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Use of hormones on New Zealand dairy farms: an analysis of the results from a survey of farmers and a survey of veterinarians

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ABSTRACT

Aims: To survey New Zealand dairy farmers and veterinarians on their attitude and use of reproductive hormones in treating cows identified as non-cyclers. Whilst hormones have been identified as effective tools in assisting reproduction in dairy cattle, there is widespread but anecdotal concern about their cost-effectiveness and a lack of high-quality information on the attitude and practices around hormone use on New Zealand dairy farms.

Methods: Electronic links to separate farmer and veterinary survey forms were sent to all dairy clients and all veterinary employees of five, convenience-selected veterinary practices across New Zealand. Using closed, open, and Likert-style questions, the surveys covered cost-effectiveness of hormonal interventions, value judgements on their use, and impact on the public perception of dairy farming.

Results: Usable surveys were returned by 424 farmers and 70 veterinarians. Response rates are not known as denominator data were not sought. Of the farmers, 253/424 (60%) reported using hormone treatments, with 153 (36%) primarily using them before mating started. However, only 163 (38%) thought treatment was cost-effective, compared to 65/70 (93%) veterinarians. Beliefs around cost-effectiveness affected use: 8/171 (5%) farmers who never used hormones believed they were cost-effective, compared to 38/94 (40%) who used hormones occasionally and 117/159 (74%) who used them routinely. Other reasons put forward by farmers for not using hormones included "breeding infertility", "not natural", and "not treating the cause". Farmer and veterinary opinion also varied around the trajectory of hormone use. Amongst veterinarians, 12/70 (17%) thought use should decrease compared to 271/424 (64%) farmers, while 19/70 (27%) veterinarians thought use should increase compared to 21/424 (5%) of farmers.

Conclusions: The results suggest a disconnect around hormone use between the participating veterinarians and farmers. Many farmers did not believe hormone use was cost-effective, despite strong evidence to the contrary. As other reasons for not using hormones were also cited, and as most farmers believed hormone use should decrease, it seems unlikely that further education on cost-effectiveness will change practice. Rather, it could increase the proportion who think veterinarians benefit financially more from hormone use.

Clinical relevance: Veterinary focus on maximising synchronisation use and efficacy is bypassing a significant proportion of dairy farmers. There is an opportunity for veterinarians to focus on what their clients want and work with them to improve herd fertility without relying on hormones to fix management problems.

Abbreviations: AI: Artificial insemination; FTAI: Fixed time artificial insemination; GPG + P4: Gonadotrophin-releasing hormone, prostaglandin, and progesterone used in combination; P/AI: Pregnant after fixed time artificial insemination

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Knowledge; attitude and practice; synchronisation; non-cyclers; cost-effectiveness; reproduction

Introduction

In the early 2000s, multiple papers demonstrated that the fertility of the modern dairy cow was less than it had been (Royal *et al.* 2000; Lucy 2001; Harris *et al.* 2006), principally because of selective breeding for milk production, at the expense of fertility. Subsequently, an increased emphasis on fertility in breeding objectives has resulted in many countries showing an improvement in both phenotypic and genetic trends for fertility in dairy cows (Pryce *et al.* 2014; Haile-Mariam and Pryce 2019). Nevertheless, the relatively low heritability of fertility and its negative correlation with milk yield (Pryce *et al.* 2014), means it is likely to be a considerable time before the adverse effects of the decline in breeding values are fully reversed (Morton 2023). This has led to the development of alternative non-genetic strategies to try and maintain/improve reproductive performance.

This has been most obvious in the USA, perhaps because of all the major dairy-producing countries, it is probably the USA that saw the greatest fall in dairy cow fertility (Fricke and Wiltbank 2022). One of the

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key impacts was a reduction in the proportion of cows showing visible oestrus in early lactation (Veerkamp *et al*. 2003). This led to the development of the Ovsynch programme (Pursley *et al*. 1995), which synchronises ovarian function and ovulation, allowing the use of fixed time artificial insemination (FTAI) without oestrus detection.

The original impact of the Ovsynch programme (and other similar programmes) was to increase submission rate to artificial insemination (AI) (Carvalho *et al*. 2018). However, alterations to the Ovsynch programme, especially the development of pre-synchronisation programmes (Carvalho *et al*. 2018), has resulted in increases in the proportion of the cows which become pregnant after FTAI (P/AI), even to the point that P/AI can be higher in synchronised cows than in cows given AI after a standing oestrus (Consentini *et al*. 2021). This has led to such programmes being described as 'fertility programmes', as, despite only small improvements in genetics, their use has improved reproductive performance on many US dairy farms (Fricke and Wiltbank 2022).

Routine use of exogenous hormones is generally accepted by the US dairy industry and US veterinarians. However, it is likely that few US consumers are aware of this practice, and they would, if asked, see this routine use as problematic (von Keyserlingk *et al*. 2013). In Europe, it is clear that there is consumer concern (Pieper *et al*. 2016; Lund *et al*. 2023), which is reflected in rules around hormone use. For example, both the Arlagården Programme (Anonymous 2022), and the Royal Dutch Society for Veterinary Medicine (KNMvD 2021) recommend that, outside of embryo transfer, cows must not be synchronised unless it is as a treatment for a disorder diagnosed by a veterinarian.

This ambivalence towards hormone use is reflected in European research. For example, Wicaksono *et al*. (2023) found that, at the herd level, hormone use was associated with a reduction in the interval between calvings, and between calving and the first insemination but decreased P/AI. However, Wicaksono *et al*. (2023) focused not on improving P/AI by increasing hormone use (as would be the case in the USA) but on ensuring "prudent use of hormones". This reticence about routine synchronisation is reflected in a survey of UK veterinarians regarding the use of hormones in lactating dairy cows without reproductive pathology (Higgins *et al*. 2013). Many of the veterinarians surveyed had concerns about the use of hormones, with most tending to have a negative attitude towards the outcomes of using hormones and a positive attitude towards addressing the underlying causes of poor fertility. Nevertheless, most still believed that long-term routine hormone use in normal cows was acceptable, even if herds were not actively addressing management-related infertility, provided cows were not treated as soon as they became eligible for breeding.

