Detecting the onset of heat fertility in purebreds using CIDR.

Interesting results, but still many unanswered questions!

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Artificial insemination is a growing interest among SEMPRQ member-breeders. In sheep, fixed-time artificial insemination requires that females be synchronized with hormonal techniques, such as CIDR, for ovulation to occur at a precise time. Coordinating the timing of heat and ovulation are essential to achieving favourable fertility results. But how do our breeds respond to these hormonal treatments? We cannot know when ovulation occurs. And what about the onset of heat behaviour due to the removal of the CIDR?

CONTEXT. Purebred sheep are the pillars of production in the Quebec ovine industry. CEPOQ estimates that the genetic progress made by purebreds in last decade generated economic benefits of $228,956/year for the industry (Fortin, 2018). Genetic selection is therefore profitable for producers and the industry at large. In order to accelerate its progress and further improve its financial impact, artificial insemination (AI) needs to be used more intensively amongst breeders. AI in sheep is more complex and expensive than in other species because it requires the use of laparoscopic techniques for frozen semen. While it is possible to inseminate females with fresh semen using natural means, this technique also involves significant costs for breeders (synchronization of females, harvests, semen preparation, etc.). Thus, for both insemination with fresh semen and frozen semen, it is essential to inseminate at the right time. Achieving decent fertility performance (>60%) is therefore necessary to justify the use of insemination and thus, justify more widespread use by breeders.

In recent years, significant research has been carried out by Université Laval researcher François Castonguay and his team. Heat synchronization protocols with CIDR and AI have been well studied in the Dorset, Romanov, and Suffolk breeds. In these studies, the Romanovs and Suffolks showed very interesting synchronization and fertility results, while the Dorsets showed poorer results. Moreover, the effectiveness of the CIDR technique had never been studied on other common breeds in Quebec's sheep genetic programme. Several reports from our breeders indicate very poor fertility performance when using AI with frozen semen, thus increasing costs. This was mainly the result of females exhibiting heat behavior much too late compared with the veterinarian's planned insemination schedule. These were important details to help determine whether technical adjustments were needed to the CIDR protocol, both among the Dorset and among breeds that had not benefited from such studies in the past.

OBJECTIVE. The main objective of this study was to determine the timing of heat in five sheep breeds subject to the protocol of heat synchronization with the CIDR, with a view to improving the reproductive performance of AI and thus contributing to the genetic progress of our sheep population. The results would make it possible to give recommendations to breeders wishing to improve their performance with the use of this technique.

METHODOLOGY. The experimental phase began on 8 October 2019 and ended on 18 March 2020 in participating sheep farms. The operational protocol was applied to five breeds influential in the Quebec sheep genetic pattern (HA, CD, DP, PO, RI). Fourteen sheep farms from different regions of Quebec participated in the study. A total of 588 ewes were subjected to conventional CIDR treatment (14 days and PMSG injection at

withdrawal, variable dose depending on the breed).[1] Twelve to fourteen hours after the removal of the CIDR, a ram vasectomized or equipped with an apron (preventing mating) was integrated with the females for the period of heat behaviour detection. The research team was responsible for recording the timing of the onset of heat behaviour in groups of ewes until 30 hours after the withdrawal of the CIDR. If females came in heat after this period, the breeders had to transmit the data to the research team. Thus, the time of the onset of heat behavior was noted for each female. The ewes in heat were then covered by a fertile ram, the choice being at the discretion of the breeder. Lambing data were sent by producers in the months following (data compilation ended in September 2020). The statistical analysis was carried out in the fall of 2020 by Frédéric Fortin, geneticist at the CEPOQ.

INTERESTING RESULTS ... BUT VARIABLE

In total, 22 females lost their CIDR out of a total of 588 ewes. This represents a loss rate of 3.5%, which is very acceptable. After removing the females who had lost their CIDR or those who encountered health problems, the results were analyzed on a total of 569 ewes, within the five breeds studied. **Figure 1** shows the distribution of the number of females by breed and by enterprise (non-nominative).

