Sheep Reproduction: Accelerated Lambing Systems

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Abstract
Most sheep are managed to lamb in the spring to take advantage of summer pasture for lactation. After weaning and a dry period, ewes are rebred in the autumn to lamb again in the spring. This seasonal lamb production can be evened out by accelerated lambing in areas where feed resources are not limited. Accelerated systems include lambing 1) twice a year; 2) three times in two years; 3) four times in three years; 4) five times in three years (the Cornell STAR system); and 5) six times in three years (the Cornell alternate monthly accelerated lambing system or CAMAL). Of these, the STAR is the easiest to manage and offers almost as much productivity as the CAMAL system, which is very difficult to manage because it violates sheep biology. An even more productive system that remains to be tested would place rams with the lambing flock during each 30-day lambing season. This would identify ewes that lamb early and rebreed quickly so that some ewes could lamb twice yearly in the STAR system.

INTRODUCTION
Sheep have been managed by herding since their original domestication about 12,000 yr ago.[1] The process of herding at least part of the year continues for many sheep flocks throughout the world, particularly in areas with sparse rainfall and vegetation. Traditional once-yearly lambing management is based upon the fact that most sheep are seasonal breeders with ewes bred once in the autumn to lamb in the spring to take advantage of summer pasture for lactation. In a few parts of the world, farmers specialize in dairy sheep management for cheese and other products. This article will discuss intensive management systems primarily aimed at lamb production.

HIGHLY PRODUCTIVE SHEEP MANAGEMENT SYSTEMS
Intensive management systems are associated with soil and climatic conditions that allow high feed production. In countries like the United States, where grains or their by-products are relatively inexpensive, forages are often supplemented with concentrate feeds to increase growth rates of lambs and to improve reproductive performance of ewes. Often, complete concentrate feeds with sufficient fermentable fiber are cheaper to feed during the winter months than forage preserved as silage or hay.

Highly productive sheep systems take advantage of the prolificacy and short gestation of sheep. Many sheep farmers select for twinning, and fertility genes have been identified that dramatically increase prolificacy.[2] Other farmers have also implemented accelerated lambing systems[3] under conditions that allow feeding ewes to maintain body condition year-round. Most sheep are seasonal breeders that respond to shorter daylengths by exhibiting estrus. Thus, accelerated systems require sheep that breed aseasonally, or use of light control, or use of hormones to induce estrus.[4] For best results, vasectomized (teaser) rams should also be used prior to the start of the breeding season to stimulate reproductive cycles through the "ram effect."[4]

The most economically feasible way to ensure that flocks can be managed for accelerated lambing is to select breeds which are known to lamb out of season and then to practice within-flock selection or to select rams from other accelerated-lambing flocks. Most of the equatorial breeds (mainly hair sheep breeds) have lost their dependence on day length to control the breeding season so that they may work well in accelerated lambing systems. The Dorset breed from England is one of the few developed in temperate regions which is known to breed and lamb out of season. Selection of Dorset breeding stock for an aseasonal-lambing flock must be done with caution, however, because many registered Dorsets in the United States are the result of crossbreeding with breeds—like Columbia—to meet the need for large size in the show ring instead of production agriculture. Traditional Dorsets or their crosses with other maternal breeds, like Finnsheep, have performed well in accelerated lambing systems.

Advantages of accelerated lambing systems include increased lambs sold per ewe per year and the availability of lambs to meet year-round market demands. Full-time labor, buildings, and equipment can also be used more efficiently.

In 1983, Magee described the development of a new accelerated lambing system from the CAMAL system.[5] It became known as the STAR system after Magee...
developed the diagram in Fig. 1. In 1987, after 15 yr of testing accelerated lambing systems, Hogue[5] summarized frequent lambing systems and concluded that the Cornell STAR system was the “production system of choice” (Table 1). Since then, the STAR—or some variation of it—has been adopted by productive sheep farmers and continues to be tested in many parts of the world.[6]

Selection for accelerated lambing since 1987 has not been intensive enough to develop a flock in which every ewe stays on schedule to breed at the first opportunity. Selection has been slow because accelerated lambing is composed of two traits, i) aseasonal breeding and ii) quick recovery to breeding after lambing. These traits, themselves, are composed of multiple biological traits. These include year-round estrous cycling, ovulation rate, conception, embryonic survival, and ability to consume sufficient feed to stay in condition for lactation and rebreeding. None of these traits is easy to measure so that selection in accelerated lambing flocks is based primarily on dam records of ram replacements, in which environmental variation makes up a large part of the phenotype so that genetic progress is slow.