The situation in New Zealand is different from the USA and Europe. The seasonal, pasture-based nature of most dairy farms in New Zealand means that there is significant pressure to maintain fertility, with cows that fail to get pregnant during the approximately 12-week breeding season usually being culled. This, combined with relatively low milk production, has meant that overall fertility in the New Zealand dairy cow has remained relatively high. For example, in recorded herds in New Zealand, the mean 21-day pregnancy rate has been approximately 40% for at least the last 10 years (Anonymous 2023), with the best herds achieving over 50%, whereas in the USA, a 21-day pregnancy rate of 34% is seen as exceptional (Carvalho *et al*. 2018). Nevertheless, synchronisation of large groups of cattle is very common because a high proportion of cows (approximately 20–30%) are not detected in oestrus before the start of the seasonal breeding season ('non-cyclers') (Rhodes *et al*. 2003). Treatment of these cows with a combination of gonadotrophin-releasing hormone, prostaglandin, and progesterone (GPG + P4) decreases the interval from the start of breeding to conception (McDougall 2010a). Furthermore, blanket treatment of all non-cyclers with GPG + P4 is recommended as veterinary diagnosis increases costs without changing treatment (McDougall 2010b). The most important risk factor for failure to show oestrus prior to the breeding season is time since calving (Rhodes *et al*. 1998), so many non-cyclers are cows with no reproductive pathology which have simply not had sufficient time to resume oestrous cycles. Thus, recommended practice in New Zealand is to use synchronisation, with no pre-treatment diagnosis, in approximately 20% of the herd, even though many treated cows will have no reproductive pathology. This is clearly different from the European-style, individual cow approach but does not go as far as the USA, as FTAI programmes are generally used in only some of the herd (i.e. non-cyclers) and their principal aim is to reduce calving to conception interval rather than improving P/AI (Herlihy *et al*. 2013).

There has been some limited pushback against the use of synchronisation programmes in New Zealand (e.g. Anonymous 2015). As far as the authors are aware, the principal issue for farmers is the up-front costs of the programme (even though the cost-benefits of the programme are very clear; McDougall *et al*. 2010b). These cost concerns are often reflected in statements from farmers that veterinarians promote synchronisation to increase veterinary income rather than improving farm profitability. However, we lack good quality, non-anecdotal information regarding the attitude and approach of New Zealand dairy farmers to hormone use in non-cyclers. Such information would be very useful in understanding why hormones are currently used in the way they

are on New Zealand dairy farms, and how they should be used in the future, especially if combined with a similar survey of veterinary attitudes and approaches.

The aim of this study was, therefore, to survey New Zealand dairy farmers and veterinarians on their attitude and use of reproductive hormones in treating non-cycling cows, and to use that data to evaluate whether current recommendations and usage around the role of reproductive hormones are meeting the present-day needs of New Zealand dairy farmers and whether it will be sustainable in the future.

Materials and methods

The study was evaluated by peer review and judged to be low risk and notified as such to the Massey University Human Ethics Committee (4000020445; Massey University, Palmerston North, NZ).

Two separate surveys were created: one for dairy farmers and one for veterinarians. Questions were compiled independently by a veterinary representative from Zoetis Animal Health (Auckland, NZ) and by veterinarians from VetEnt (Hamilton, NZ). These questions were broadly based on the approach of Higgins *et al.* (2013). Questions from both surveys were circulated to veterinary colleagues for comment, prior to the questionnaires being finalised. Each survey started with questions on the respondent's demographics, followed by questions relating to beliefs in relation to the value of using hormones to treat non-cyclers. The final section focused on the respondent's ethical beliefs around the use of hormonal interventions and how their use may affect perceptions of the dairy industry. Both surveys were designed to be completed within 15 minutes and to have a maximum of 25 questions. Once the design phase was completed, both surveys were collated onto Survey Monkey (San Mateo, CA, USA).

The surveys were sent out via Survey Monkey to five veterinary practices (three based in the North Island of New Zealand, one in the South Island and one in both). The practices were chosen because they were large multi-clinic practices so would have a large geographical and client spread. Within each of these practices, one employee was selected to be responsible for emailing the farmer survey link to all dairy clients, and to ensure that veterinary employees of the practice completed the survey. Farmers and veterinarians had 6 weeks to return the survey, with three reminders being sent during that period. Response rates could not be collected as data on the number of serviced dairy farms and veterinary employees was not sought.

Statistical analysis

Not all returned questionnaires contained completed answers to all questions. In these cases, the completed answers were used, thus the denominator for the analyses varied between questions. Where thought useful, RR (and associated 95% CI) were calculated as per Morris and Gardner (1988), and OR (and associated 95% CI) were calculated using logistic regression (binomial or ordinal depending on the number of outcome variables and with proportional odds checked for the ordinal outcomes, using parallel lines test). All analyses were undertaken using SPSS version 29 (IBM, Armonk, NY, USA).

Results

Farmer responses

The survey was completed by 427 farmers; however, responses of three farmers were removed due to data entry errors, leaving a total of 424 respondents. Demographic data are presented in Table 1. Of the 424 respondents, 264 (62%) came from the North Island. Most came from Waikato (n = 126), Taranaki (n = 70) and Northland/Auckland (n = 38). Of the 160 South Island respondents, most came from Southland (n = 70), Canterbury (n = 54) and Otago (n = 32). Across all respondents, median herd size was 440 (min 90, max 2,700) cows.

Hormone use to treat non-cyclers

Of the respondents, 253/424 (59.7%) stated that they typically used hormones to treat non-cyclers, with 159 reporting using hormone treatment every year, i.e. 37.5% of all respondents and 62.9% of respondents

Table 1. Demographics of the 424 New Zealand dairy farmer respondents to an online questionnaire on the use of hormones to treat cows that have not been observed in oestrus at the start of the mating period for seasonal pastoral dairy farms.

