

Use of light control to enhance reproduction in Québec

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Adapted from a presentation to the 2011 Profitable Flock Expansion Seminars held in Atwood and Napanee, Ontario in November, 2011.

Background

Improving the efficiency of out-of-season breeding and lambing is important for two reasons: (1) spreading lamb production over the entire year allows producers to meet the year-round demand by distributors and consumers; (2) increasing the total number of lambs produced each year should lead to greater profitability.

Photoperiod basics

- Seasonal variations in the length of the day determine the start and end of the breeding season in sheep;
- The length of the day is the most important environmental trigger of the breeding season in males and females;
- Long days (LDs) inhibit sexual activity, whereas short days (SDs) stimulate it;



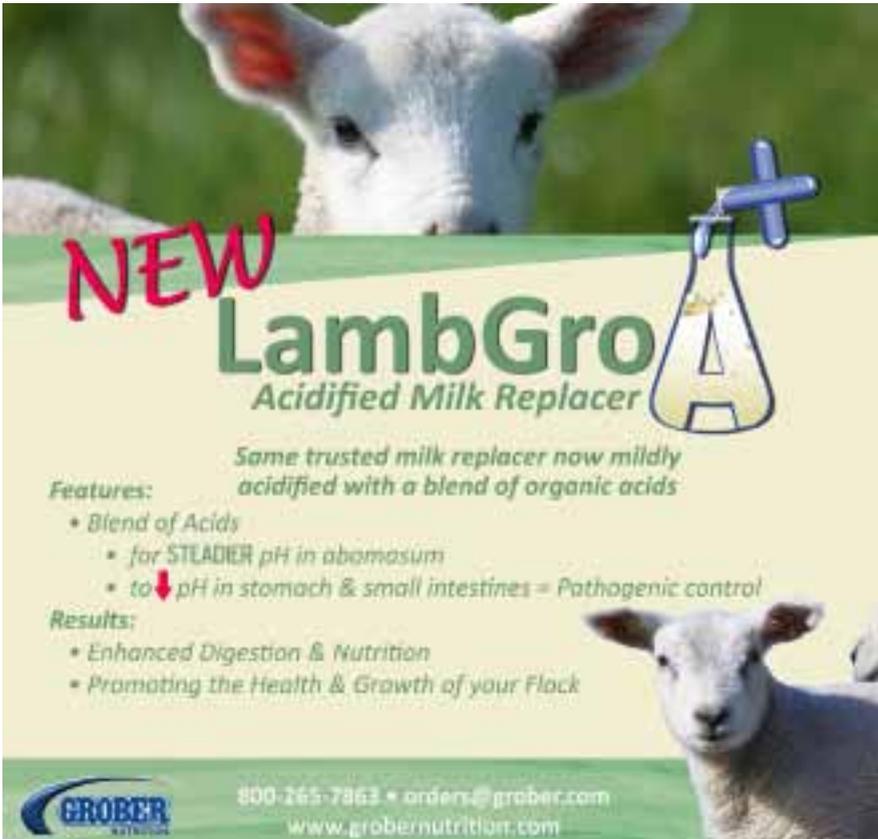
Front: Researchers Mireille Thériault, François Castonguay and Johanne Cameron. Back: Project cooperators and Rideau Arcott breeders Garry and Barbara Jack, Valcartier, Québec. Photo by Patrice Laroche, Le Soleil.



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- If animals are continually exposed to SDs or LDs, they become resistant to them;
- By alternating LDs and SDs, reproduction can be controlled in males and females;
- To stimulate estrus, SDs must be preceded by LDs;
- LDs serve to synchronize the reproductive system and sensitize it to the SDs;
- SDs ensure that the breeding season is long enough;
- Artificial changes to the length of the day make it possible to resume reproduction

at a time of year when it is naturally inhibited;

- A difference of at least six to eight hours of light is required between the LD and SD periods.

The 'conventional' program

A conventional program of light control consists of exposing a group of ewes to three months of LDs (16 hours of light) from November to February, followed by three months of SDs (8 hours of light). This technique is economical and generally has excellent results during spring mating, in addition to reducing the use of sponges in accelerated flocks. The investment required to adapt existing buildings for the use of this technique is usually minimal, unless the buildings are greenhouses (or Coverall buildings), or have open slatting or natural ventilation.