A total of 503 of the 569 ewes studied expressed heat behaviour following the removal of the CIDR. The frequency of females expressing heat behaviour was somewhat lower than expected, at 88.4%. It is generally expected that more than 95% of females exhibit heat behaviour with the use of this technique (Blais *et al., 2013, 2014).* However, significant variations were observed between races, but above all between sheep farms (**Table 2**).

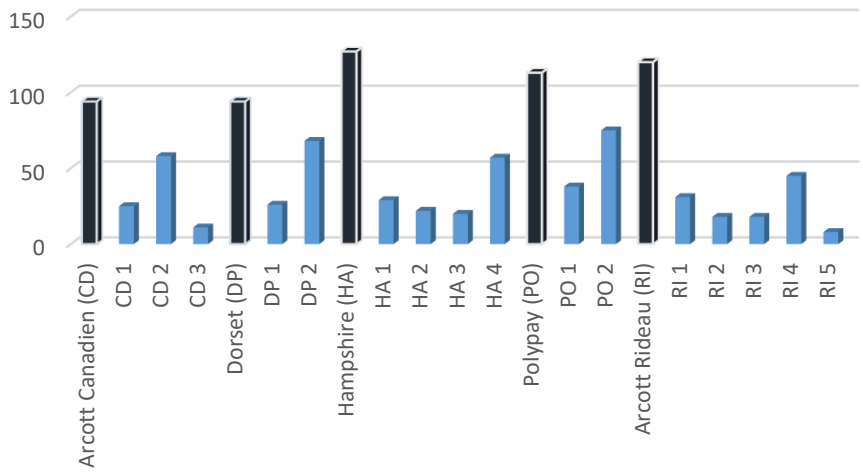

Table 1. Number of females by breed and by flock.

The Hampshire and Canadian Arcott terminal breeds have had the lowest proportions of ewes with heat following CIDR treatment. These averages were affected downwards by some flocks.

[1] Hampshire-HA, Canadian Arcott -CD, Dorset-DP, Polypay-PO and Rideau Arcott -RI

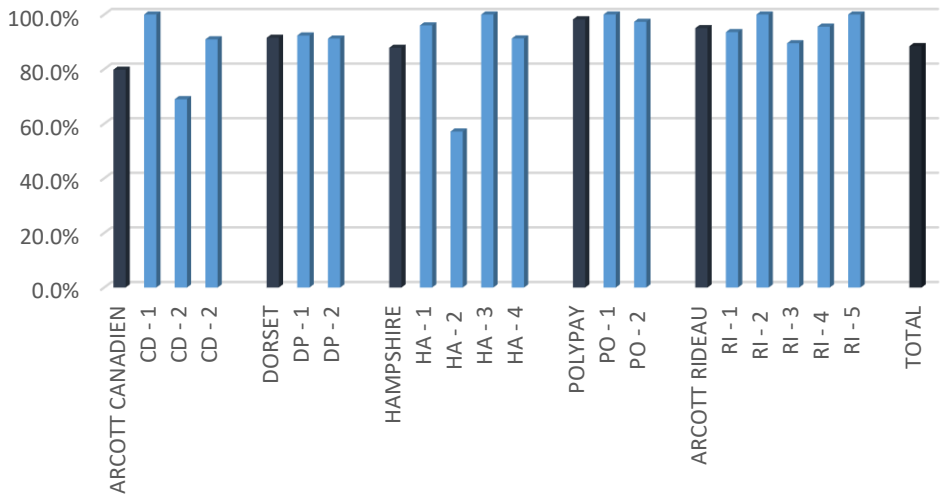

Table 2. Percentage of females in heat after CIDR treatment.

The main objective of the study, however, was to determine when heat behaviour appeared in the subjects studied. It is interesting to note that females expressed heat behaviour as early as 13 hours after removal of the CIDR. **Table 3** shows the distribution of the number of females (all breeds combined) having exhibited heat behavior as a function of time, after the withdrawal of the CIDR. Significant variations in the timing of the onset of heat behaviour were observed between breeds and between sheep farms (Table 1).