Demographic characteristic	Number (percentage) of respondents
Gender	419
Male	259 (61.8%)
Female	160 (38.2%)
Age	419
18–24	2 (0.48%)
25–34	94 (22.4%)
35–54	237 (56.6%)
≥ 55	86 (20.5%)
Role	424
Owner-operator	230 (54.2%)
Sharemilker	117 (27.6%)
Contract milker	35 (8.3%)
Manager	24 (5.7%)
Other	18 (4.2%)
Island	424
North Island	262 (61.8%)
South Island	162 (38.2%)
Herd size	424
<300	118 (27.8%)
300–500	125 (29.4%)
>500	181 (42.7%)
Milking frequency	417
Once-a-day	42 (10.1%)
Twice-a-day	350 (83.9%)
Other	25 (6%)

who used hormones. Of the 253 farmers who reported treating non-cyclers with hormones, 153 (60.5%) predominantly used hormones prior to the start of mating, rather than during mating. The respondent's role on the farm had a moderate effect on whether hormones were used to treat non-cyclers, with owner-operators being more likely to never use hormones than sharemilkers (100/230 *vs.* 37/117, respectively; RR 1.37; 95% CI = 1.10–1.86).

The sources of information on hormones used by the respondents are shown in Figure 1. Veterinarians were the most common source, with 218/398 respondents (54.8%) consulting their veterinarian regularly or all the time. Nevertheless, 44/398 (11.1%) respondents never consulted their veterinarian. Despite 144/424 (34.0%) respondents reporting that their veterinarian did not contact them prior to the planned start of mating, 348/424 (82.1%) were happy with the reproductive advice that their veterinarian provided. Nonetheless, veterinary contact prior to mating increased the likelihood that a respondent was happy with their veterinarian's reproductive advice (RR 1.14; 95% CI = 1.03–1.27).

To investigate respondents' motivations around when they treated cows with hormones, conditional question selection was built into the survey structure. Those who were open to treating cows before and during mating were asked to select up to six different reasons, and/or complete a free text response, for why they chose early treatment, and to select up to seven reasons for why they might also use hormone treatment after mating had started.

Those who only treated cows with hormones after mating had started, were only asked to select options from this latter list of seven reasons for delayed treatment.

Of the respondents, all 153 of those who reported predominantly using hormones before the breeding season detailed why they used hormones before the breeding season. The proportions of these 153 respondents choosing each option are shown in Figure 2. The two most common options were return on investment (112; 73.2%) and improving submission rates (94; 61.4%). Twenty-four respondents provided reasons for using hormones under the 'other' option. Thirteen of these respondents stated that using hormones before the breeding season increased the number of opportunities a cow would have to get pregnant during the breeding season (especially during the AI period), with a further five explicitly stating that it reduced the chance of a cow being non-pregnant at the end of the breeding season and one that it improved 6-week in-calf-rate. Five of the 24 respondents stated they used it to get cows pregnant earlier (improving calving pattern and increasing days in milk) – one of these respondents also stated it gave cows more opportunities to get pregnant. Two respondents (one of whom also stated that it increased breeding opportunities) commented that synchronising before mating started meant that management was easier as it avoided trying to organise synchronisation and AI at the same time.

Across all respondents, there were 154 responses to the question on motivations for use of hormones

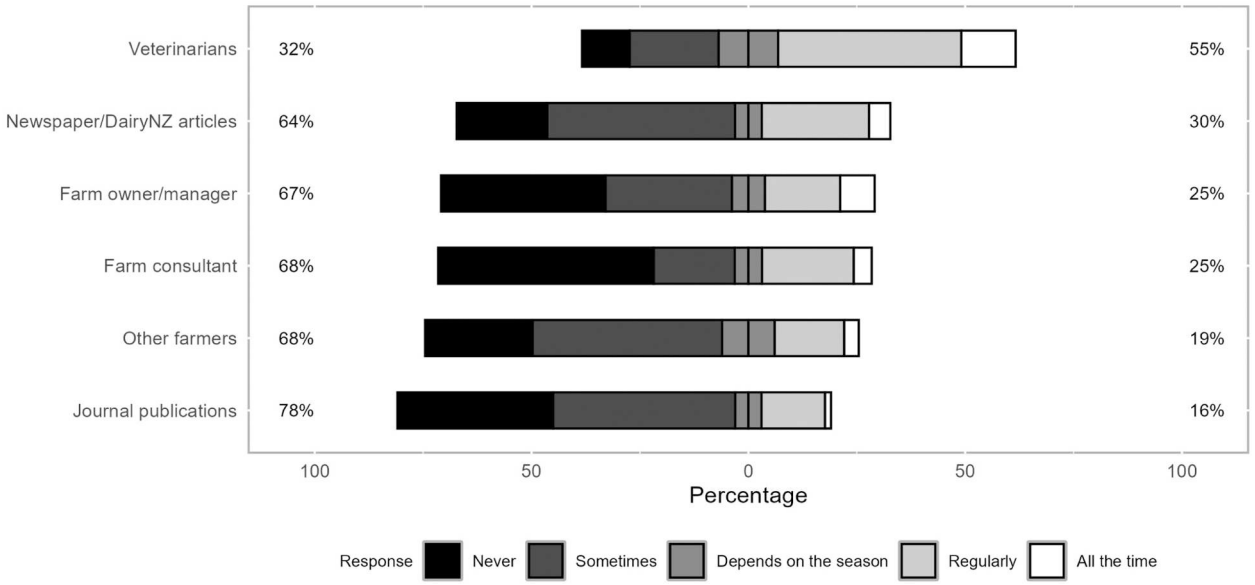

Figure 1. Likert chart showing the distributional frequency of usage for various sources of information by New Zealand dairy farmers when considering the use of hormones for cows not observed in oestrus (non-cyclers). The horizontal distance from zero along the x-axis represents the percentage of respondents in each of the categories. The percentage of respondents who use the source regularly or all the time is shown on the x-axis to the right of the zero, with the combined total at the right of each bar. The percentage never or sometimes using the resource, is shown on the x-axis to the left of the zero and the combined total printed at the left of each bar. The percentage of respondents whose source of information depends on the season is shown as a segment equally split about the zero line.