Despite the excellent fertility results obtained with the conventional

program, it has several drawbacks:

- For good results, new ewes cannot be added to a group, because these new ewes would not experience the full three months of LDs or SDs;
- Ewes under light control must be isolated from the rest of the flock. It is not possible to expose the entire flock to the conventional regimen, because the light control will have a negative effect on the fertility of ewes that are scheduled for natural breeding in the fall. A building, or part of a building, must therefore be set aside for the ewes under light control, where they will remain together for six months.
- Most farms will have only one building to isolate ewes, so it will only be possible to synchronize one group for one out-of-season lambing at

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Ewes lambing three times in two years were ultrasounded to monitor their body condition. Photo by François Castonguay.



a time.

- After the spring mating with light control, non-pregnant ewes may be slow to resume their natural cycle in the fall. This 'residual effect' results in a significant reduction in productivity;
- Rams subjected to light control for breeding in the spring may be less efficient in mating the next fall.

To be able to benefit from all the advantages of light control, without the disadvantages of the conventional program, a new protocol was needed. The ultimate goal was to control the length of the day for all ewes in the flock year-round, not just a single group of ewes for part of the year. With a view to meeting this new challenge, the AAFC type CC4 light program was developed.

AAFC type CC4

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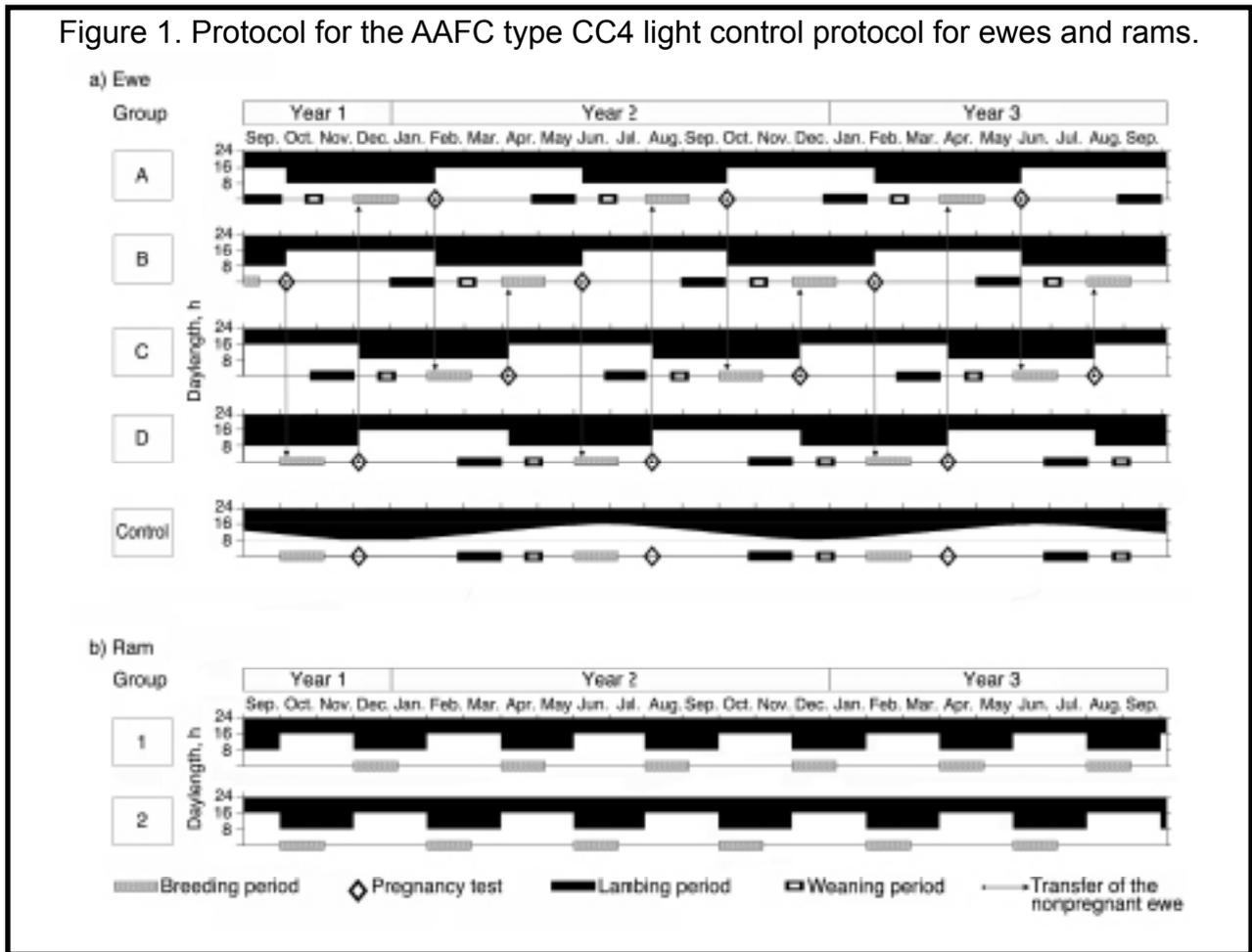
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Figure 1. Protocol for the AAFC type CC4 light control protocol for ewes and rams.



