Factors limiting the reproductive performance of New Zealand Thoroughbred stud farms

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Background: A major concern for the New Zealand Thoroughbred industry is a steadily declining foal crop over the last decade. A direct result is declining field numbers, which result in decreased betting turnover, decreased returns to owners and breeders, and a contraction in the number of people involved in the breeding and ownership of Thoroughbreds. Identifying factors that limit reproductive performance will increase the production of viable foals and improve the economic performance of the Thoroughbred industry. In comparison with other domestic species, the reproductive performance of horses is relatively low. This is in spite of significant technological advances in veterinary science, such as ultrasonography, ovulation inducing drugs, treatment for endometritis etc. over that time period. Given the value to the New Zealand economy of the thoroughbred industry ($1.4 billion), it is surprising that little work has been done in New Zealand to determine the basic reproductive performance of mares and to identify those areas in which wastage is greatest. The horse is a seasonal breeder, with the onset of normal, regular oestrous cycles occurring during the spring. Throughout the year, the annual cycle of reproductive activity of the mare is best defined as:

1. Spring/Summer – normal, regular oestrous cycles
2. Autumn Transition – transition from regular oestrous cycles into winter anoestrus
3. Winter anoestrus – no oestrous activity. The reproductive system is "dormant"
4. Spring Transition – transition from winter anoestrus to normal, regular oestrous cycles

The New Zealand and Australian Thoroughbred stud books have an "imposed" start of the breeding season of the 1st September, a time of the year when most mares are in the spring transition period. The transition period is associated with erratic oestrous behaviour, the growth and regression of ovarian follicles which fail to ovulate, and lasts between 60-80 days. The natural tendency of mares to produce one or more large anovulatory follicles during the transition period means that enormous amounts of time, effort and money are wasted in attempts to produce fertile breedings from these unproductive follicles.

Objectives:

1. To quantify the sources of reproductive wastage on New Zealand Thoroughbred stud farms.
2. To investigate intervention strategies that could potentially increase the number of mares conceiving as early as possible in the breeding season.
3. To develop a model for the study of ovulation failure in the mare.

A prospective cohort study is currently nearing completion involving five Thoroughbred farms and 2007 mares bred on 3800 cycles. The main "exposure variables" of interest can be broadly categorized into three areas; 1. farm-specific variables (mainly management effects), 2. mare-specific variables, and 3. stallion-specific variables.

Results: Initial analyses indicate that farm and stallion effects are minimal, and that by far the most important drivers of reproductive performance are mare-related variables. In particular, mare age, reproductive status (foaling or dry), foaling date and month of breeding have major effects on reproductive success. Of note is the effect that the length of the breeding season exerts over the number of foals produced. The New Zealand Thoroughbred breeding season is arguably the shortest in the world; breeders are reluctant to breed their mares beyond the first week of December, a decision driven presumably by the fact that the main yearling sales are held at the end of January, and later foals are at a growth disadvantage compared to earlier born foals. This results in a breeding season duration of about 95-100 days, compared with a breeding season of around 150 days in the Northern Hemisphere. Given the brevity of the New Zealand breeding season, the importance of breeding as many mares as early as possible in the season is

paramount. Mares that foaled before the 16th October were found to be three times more likely to conceive, and produce another foal, in the following season compared with mares foaling after the 16th October.

In the second phase of this research, a field trial was conducted to investigate the effects of intra-vaginal progesterone treatment on the reproductive performance of transitional Thoroughbred mares. Two hundred and twenty seven (227) non-lactating Thoroughbred mares aged between 4 and 18 years (mean 9.4 ± 3.2 years), located on three stud farms in the Waikato region of New Zealand, were used for this study, performed during four consecutive breeding seasons (2007-2010). On each stud farm, the reproductive tracts of all non-pregnant resident mares were examined by transrectal ultrasound between the 18th and 31st of August in each breeding season. Mares were selected for the study if they had been exhibiting oestrous behaviour continuously for at least 10 days prior to treatment, and the diameter of the largest follicle at any examination during this period was between 20 and 25mm. Selection of mares based on follicle size and oestrous behaviour was performed to ensure that they were in the transitional phase of the anovulatory period. Mares were age-matched in pairs, and alternately treated with an intra-vaginal progesterone releasing device (Cue-Mare®, 1.72g progesterone, 10% w/w) for up to 10 days (Treated; n = 126) or left untreated (Control; n = 101). Human chorionic gonadotrophin (hCG, 1667 iu IV) was administered when a follicle ≥ 35 mm was detected in conjunction with oestrous behaviour. Each mare was served by natural service 24-36 hours after hCG administration to one of nine different Thoroughbred stallions of proven fertility. Treated mares were served significantly earlier in the breeding season (mean number of days to first service 13.9 ± 0.3 days vs 26.7 ± 1.3 days for Treated and Control groups respectively; $P < 0.001$). In the Treated group, 95.2% of mares were served within the first 21 days of the season, compared with 42.6% of Control mares ($P < 0.001$). Treated mares conceived significantly earlier in the breeding season (mean number of days to conception 37.5 ± 3.1 days vs 50.8 ± 4.2 days for Treated and Control groups respectively; $P = 0.01$). There was no significant difference between groups in the first service pregnancy rates, which were 53.9% and 50.5% for Treated and Control mares respectively ($P=0.89$). Treatment with an intravaginal device significantly increased the number of mares conceiving by the end of the breeding season (91.3 vs 82.3% for Treated and Control groups respectively; $P = 0.04$). This treatment protocol appears to offer a convenient, economical and reliable method for managing transitional mares on commercial Thoroughbred stud farms.

In the third phase of this research, a study was conducted to investigate the condition of "ovulation failure" in the mare. In the mare, the most commonly described anovulatory condition is the development of haemorrhagic anovulatory follicles (HAF). The aim of this study was to determine whether transplantation of equine chorionic girdle (eCG) into non-pregnant recipient mares and the subsequent secretion of eCG by the trophoblast cells. would modulate the ovarian dynamics of the mares. Segments of chorionic girdle from day 34 conceptuses were transplanted into the vulval submucosa of four non-pregnant recipient mares. Three control mares were transplanted with allantochorion and one control mare was transplanted with serum-free media only. Mares were examined by transrectal ultrasonography bi-weekly for up to 105 days after transplant and serum samples for eCG and P4 assay were collected at the same time. No HAF formation occurred in the control mares. The diameter of follicles that became HAFs was smaller (30.9 ± 1.3 mm) than the diameter of follicles that ovulated normally in control mares (41.2 ± 1.9 mm; $P<0.001$). eCG and serum P4 concentrations were elevated above pre-treatment levels in all recipient mares. We propose that HAF formation in this study was a result of the exposure of follicles to eCG, produced by the trophoblast cells of the transplanted chorionic girdle. This method appears

to offer a model for studying the HAF syndrome in mares and possibly luteinized unruptured follicle (LUF) syndrome, a similar condition, in women.

Conclusion: The most important limiting factors appear to be the unique "shortness" of the New Zealand breeding season. Treatment strategies that ensure mares are cycling and are served early in the season have been identified from these studies. In addition, the development of a reliable model for ovulation failure in the mare will help develop strategies to treat and/or prevent this condition.