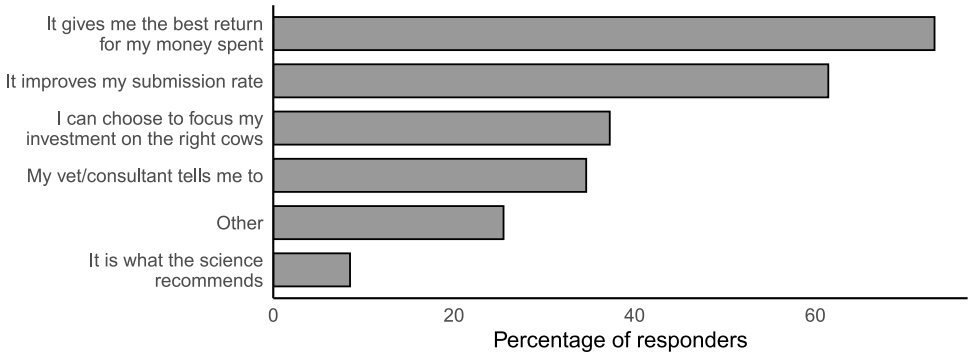

Figure 2. Percentage frequency distribution of the reasons cited by New Zealand dairy farmers (n = 153) for using hormones to treat cows not observed in oestrus before the start of mating (non-cyclers). Respondents could choose all the options they thought were applicable.

during the breeding season. Some of these responses came from respondents who only used hormones during mating, and some from respondents who also treated before mating had started. The proportions of these respondents choosing each reason for hormone use are shown in Figure 3. The two most common options were giving cows a chance to cycle (108; 70.1%) and waiting until mating had started before focusing on non-cyclers (67; 43.5%). Forty-four respondents (28.6%) chose saving money by treating fewer cows as a reason for treating non-cyclers during the breeding season.

Reasons for not using hormones to treat non-cyclers

Respondents who did not use hormones were asked why, using an open-ended question with no options provided; all 171 respondents who reported not using hormones provided at least one reason as to why they did not. The reasons provided by the respondents were categorised by the authors using seven categories: (i) cost (focus on the cost of treatment); (ii) effectiveness (focus on whether hormones work); (iii) not needed; (iv) breeding poor fertility; (v) naturalness; (vi) not treating the cause; and (vii) other. All relevant categories were recorded, so one respondent could be included in multiple categories. The proportion of the 171 respondents in each category are summarised in Figure 4.

The most commonly allocated category was 'breeding infertility', with 50 responses (29.2%). This category included reasons such as 'we don't want to breed from cows that don't get in calf', and hormone treatment 'allows cows with lower fertility to go through instead of being culled as empties, not being bred out of the herd'. Of the 50 respondents whose response included concern about 'breeding infertility', 20 were not included in any of the other response categories. Of the 30 whose response related to one or more additional categories, 10 were included in the 'cost' category, seven in 'not natural', and seven in 'not treating cause', while 'effectiveness' and 'don't need to' each accounted for five responses.

The second most commonly allocated category was 'cost', with 41 responses (24.0%) included in the category. Most respondents included only in this category just stated 'cost' with little elaboration, but 33/41 had responses that were allocated to additional categories. The most common additional category was effectiveness (10/41). Respondents who were allocated to both categories focused on cost-effectiveness, questioning both the cost of treatment and the return on investment; e.g. "the cost is too high and the success rate only mediocre" and "a lot of feedback I hear is

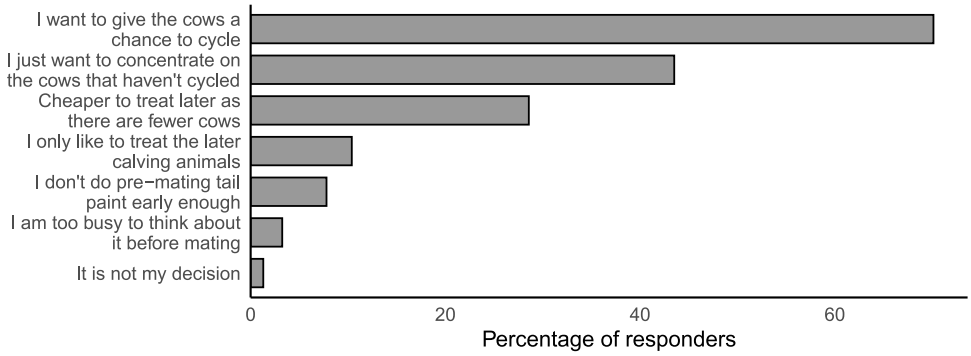

Figure 3. Percentage frequency distribution of the reasons cited by New Zealand dairy farmers (n = 154) for delaying hormone treatment of cows not observed in oestrus until the breeding season (non-cyclers). Respondents could choose all the options they thought were applicable.

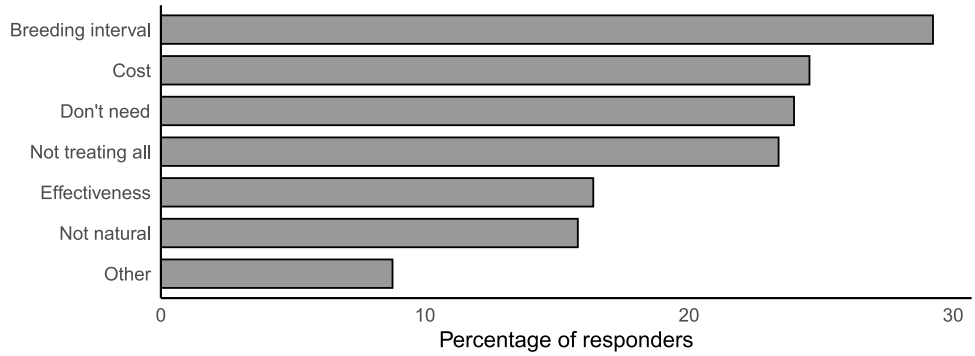

Figure 4. Percentage frequency distribution of the reasons cited by New Zealand dairy farmers (n = 171) for not using hormones to treat cows not observed in oestrus (non-cyclers) at any stage of the breeding season. Free text responses were analysed by the authors of this study and allocated to one or more of the seven categories displayed on the x-axis, so that one response could be allocated to multiple categories.

that return on investment is poor and results vary a lot".

Lack of effectiveness was the third most commonly allocated category, selected by 28/171 (16.4%) of all respondents. Of these, 18 had made a response that was only allocated by the authors to the effectiveness category. The focus of these 18 respondents was on hormone use not working. For most, this was based on personal experience – one respondent stated treatment "had not fixed our late or empty cows in the past" while one reported they had been involved in multiple trials which had not shown a benefit on days in milk or 6-week in-calf rate, and another that hormone treatments had been giving "poor results since the ban on oestradiol". Some respondents did cite research – e.g. "Dairy NZ research suggests that the effects are not long lasting and that it acts as a band aid for only one season".