It should be noted that most of the females (73,7 %) came in heat within 24 hours of removal from the CIDR. During the 25–30 hour period following the removal of the CIDR, a total of 9.1% of females expressed heat behaviour. Thus, 82.8 % of females came in heat during the controlled period of detections. Within 30 hours of the removal of the CIDR, a small proportion of females were observed in heat by breeders, i.e., 5.6 %. Note that only 1.9 % of the study population developed very late heat, i.e., after more than 40 hours. It is obvious that females with such late heat behaviour are not good candidates for artificial inseminations at a fixed time.

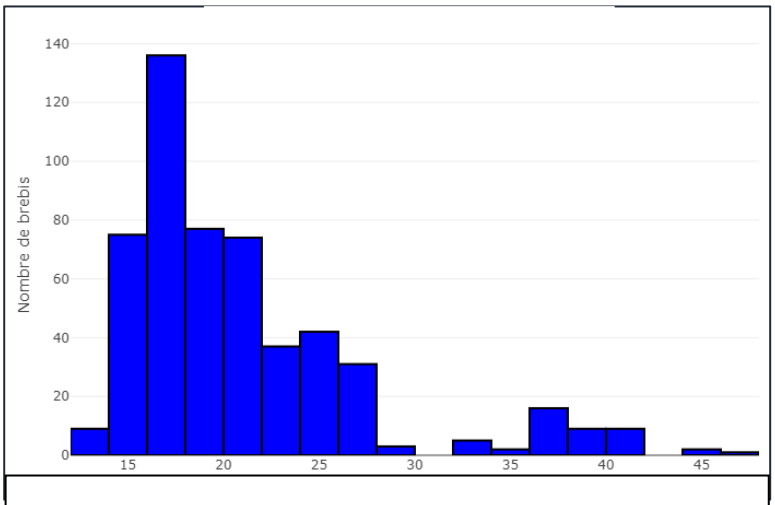

Table 3. Distribution of the number of ewes coming in heat as a function of the time interval between the removal of the CIDR and the onset of heat.

Table 1. Frequency of ewes exhibiting heat behaviour, time of onset of heat behaviour after removal from the CIDR (in hours), depending on breeds and companies.

Breed and Flock #	% heat on CIDR	Time of arrival in heat			Age of females			Body score		
		Average	Min	Max	Average	Min	Aax	Average	Min	Max
Canadian Arcott	**79,8 %**	**21,3 ± 6,0**	**15,3**	**39,8**	**3,1 ± 1,3**	**1,3**	**5,8**	**2,8 ± 0,4**	**2,0**	**3,5**
Flock 1	100,0 %	22,8 ± 4,7	17,8	39,8	2,9 ± 1,2	1,4	5,3	2,9 ± 0,3	2,0	3,5
Flock 2	69,0 %	20,7 ± 6,7	15,3	36,8	3,0 ± 1,3	1,3	5,4	2,8 ± 0,4	2,3	3,5
Flock 3	90.9%	21,2 ± 3,7	16,5	26,1	3,7 ± 1,2	2,5	5,8	2,3 ± 0,1	2,3	2,5