four-month treatment of LDs (16 hours) followed by four months of SDs (8 hours), alternating continually throughout the year. It is designed to obtain three lambings over two years for each ewe in the flock.

The main aspects of the AAFC type CC4 protocol are as follows:

- The period between lambing and mating averages 80 days;
- Ewes are dried off before being rebred.

- The start of the mating period is at the optimal time, 55 days after the SDs begin;
- Ewes lamb during the LDs, which facilitates flock management during lambings;
- Rams also receive light control preparation.
- Management procedures are included in the light protocol

(flushing, nutritional preparation before lambing, shearing, vaccination, etc.).

Figure 1 demonstrates the basic AAFC type CC4 protocol for ewes and rams. In order to have lambs born throughout the year, ewes are divided into four mating groups (A, B, C and D). Each group is exposed to

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four months of LDs, followed by four months of SDs, continuously throughout the year. In this way, lambing occurs approximately every two months, which allows for lambs to be sold year-round.

Mating periods last for 35 days, and begin 55 days after the start of the SDs. Lambing takes place during the LDs. The lambs are weaned around day 55 (day 40 to 75) and are then exposed to LDs in order to promote eating and growth. After one week of dry-off, the ewes are flushed. This flushing therefore begins two to three weeks before introduction of the rams, and ends when the males are taken away or the females have the desired body condition. As a result, the average time between lambing and mating is approximately 80 days (60 to 95 days). Each group of ewes is mated every eight months (three lambings in two years). Ewes that are open when scanned 75 days after ram introduction are sponged to reduce the period



A confinement barn typical of that used on the AAFC type CC4 light control protocol. Photo by François Castonguay.

of time they will be out of production. Rams are divided into two groups, which alternate between two months of LDs and two months of SDs. This quick cycle promotes testicular growth, semen quality and libido. By creating these two groups of males,

the four groups of females can be mated by alternating the ram groups each time.

One section of the barn is exclusively set aside for LDs while another is continually in SDs; the sheep are simply transferred from one section of

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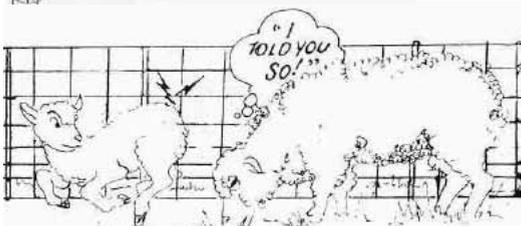
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the sheep barn to another depending on which daylength they are scheduled to receive.

This full-year regimen has the following benefits:

- All of the ewes in the flock are under light control, which improves the fertility and prolificacy of the entire flock;
- The residual effect discussed earlier is controlled by alternating the LDs and SDs of all ewes in the flock; the ewe environment is fully controlled, which makes it easier to manage reproduction;
- Ram fertility is maintained at an optimum level by alternating two months of LDs with two months of SDs;
- Spinging is minimal. The hope is to eliminate it by selecting the animals that respond best to light control treatment;
- Buildings are used optimally and areas of operation become highly specialized, facilitating management of the livestock operations and the work (lambing section, breeding section, fattening pen, etc.);
- Management procedures are known and planned well in advance. Management of smaller groups spreads the work out through the year.

Initial trial in a real barn, not a research station

The new regimen was first tried under commercial conditions between September 2001 and August 2003 at the Bergeries d'Amérique farm. The flock consisted of 248 purebred Rideau Arcott ewes and a dozen rams (Rideau Arcott, Suffolk and Texel). The main goal was to verify the effectiveness of the AAFC type CC4 program by comparing ewes in this program to a control.

The basic protocol described in the previous section was followed. Ewes under light control (n = 211) were separated into four groups (A, B, C and D). The control group of 37 ewes was left in natural light in another building, and mated naturally in season and synchronized with sponges during summer mating.