Of the 40/171 (23.4%) respondents whose responses were allocated to not treating the cause, 23 specifically mentioned feeding, with comments ranging from "a well-managed and well-fed cow should be able to cycle without intervention" through to "we believe healthy, well-fed cattle should not need to be interfered with" and "they don't work, feed cow better". The comments of the 27/171 (15.8%) of respondents whose responses were allocated to the 'not natural' category included "it's against nature"; "if you interfere with nature then you end up with cows that have issues with getting in calf"; "I prefer to let nature run as much as possible"; and "I want a naturally fertile herd".

When specifically asked if hormone treatment of non-cycling cows was cost-effective for most dairy farmers, across all respondents, only 163/424 (38.4%) agreed. There did not appear to be an association between a respondent's role and their opinions on cost-effectiveness, with similar proportions of share-milkers and owner-operators stating hormone treatment was cost-effective (40/117 *vs.* 87/230 respectively; RR: 1.1; 95% CI = 0.82–1.50).

The association between the respondents' use of hormones to treat non-cyclers and their perceptions of their cost-effectiveness is summarised in Table 2. Of the 163 who thought hormones were cost-effective, 155 (95.1%) used hormone treatment at least occasionally, while of those who didn't think hormone treatment was effective, 116/162 (71.6%) never used hormone treatment. Very few farmers who reported using hormone treatment routinely believed it was not effective (9/159; 5.7%), and very few farmers who never used it believed it was effective (8/171; 4.7%). Interestingly, the proportions in both groups who were not sure of the effectiveness of hormone treatment were not markedly different (33/159 *vs.* 47/171, respectively; RR 0.76; 95% CI = 0.51–1.11). Farmers who reported using hormone treatment occasionally were much more likely to believe hormone treatment was ineffective than those who used it routinely (37/94 *vs.* 9/159; RR 6.9; 95% CI = 3.5–13.8), but, the proportions in both groups who were not sure of the effectiveness of hormone treatment were more similar (19/94 *vs.* 33/159; RR 0.97; 95% CI = 0.59–1.61).

In relation to who got the most financial benefit from the use of hormones, the most common response was pharmaceutical companies (175/424, 41.3%), followed by farmers (139/424, 35.7%) and then veterinarians (104/424, 26.4%). The association between the use of hormones to treat non-cyclers and perceptions of

Table 2. Cross tabulation of the use of hormones by New Zealand dairy farmers to treat cows not observed in oestrus at the start of the mating period (non-cyclers) and the beliefs held by these farmers about the cost-effectiveness of these treatments.

Do you use HTNC?	Is HTNC cost-effective?		
	Don't know	No	Yes
No	47	116	8
Yes – occasionally	19	37	38
Yes – routinely	33	9	117

HTNC = hormone treatment of cows not observed in oestrus.

who gets the most financial benefit is summarised in Table 3. Only a small majority of farmers who used hormones routinely (85/159; 53.5%) thought they got the most financial benefit. Nevertheless, farmers who used hormones routinely were more likely than the farmers who used hormones occasionally to believe farmers got the most financial benefit (85/159 vs 36/94; RR 1.4; 95% CI = 1.03–1.9) and very much more likely than farmers who never used hormones (85/159 vs 18/171; RR 5.1; 95% CI = 3.2–8.0).

For the likely impact of using hormonal treatment on overall herd fertility, there were 411 responses. Of those, 168 (40.9%) stated that hormone use would decrease herd fertility, 113 (27.5%) that it would have no impact, and 130 (31.6%) that it would improve it. For genetic gain (n = 407 responses), 206 (50.6%) thought hormone use would decrease such gain, 97 (23.8%) that it would have no impact and 104 (25.6%) that it would increase genetic gain. Farmers who used hormone treatment routinely had three times higher odds of reporting a better opinion of its impact on genetic gain than farmers who never used it (OR 3.04; 95% CI = 1.97–4.7) and a > 5 times odds of reporting a better opinion of its impact on overall herd fertility (OR 5.59; 95% CI = 3.6–8.66). Farmers who used hormone treatment occasionally were also more likely to have a better opinion of its impact on genetic gain (OR 2.3; 95% CI = 1.39–3.57) and overall herd fertility (OR 2.6; 95% CI = 1.59–4.24) than farmers who never used it.

Across all respondents 271/424 (63.9%) stated that they thought hormone use in the New Zealand dairy industry should decrease compared to only 21 (5.0%) who thought it should increase. Farmers who did not use hormones were more likely to believe hormone use should decrease than farmers who used hormones routinely (149/171 *vs.* 68/159; RR 2.03; 95% CI = 1.69–2.46%) Nevertheless, of the 159 respondents who routinely used hormones only 15 (9.4%) believed hormone use should increase.

Veterinary survey

This was completed by 70 veterinarians: 37 (53%) from the North Island and 33 from the South Island. Ten regions were included, with Waikato, Southland and Taranaki accounting for 69% of respondents and 19, 17 and 12 veterinarians, respectively. The median years practicing was 10 (min 1, max 41), and there was a relatively even split of male (n = 37) and female (n = 33) respondents. Of the respondents, 24 (34%) were shareholders/owners of a veterinary business, most were New Zealand graduates (55; 79%), and almost all (65; 93%) had a caseload that was > 50% dairy.

The median proportion of farms that veterinarians thought used hormones to treat non-cyclers was 60% (IQR 36.5–75%), with one respondent reporting none of their farms used hormones to treat non-cyclers and two stating that all their farms did. Farmer resistance to hormone use was stated as the principal reason why farms did not use them (61/70; 87%). Fourteen (20%) respondents stated that hormone use had increased in their practice, 7 (10%) that it had decreased, 33 (47%) that it had stayed the same, and 16 (23%) that they were unsure.

The median estimate of the proportion of all farms that started hormone use before the breeding season was 30% (IQR 15–40%). The equivalent figures were 25% (IQR 12–50%) for starting in the first 3 weeks of the breeding season and 10% (IQR 5–30%) for starting after 3 weeks or more.