Dorset	**91,5 %**	**21,0**	**± 4,1**	**14,8**	**38,9**	**3,3**	**± 1,3**	**1,5**	**6,1**	**3,3**	**± 0,5**	**2,5**	**4,5**
Flock 1	92,3 %	20,0	± 3,4	16,1	26,8	3,1	± 1,3	1,5	5,5	3,0	± 0,4	2,5	4,0
Flock 2	91,2 %	21,4	± 4,3	14,8	38,9	3,4	± 1,4	1,5	6,1	3,5	± 0,5	2,5	4,5
Hampshire	**87,8 %**	**22,9**	**± 9,0**	**13,6**	**46,6**	**3,0**	**± 1,4**	**0,7**	**7,3**	**3,3**	**± 0,4**	**2,0**	**4,5**
Flock 1	96,0 %	24,5	± 7,2	15,8	37,3	2,9	± 1,9	0,7	6,7	3,1	± 0,4	2,3	3,8
Flock 2	57,1 %	16,5	± 1,8	14,8	20,0	3,5	± 1,6	1,3	7,3	3,1	± 0,3	2,5	3,5
Flock 3	100,0 %	20,1	± 7,6	14,1	46,6	2,3	± 0,6	1,6	3,7	3,2	± 0,3	3,0	4,0
Flock 4	91,2 %	25,6	± 10,5	13,6	44,7	3,1	± 1,2	1,1	5,6	3,4	± 0,4	2,0	4,5
Polypay	**98,2%**	**20,2**	**± 5,7**	**13,9**	**38,8**	**2,9**	**± 1,1**	**1,2**	**6,0**	**3,1**	**± 0,4**	**1,8**	**4,0**
Flock 1	100,0 %	25,0	± 6,4	18,0	38,8	2,9	± 1,0	1,2	5,2	3,1	± 0,4	1,8	3,8
Flock 2	97,3 %	18,0	± 3,4	13,9	26,5	2,9	± 1,2	1,3	6,0	3,1	± 0,4	2,3	4,0
Rideau Arcott	**95,0 %**	**17,6**	**± 2,4**	**13,9**	**27,1**	**3,0**	**± 1,0**	**1,5**	**6,3**	**3,1**	**± 0,6**	**2,0**	**4,5**
Flock 1	93,5 %	16,7	± 0,6	16,1	18,0	2,6	± 1,0	1,8	4,9	3,5	± 0,6	2,8	4,5
Flock 2	100,0 %	17,4	± 3,7	13,9	27,1	2,6	± 0,0	2,6	2,6	2,4	± 0,2	2,3	3,0
Flock 3	89,5 %	17,5	± 1,7	16,3	21,7	3,5	± 1,3	1,6	5,0	3,2	± 0,5	2,8	4,5
Flock 4	95,6 %	18,0	± 2,1	15,8	25,6	3,1	± 0,9	1,5	5,8	3,1	± 0,4	2,3	3,8
Flock 5	100,0 %	19,5	± 3,6	16,3	24,7	3,5	± 1,6	2,5	6,3	2,2	± 0,2	2,0	2,5

Although trends can be observed in some breeds, there were no significant statistical differences regarding the effect of the breed on the timing of the onset of heat behaviour after the removal of the CIDR. Breed/enterprise effects probably masked the differences that could have been observed between breeds. In this sense, the different management practices between breeders of the same breed shows an important bias on the interpretation of the data and does not permit a clear and significant portrait. A greater number of repetitions over time and over a wider population (by breed) would clarify the observations made in this study.

Although no significant differences were measured between breeds, our observations lead us to believe that females of the Rideau Arcott breed would respond more quickly to CIDR treatment. Indeed, in this breed, most of the females came in heat quickly and with little variation in time after the withdrawal of the CIDR. The results may be caused by the lower dose of PMSG administered to subjects of this breed. This hypothesis will need further investigation. It is not possible at this time to recommend reducing the dose of PMSG in our various Quebec breeds, since this hormone plays an important role in the time of ovulation and the rate of ovulation. A change in dosage could thus influence the fertility and final prolificity of the subjects. Studies to assess the effect of PMSG dosage within each breed population will therefore be necessary. This type of research study will help determine the optimal dosage (by breed), making it possible to contribute to an accuracy of the moment of heat, but above all to guarantee sufficient productivity.

In contrast to the observations made in the Rideau Arcott breed, the Hampshire terminal breed had the least favourable fertility performance, as well as the greatest variation in the time of heat in females after the removal of the CIDR. It is difficult to explain this phenomenon. However, it is possible that the selection of terminal breed subjects based on carcass growth and quality traits could affect reproductive performance, as the latter is negatively correlated. Although these animals are selected with the aim of producing high-quality lambs for the industry, the profitability of companies breeding these subjects is also dependent on the potential of their animals to reproduce easily, especially since the prolificity of these subjects is very low.

What about fertility? Lambing data from breeders were used to determine fertility on heat induced by synchronization with CIDR. **Table 4** shows these performances.

