use of the weighted average, and the expected variation in the bodyweight of horses in the different stock classes from the model average. Thus, as an interim mechanism, the weighted average *equineRSU* for the different stock classes should provide input data within Overseer® that reflects the biology and systems involved with Thoroughbred breeding farms. Future work should examine if these moderators are farm specific or could be routinely used to reflect farm level fluctuations in stock numbers during the year.

References

Chin, Y. Y., Back, P. J., Gee, E. K., Horne, D. J., & Rogers, C. W. (2023). The quantification of Relative Stock Units for horses within a pasture-based production system. *Diverse Solution for Efficient Land, Water and Nutrient Use, Occasional report No. 35*.

NRC. (2007). *Nutrient requirement of horses* (6th ed.). USA: The National Academies Press.

Rogers, C. W., Gee, E. K., & Bowlwell, C. F. (2016). Reproductive production constraints within the New Zealand racing industry. *Proceedings of the New Zealand Society of Animal Production*, *76*, 146–150.

Wheeler, D. M. (2018). Urine patch sub-model. In OVERSEER® Technical Manual (p. 30). New Zealand: OVERSEER Limited.