The majority of veterinarians stated that when working with a herd that did not routinely use reproductive hormones and that had poor fertility, they would recommend the use of hormones most of the time (27/70, 39%) or sometimes (30/70, 43%). Fewer respondents reported always or rarely recommending hormones (9/70 (13%) and 4/70 (6%) respondents, respectively). In relation to farms which had poor fertility while also using hormones regularly, 25/70 (36%) stated that their aim would be to reduce hormone use, 12/70 (17%) that they would aim to increase use and 6/70 (9%) that they would not change hormone use. Twenty-seven (39%) recorded 'other' responses, including better investigation of the underlying problem (13/70; 19%), and better targeting of hormone treatment (e.g. using them earlier) (8/70; 11%).

In one section of the survey, veterinarians were given three potential reasons for recommending hormone use on farms and asked to identify the one they felt most closely summarised their own position. The most frequently chosen reason was "helping herds with poor reproductive performance" (38/70; 54%), followed by "helping herds with high reproductive performance to do even better" (14/70; 20%) and "keeping high reproductive herds at their current level" (10/70; 14%). Eight of 70 respondents (11%) answered "none of these options".

Veterinarians' opinions as to the key benefits of hormone treatment are summarised in Figure 5

Table 3. Cross tabulation of the use of hormones by New Zealand dairy farmers to treat cows not observed in oestrus at the start of the mating period (non-cyclers) and the beliefs held by these farmers about who gets the most financial benefit from this use.

Do you use HTNC?	Who benefits the most from HTNC?			
	Consumers	Farmers	Pharmaceutical companies	Veterinarians
No	2	18	96	55
Yes – occasionally	0	36	35	23
Yes – routinely	4	85	44	26

HTNC = hormone treatment of cows not observed in oestrus.

(more than one option could be chosen). More days in milk (69/70 respondents; 99%) and more compact calving (63/70 respondents, 90%) were by far the most common answers. Of the nine respondents who answered 'other', three mentioned more potential replacement heifers, two mentioned improved 6-week in-calf rate, and two mentioned cows calving earlier and therefore being more likely to stay in the herd.

Across the 70 veterinarians, 43 (61%) stated that they did not believe hormone treatment decreased fertility at the individual cow level, 10 (14%) that it did, and 16 (23%) that they did not know (one respondent did not want to state an opinion). However, when asked whether it affected genetic selection for fertility in the long run, of the 70 veterinarians, 22 (31%) responded that it would result in a decrease, 8 (11%) that it would improve it, and 40 (56%) that it would have no clear-cut effect. Thus, veterinarians were twice as likely to believe that hormonal treatment of non-cyclers would reduce genetic selection for fertility as to believe that it contributed to individual cow infertility (RR 2.2; 95% CI = 1.1–4.3). Nevertheless, most veterinarians (39/70; 55%) did not believe that it would reduce fertility either directly or through an impact on genetic selection.

Most veterinarians (43/69; 62%) stated that, at the herd level, the use of hormones increased herd fertility with 21/69 (30%) stating it had no clear-cut effect and 5/69 (7%) that it decreased it. Stopping hormone treatment of non-cyclers was thought likely to reduce fertility performance at the national level by 46/69 (65%) respondents with 8/69 (11%) suggesting it would improve and 15/69 (21%) that it would stay the same.

Of the 69 respondents who answered the question as to whether the frequency of hormone use should change, 12 (17%) thought it should decrease, 15 (23%) stay the same, 19 (27%) increase, and 10 (14%) that they did not know. Thirteen respondents answered 'other' to this question. Of these respondents, themes were principally around continuing to treat non-cyclers but reducing the number treated by better planning and management, but two respondents stated that frequency of treatment was a farmer choice. Veterinarians were much more likely to believe that hormone use should increase than the farmers surveyed for this study (19/69 *vs*. 21/424, respectively; RR: 5.56; 95% CI = 3.16–9.79).

When asked about the impact of hormone treatment on farm and veterinary practice profitability, 65/70 (93%) believed it increased farm profitability, and 63/70 (90%) that it increased veterinary practice profitability, and 60/70 (i.e. 85% of all respondents) believed it improved both. One respondent believed it decreased the profitability of both businesses, and 6/70 (7%) respondents that it had no impact on veterinary practice profitability. Of these six respondents who thought that hormone use was cost-neutral for veterinary businesses, five believed hormone use was financially beneficial to farmers and one that it decreased farm profitability. In response to the question: "Do you believe that the use of hormonal treatments for non-cycling cows is profitable?", 20 (27%) respondents stated it depends on the farm, 43 (60%) that it was profitable only when used before the planned start of mating, and one that it was profitable at any time. From the 70 respondents, six (9%) answered 'other' to this question; of these, five stated that use during the early breeding season was also profitable while the other stated that days in milk were important.

Discussion

As far as the authors are aware, this is the first survey of its kind in New Zealand. Our aim was to survey a spread of veterinarians and farmers across New Zealand. However, this was a convenience selection of both veterinary practices and farmers, as all dairy clients within a practice were eligible for inclusion in the survey. As responding was voluntary, this could mean that our farmer population was biased towards those with a more positive relationship with the practice, especially around reproduction and hormone treatment of non-cyclers, but it is also possible that

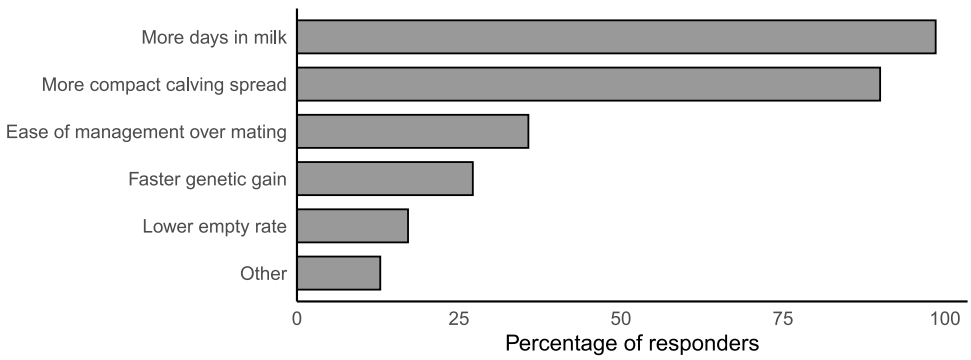

Figure 5. Frequency distribution of the key benefits selected by New Zealand veterinarians (n = 70) of using hormones to treat cows not observed in oestrus (non-cyclers) during the breeding season. Respondents could choose all the options they thought were applicable.

the sample was also biased towards farmers who were strongly against reproduction interventions. For veterinarians, we included only a small convenience sample of practices, so it is plausible that the responses of the veterinarians are more consistent than they would have been if we had sampled more practices, because of potential clustering of opinion around hormone use within individual veterinary practices.