The AAFC type CC4 photoperiod protocol produced very good results in all groups throughout the year (Table 1; next page). The light control treatment led to excellent fertility in all groups bred out of season (91.9%, 90.7%, 88.2% and 88.0%, respectively, for groups A3, B2, C3 and D2). The lowest fertility was observed in group A2, when the sheep were mated at the beginning of their natural breeding season (69.1%). Marks left by the rams' marking harnesses indicated that more than 90% of females had an estrus during this mating period. The decrease in fertility may have been

caused by high temperatures at the time of mating.

Surprisingly, the control group also had good results (76.5%) when bred out of season (June). This may have resulted from the fact that the rams used to breed these ewes were subjected to light control, contributing to their fertility and libido.

Just to be sure!

Despite these extremely encouraging initial results, the new regimen still needed to be validated over a longer period and on a greater number of farms. Seven sheep producers from around Québec volunteered. The challenge was to put 2,400 ewes on the AAFC type CC4 program for two years. The effectiveness of this regimen could therefore be evaluated in a variety of environments with a number of breeds.

During the first meetings with the producers, it became evident that the basic protocol needed to be adjusted slightly to address constraints and make the program fit better with their goals, facilities, breeds and management. For example, some producers wanted to lamb slightly less often, to allow their ewes to recuperate more fully between lambings. Others expressed concern about moving ewes and lambs from LDs to SDs in the middle of lactation, either because of a lack of space in a warm, isolated building, because they didn't want to upset the ewes and lambs by moving them, or because of the difficulty in handling such young lambs.



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Table 1. Reproductive performance of ewes under the AAFC type CC4 photoperiod protocol (groups A, B, C and D) compared to that of ewes in natural light and treated with intravaginal sponges out of season (control).

	Mating groups in artificial photoperiod				Control
	A	B	C	D	
Mating period 1	Oct 23	Jul 27	Feb 6	Sep 29	Oct 15
Number of females	52	47	54	58	37
Fertility (%)	100.0	98.0	98.1	91.4	87.2
Prolificacy	2.37	2.35	2.88	2.79	2.14
Mating period 2	Aug 1	Apr 3	Oct 4	Jun 8	Jun 13²
Number of females	55	43	47	50	34
Fertility (%)	88.1	80.7	100.0	88.0	78.5
Prolificacy	2.63	3.18	2.83	2.87	2.31
Mating period 3	Mar 29	Nov 29	Jun 1	Feb 1	Feb 7
Number of females	37	35	51	40	25
Fertility (%)	91.9	88.6	88.2	95.0	78.0
Prolificacy	2.88	2.81	2.71	2.87	2.37

² Treated with intravaginal sponges

For these producers, the schedule was extended so that ewes would lamb every nine months (type CC4½; 135 LDs and 135 SDs) rather than every eight months (type CC4; 120 LDs and 120 SDs), as in the basic program. In flocks with prolific breeds, in addition to helping the ewes regain their body condition between each lambing, this method reduces and facilitates

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the moving of animals in buildings that are not as well adapted (weaning of lambs in LDs and moving of ewes only). In fact, in the type CC4½ schedule, the weaning and transfer of ewes to SDs are done at the same time.

Some producers preferred having larger groups of ewes, with births spaced further apart in order to have a breather between lambings, while others liked smaller groups lambing more often. Ewes in the participating flocks were divided into three, four or six mating groups. For the largest flocks (>450 ewes), six groups is preferable to decrease the number of ewes per group, which lessens the workload during lambings and reduces lamb death loss.

The length of the daily lighting period was also adjusted based on the schedules of each producer. It is important in a light control program that the difference between the length of the SDs and the length of the LDs be about eight hours.

Does it work?

The average fertility of females that underwent the two variations of the photoperiod program (CC4 and CC4½) was 88% (not counting females treated with sponges). Average



fertility was approximately 90% in mature ewes and 80% in ewe lambs. Results varied among producers and mating groups. Results were often lower during mating in the hot summer months, with the poorest results on farms where the environmental conditions in the SD buildings were the least favourable, because of a lack

of significant ventilation.

Not following the protocol also resulted in a few failures in the fertility of ewes, on one farm in particular, and in certain groups of ewe lambs. By correcting these minor transgressions, the levels of fertility were re-established in all cases. Fertility problems in the rams were also the cause of occasional poor results, in cases where ewes were mated to a single sire.