Thus, given that a large proportion of the flock will not stay on an accelerated schedule, a clear advantage of the CAMAL and STAR systems is that ewes have more frequent opportunities to become pregnant than ewes managed under any of the other systems (Table 1). The CAMAL system was difficult to manage[5] so details of the STAR system will be discussed in depth.

**THE CORNELL STAR ACCELERATED LAMBING SYSTEM**

The Cornell STAR accelerated lambing system is diagramed in Fig. 1. Dividing the year into 73-day periods yields five half-gestation periods. Ewes are either in the

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**Fig. 1** The Cornell STAR accelerated lambing system.

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lambing and lactating flock or in the breeding and gestating flock so that there are only two management
groups. Perfect ewes will lamb every 7.3 mo and a flock composed entirely of perfect ewes can be balanced so that
only one-third of the flock is lambing during any period and two-thirds of the flock is in the breeding and gestating
period; the other half will be breeding at the start of the period. The fact that the entire flock does not lamb at
one time reduces the facilities needed for lambing during inclement weather (in northern or southern latitudes)
and—in flocks where lambing is managed intensively—the need for a large amount of labor at one time.

Lambs are weaned beginning at about day 70 of each STAR period. Prior to weaning and assuming the lambs
are adapted to creep feeding or creep grazing with water available in the creep, feed and water may be limited to the
ewes for two to three days to depress milk production yet allow the lambs to suckle to prevent udder engorgement
and reduce the incidence of mastitis.

A ewe that starts in the breeding group in period one stays in the breeding and gestating group
until she is found to be pregnant either by ultrasound at the end of period one or by udder palpation at the end of period
two. She then enters the lambing and lactating group and

The flow of animals through the STAR system is described in Fig. 2. A ewe that starts in the breeding group
in period one stays in the breeding and gestating group until she is found to be pregnant either by ultrasound at the end of period one or by udder palpation at the end of period two. She then enters the lambing and lactating group and

Lambs are weaned to pasture or to a complete mixed
concentrate diet. Because lambs can vary in age from 43 to
73 days at weaning time, there is a wide range of weights from each of the five lamb crops a year. Thus, lambs will
be available to fit the needs of any celebratory, ethnic, or
traditional market at all times of the year. This is an
advantage because buyers never have the opportunity to
discount their prices because lambs are “too light” or “too
heavy.”

The STAR system can be optimized to fit individual
flock management. The STAR can be rotated in Fig. 1, so that the first period can start on any of the first 73 days of the year. The diagrams in Figs. 1 and 2 are based upon coincident 30-day lambing and breeding seasons. Thus, the
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Table 1  Comparison of several frequent lambing systems and a normal once-a-year system of production

<table>
<thead>
<tr>
<th>Lambing periods per year</th>
<th>Common name</th>
<th>Lambing interval (months per cycle)*</th>
<th>Lambing opportunity (lambings per ewe per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>First</td>
<td>Second</td>
</tr>
<tr>
<td>1</td>
<td>Normal</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Twice yearly</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Three in 2</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Four in 3</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>STARb</td>
<td>7.2</td>
<td>9.6</td>
</tr>
<tr>
<td>6</td>
<td>CAMALc</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

*aAssumes ewes are grouped and moved to the next group if they do not conceive at one breeding.

bSee Figs. 1 and 2.
cCornell alternate monthly accelerated lambing system.

Source: Adapted from Butterworths (see Ref. 5).
there are about 150 days of lambing in a standard STAR system. In many flocks that use teaser rams, the three autumn breeding seasons can be shortened to 20 days, so that the number of lambing days is shortened to 120 days. If managing five lambing seasons a year interferes with other activities like family vacations, one or more of the STAR periods can be omitted.

Management of commercial STAR sheep does not require ear tagging or record-keeping. Udders of ewes in the breeding and gestating group are palpated near the end of each period to sort breeding and gestating ewes into the lambing and lactating group for the next period. Ewes should be shorn prior to one lambing each year, so if a ewe has more than a one-year fleece, she has not lambed in a year and is a likely candidate for culling.

CONCLUSIONS

Most sheep are managed to lamb in the spring to take advantage of summer pasture for lactation. After weaning and a dry period, ewes are rebred in the autumn to lamb again in the spring. This seasonal lamb production can be evened out by accelerated lambing in areas where feed resources are not limiting. The Cornell STAR accelerated lambing system, or a variation of it is the easiest to manage because it[5]: 1) does not violate sheep biology; 2) fits into the calendar year; and 3) simplifies management by making breeding and lambing dates exactly coincident. An even more productive system that remains to be tested would place rams with the lambing flock during each 30-day lambing season. This would identify ewes that lamb early and rebreed quickly so that some ewes could lamb twice yearly in the STAR system.

REFERENCES