Despite these potential biases, the usage of hormones to treat non-cyclers reported by farmer respondents, reflected the usage of hormones on farms reported by our surveyed veterinarians. We thus believe that this pair of surveys adds significant support to the hypothesis that there is a clear disconnect between most veterinarians and many dairy farmers in their perception of the value of hormonal treatment of non-cyclers. For example, in our survey population, 93% of veterinarians believed hormonal treatment of non-cyclers increased farm profitability, whereas only 38.4% of farmers thought it was cost-effective. Interestingly, this disconnect has occurred despite veterinarians being the principal source of information for farmers on hormone use (Figure 1) and key leaders in the development and on-farm use of reproductive programmes (Brownlie *et al.* 2011). This failure of veterinarians to persuade farmers that hormone treatment is cost effective is probably the principal reason why, despite strong evidence of the cost-effectiveness of hormonal treatment of non-cyclers under New Zealand conditions (McDougall 2010a), only 37.5% of all respondents routinely used hormones to treat non-cyclers, with slightly more (40.3%) never using such treatment. Beliefs around cost-effectiveness were strongly associated with the use of hormones, with almost all (95%) of the respondents who stated that hormone treatment was cost-effective using hormone treatment at least occasionally, whereas 72% of those who stated hormone treatment was not cost effective never used such treatment (Table 2). Intriguingly, this means that 28% of respondents who stated that hormone treatment was not cost-effective used hormones to treat non-cyclers on at least an occasional basis. Although most of these respondents (37/162; 23%) only used hormones on an occasional basis, 9/162 (5%) of the respondents who stated hormone treatment was ineffective still used hormones every year.

Although anecdotal reports had suggested that a significant proportion of New Zealand dairy farmers did not believe that hormone treatment was cost effective, the proportion of farmers in this survey who stated this (38.2%) was higher than the authors anticipated. As far as the authors are aware, this is the first published survey of dairy farmer perception of hormone use, so it is unclear whether this is a New Zealand-specific problem or whether there is a more general issue with dairy farmer perception around hormone use. The data from the US around the phenotypic trends for both days open and cow conception rate (Fricke and Wiltbank 2022) strongly suggest that farmer reluctance to use hormones is not an issue in the USA as the large improvements seen in those reproductive parameters would not have occurred without significant farmer buy-in to hormone use. The situation in Europe is less clear; routine hormone use is less common than in the USA but the changes in the rules around hormone use in dairy cattle seem to reflect consumer rather than farmer concern (e.g. Pieper *et al.* 2016). These data suggest that lack of farmer recognition of the effectiveness of hormones is a New Zealand-specific problem, but the speculative nature of these conclusions highlights the paucity of published data on dairy farmer perception of hormone use and demonstrates the need for more focus on what farmers want.

There is strong evidence for the efficacy of hormone treatments (McDougall *et al.* 2010a) but the evidence for their cost-effectiveness (McDougall *et al.* 2010b) is more nuanced. In a study which included 1,500 cows in three treatment groups across 12 herds, these researchers showed that the median time from the start of breeding to conception of cows treated with a GPG + P4 programme and mated on the first day of the breeding season decreased by 16 days, with a net benefit of NZ$80.40 per treated cow (a return on investment of approximately 3 times). However, for 50:50 sharemilkers, who pay the treatment costs but get only half of the milk income, McDougall *et al.* (2010b) reported a net return of only NZ$13.20. As sharemilkers are a major part of the New Zealand dairy industry, this difference in net return could be a driver of poor farmer perception of GPG + P4 programmes, but our survey identified that similar proportions of sharemilkers to owner-operators believed hormone use was cost-effective, and that sharemilkers were less likely to report never using such programmes than owner-operators.

Another potential difference between New Zealand and Europe/USA that may affect farmer perception of hormone effectiveness is that costs are concentrated at one point in time – immediately prior to the breeding season – whereas in the non-seasonal systems that predominate in much of Europe and the USA costs are spread over a greater period of the year. This concentration of costs focuses the farmer on the immediate high price of synchronisation rather than the final return on investment (most of which occur in the subsequent lactation). This issue may be reflected in the high proportion of farmers who use hormones to treat non-cyclers who only treat cows during the breeding season (100/253; 39.6%), as delaying treatment reduces costs, as fewer cows need treatment. Reducing cost was the principal reason that 17% of farmers who used hormones gave for waiting until the breeding

season, but giving cows a chance to cycle (42.5% of farmers) and waiting until mating has started before focusing on non-cyclers (26.4% of farmers) both reduce the number of cows that need to be synchronised and thus the up-front hormone costs. However, the evidence of the economic benefit of treating non-cyclers during the breeding season is very limited. On first principles, the benefit per cow is likely to be much less than treating before the start of breeding. Firstly, treating non-cyclers before the breeding season results in treated cows being inseminated 10 days earlier than untreated non-cyclers, an advantage which is lost if cows are treated during the breeding season (Laven 2019). Secondly, non-cyclers which then go on to display oestrus in the first weeks of the breeding season are likely to have inherently better fertility, on average, than non-cyclers which do not. Thus, waiting to treat non-cyclers will mean that the population of cows which are treated will have poorer fertility (on average) than the population of cows identified as non-cyclers before the start of mating, and thus (on average) a poorer response to synchronisation, reducing the cost-effectiveness of the treatment. As treating during the breeding season is a very common option for non-cycling cows, these assumptions need testing in large scale randomised control trials.