In theory, the two schedules used by the producers (CC4 and CC4½) allow for a lambing rate of 1.35 or 1.5 lambings per ewe per year. To achieve this theoretical rate, the success rate of the matings would have to be 100%,

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which is not realistic. Despite everything, use of the regimen led to an enviable production rate, with ewes on the program giving birth 1.24 times each year to an impressive 2.6 lambs each, compared to the average productivity of Québec flocks, which is 1.85 lambs born per ewe per year.

Yes, but what did the producers think of it?

The breeders indicated the following benefits: the flock's increased productivity; a consistent production of lambs throughout the year, which in turn stabilizes both cash flow and input costs; positive fertility rates obtained with the ewe lambs; better work organization through the use of a structured, set work schedule; constant workload that is spread over the year; specialization of buildings, making it possible to build permanent, stationary facilities (lambing and breeding always in the same location, etc.); improved work areas as a result of additional handling; and increased prolificacy of the ewes in some cases.

Several breeders spoke of the ewes' increased dietary requirements. Any increase in productivity inevitably leads to increased nutritional needs. Therefore, the overall observation that the ewes required quality feed in greater supply to maintain a healthy body is not a negative consequence of the light control program, but a sign of the success of this accelerated lambing regimen (AAFC type CC4), be-

cause most of the females had three lambings in two years. Consequently the nutritional needs of the entire flock grew unavoidably.

Some did not like the fact that the program led to a loss of productivity in the first year because the mating of some ewes had to be delayed to shift them ahead into one of the spring breeding groups. Medium-term planning for implementation of the regimen could, however, minimize these unproductive periods.

Some producers would have liked to put their ewes on pasture. This option, which is not out of the question, would need to be studied and validated. In the AAFC type CC4 system, the doors of the sheep barns cannot be left open for ventilation of the SDs sections. This constraint is seen by some as a problem. Seclusion during the SDs period inside the buildings, which in many cases are poorly ventilated, leads to high environmental temperatures and a decrease in comfort for the animals, which has a negative impact on fertility. The overall recommendation to have efficient ventilation in the sheep barns (temperature and humidity control) is really essential in this production system. One producer was able to pasture his pregnant ewes in the LDs part of the schedule, and these females were grazed from May to September (inclusively).

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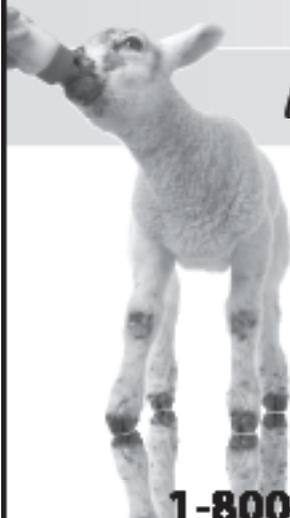
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Outcome of the AAFC type CC4 program

The initial experiment at the Bergerie des Amériques was validated by the second project on seven other farms. The success of the program requires a proper start to the light control schedule (start in the fall, respect for the natural cycle and daylength history of the females), exemplary management (feeding, mating preparation, use of marking harnesses, etc.) and full compliance with the protocol (ram introduction and withdrawal dates, weaning dates, dates for lighting changes, daily turning on and off of lights, etc.).

The decreased fertility rates observed during some summer months highlighted the importance of providing a comfortable environment for breeding. The feeding adjustments needed throughout the project also underscored the importance of closely monitoring and adjusting the diet of ewes in any accelerated lambing system.

By implementing the program in seven flocks, and despite some inflexibility in the schedule, we demonstrated that modifications to the number of groups and frequency of lambing can be made. This flexibility is important to the adoption of the program by producers.

After a first year of making adjustments (protocol, buildings, equipment, data collection sheets, permanent identification of animals, etc.), the farms that participated in the project continue to use the system with ease and, hopefully, with just as much success.

Conclusion on the AAFC type CC4 light program

The two main objectives, increasing flock productivity and producing lambs throughout the year, were achieved. Results show that the AAFC type CC4 photoperiod program is effective in controlling ewe reproduction and increases productivity by 20% to 30%. Fertility rates of more than 85% were obtained through the program for most mating groups, regardless of the time of year. The consistency of these positive results, despite the variety of environments in which the protocol was applied, is a good indicator of the program's effectiveness. The flocks' increased productivity results from increased fertility, but also the fact that the production schedule is rigid, which prevents producers from delaying the reproduction of certain groups without a valid reason. Better planning and structured work organization then enhances productivity.

That being said, this production system is not for everyone. Producers must be aware of the rigidity and conscientiousness required in establishing such a highly productive system.

In the next issue of Sheep Canada, the story continues with a new light control protocol to meet special needs: light extension.