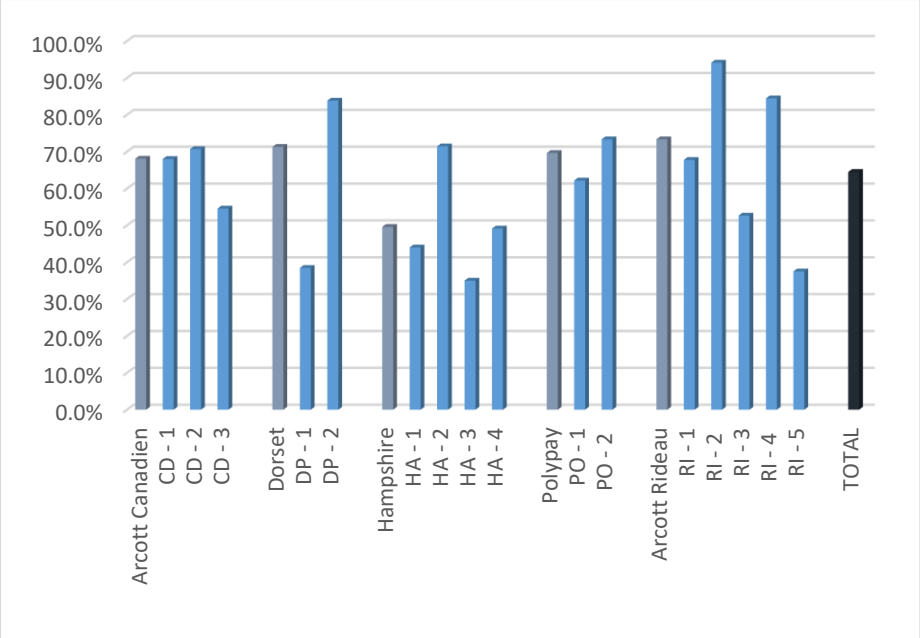

Table 4. Graph showing the fertility results at lambing as a function of the protrusion on heat induced by the CIDR. Data presented by flock and breed.

Overall, fertility on induced heat was 64.5% in the general population. Although variations in fertility can be observed between the breeds studied, there were no significant outcomes. Moreover, the timing of the onset of heat behaviour had no impact on the fertility performance of the females studied in the population.

Summary of results. This study makes it possible to highlight the impact of the age of the females, the number of lambings, the season and to a lesser extent the body score, on the timing of heat after the removal of the CIDR. Thus, females treated with CIDR during the breeding season, having had 2 to 4 lambings, aged 2 to 5 years and whose body condition is 3.0 to 3.5, came in heat more quickly (within 24 hours following removal of the CIDR). More importantly, the females came in heat in a more condensed way over time, which is desirable when using AI at a fixed time.

Additionally, we noted that fertility rates from heat induced by CIDR yielded favorable lambing results on farms where there was a shorter time lapse between the removal of the CIDR and the onset of heat behaviour. While the differences are negligible, these observations merit further study to determine if they have an impact during artificial insemination.

Since "age", "number of lambings", "season" and "body score" variables have significant effects on the outcome, this confirms even more that the season and the choice of females subjected to this technique are essential to obtain favorable results. Producers wishing to improve their chances of success in artificial insemination should apply the following recommendations:

1. Synchronize females during breeding season (ideally September to December).
2. Select females aged 2 to 5 years (inclusive).
3. Select females who have had 2 to 4 lambings without any recorded problems of dystocia.
4. Avoid including lambs, even if they are more than 1 year old and have reached a weight and development adequate for their breed.
5. Avoid females that have a body score greater than 4.0 and less than 2.0.

IN CONCLUSION ... While we have not yet finished unraveling the secrets of the sheep species as far as reproduction is concerned, this study raises interesting questions and provides food for thought that will enable further analysis. Most notably, determining the impact of PMSG dosages on the accuracy of timing of the onset

of heat. Producers of terminal breeds must also become more invested in the reproductive performance of their subjects. This is essential for profitability, but also for the effective use of AI.

Finally, more data is needed to better understand heat timing and fertility when synchronized with CIDR in Quebec sheep breeds. SEMPRQ is interested in compiling this information within a provincial database. Even if this data would not be collected during a research study where the parameters are "controlled", this information would improve our understanding of the effect of this hormonal treatment and thus, to continue our improvements!

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