Nevertheless, the widespread use of hormonal treatment of non-cyclers during the breeding season without data to support it, clearly shows that maximising the economic return from synchronisation is not the key focus of many New Zealand dairy farmers. In part, this is because translating studies demonstrating economic benefits into on-farm positive outcomes is not simple, especially for a subject as complex as reproduction (e.g. McDougall *et al.* 2014), with factors such as availability of staff time, cash flow, opportunity costs and current (and future) milk price all influencing farmer choice. However, it is also because the reticence to use hormones is not just economically focused. For respondents who did not use hormones, cost was a significant issue for only 25% of respondents, but other concerns included breeding infertility (29%), not treating the cause (23%) and not being natural (16%). These additional concerns cannot be addressed by simply reporting the evidence. Even for breeding infertility, although hormone treatment of non-cyclers does not decrease empty rate (McDougall 2010a), and therefore does not increase the chance that an 'infertile non-cycler' will be kept in the herd, in the subsequent lactation season, cows treated with hormones in the previous lactation have poorer reproductive performance than cows that calved at the same time without hormone treatment (McDougall and Compton 2006). Hormone treatment is thus not fixing the problem. This is reminiscent of the debate around induction of calving, another hormonal treatment regime developed to manage fertility in New Zealand dairy cows. Research into the impact of inductions on reproductive performance (Compton and McDougall 2006, 2010) found that many farmers were inducing cows too late to get any economic benefit and tended to have less effective reproductive management than farms which did not use inductions. The parallels are clear – many farmers are using hormone treatment of non-cyclers too late to get a clear economic benefit, and anecdotally many farmers who are not using hormones have excellent reproductive performance. This begs the question as to whether we have replaced hormones at the end of the reproductive process with hormones at the beginning, without developing strategies to improve underlying reproductive performance to reduce the need for hormones. As was done for induction (Compton and McDougall 2010), a first step towards this would be to collect data on the reproductive performance of cows on farms that use hormones to treat non-cyclers routinely and to compare their performance with those who do not.

It might be thought that simply educating farmers better would resolve these issues, but this does not consider that education has not been effective so far and may not actually be an effective approach (Hötzel 2016). One of the issues limiting the value of education is that veterinary perception around the use of hormones is so different from that of farmers; e.g. 64% of farmers stated that hormone use should reduce (including 43% of those who routinely used hormones) compared to only 19% of veterinarians. Unless we meet farmers where they are, veterinary influence at an industry level is going to be limited.

This is exemplified by recent research into the use of hormones under New Zealand conditions. The focus of such research has been on increasing the use of hormones in non-cycler programmes in order to improve the response, i.e. moving towards an American model of synchronisation (subject to the limitations of New Zealand's seasonal breeding system, especially the short time between calving and the end of breeding, and the lack of labour on-farm). Additions have included the use of equine chorionic gonadotrophin (Beasley *et al.* 2023), a second prostaglandin injection 24 hours after device removal (McDougall *et al.* 2021), and a third prostaglandin 3 days before starting GPG + P4 (Anonymous 2024). These changes are very much driven from a veterinary perspective, with little focus on what farmers want. The results of our farmer survey (particularly the large-scale scepticism towards hormone use expressed by over two-thirds of farmers) suggest that adding more hormones (increasing cost and complexity) is unlikely to persuade farmers that synchronisation is cost effective (especially when one-quarter of farmers think veterinarians are already getting the most financial benefit from hormone use).

Our data suggest that despite New Zealand farmer scepticism, New Zealand dairy veterinarians (or at least the veterinarians we surveyed) are more in favour of hormone use than the UK veterinarians surveyed by Higgins *et al.* (2013); for example, in that survey 75% of veterinarians stated that they would like the use of hormones to decrease, compared to 17% in our current survey. This is reflected in the response of the veterinarians in our survey to underperforming farmers that are not using hormones – the majority would recommend hormone use most or all the time. Our survey also shows that the veterinary profession needs to do more to combat the impression identified in this survey that much of the veterinary focus around reproduction is on hormone treatments. Firstly, veterinarians need to be more proactive in assisting their clients to optimise their reproductive performance (34% of farmers in this survey were not contacted by their veterinarian before the planned start of mating), and, secondly, veterinarians need to shift their focus from hormones to reducing the need for them. If this is not done (and perhaps even if it is), there will be increasing scrutiny of the hormone-based approach favoured by New Zealand veterinarians to treat non-cyclers.

Conclusions

Reproductive hormones are powerful tools for improving fertility in dairy cattle. Indeed, as the US experience shows, mass hormone use can actually result in better fertility of cattle than natural mating. However, the opposite side of this approach is the general reluctance of the end consumer and/or dairy companies, as exemplified in many European countries, to support the use of hormones unless it is a treatment for a disorder diagnosed by a veterinarian. In New Zealand, we are in a unique situation where, at the start of the breeding season, a high percentage of cattle (approximately 20%), the great majority of which have no reproductive abnormality, need hormone treatment in order to be inseminated within the first 3 weeks of the breeding season. Nevertheless, many farmers, notwithstanding the published scientific evidence, perceive hormone treatment of non-cyclers as an expensive treatment programme with uncertain efficacy. Despite this, the focus of the New Zealand veterinary industry seems to be on increasing programme complexity and increasing hormone use. The limitations of the seasonal breeding season mean we cannot replicate the US-style system, but the veterinary focus on maximising the use of synchronisation programmes and optimising their efficacy is pushing us towards that system. An alternative is to look at the European system, where veterinarians and farmers are being moved towards a selective individual approach, similar to that currently used to determine the use of antibiotics at drying off, where every cow that needs treatment for an underlying problem gets it, but the focus is on reducing the number that need treatment. The dry cow analogy is a good one, as both dry cow antibiotics and synchronisation programmes require veterinary prescription, and therefore veterinarians should be taking the lead on the use of such programmes. Interestingly, whereas increased use of selective dry cow was not driven by farmer concerns (McDougall *et al.* 2017), the results of this survey show that a large percentage of New Zealand dairy farmers already want to reduce hormone use. The danger, particularly for an export-focused industry, is that if the profession makes the wrong choice, it could end up as it did in regard to the use of oestradiol and inductions (McDougall 2010a; Verkerk *et al.* 2010) where the decisions were made for veterinarians rather than by them.

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