



Best Practices to Increase Your Lamb Crop

Fact Sheets: Complete Set

Click on any of the Lamb Resource Center logos to return to the Table of Contents.

The 12 Best Practices to Increase Your Lamb Crop help sheep producers determine steps that are most likely to increase the number of lambs sold per ewe, which is a key profitability factor. This document contains all of the fact sheets. They are also available individually at www.LambResourceCenter.com.

Table of Contents

Review the following 12 topics at the page numbers indicated or be taken directly to a topic by clicking on it. To return to the Table of Contents, simply click on the Lamb Resource Center logo on any page.

- Best Practices to Increase Your Lamb Crop Overview 2**
- Optimal Nutrition 6**
- Breeding Ewe Lambs at 7 to 9 Months of Age 9**
- Select for Prolific Genetics 13**
- Use Crossbreeding 15**
- Culling Underperforming Ewes..... 19**
- Reduce Lamb Loss 23**
- Test for Pregnancy Status 27**
- Disease Prevention and Treatment 31**
- Match Reproduction to Management 35**
- Testing Rams for Breeding Soundness..... 39**
- Manage for Seasonal Changes in Reproduction 43**
- Accelerated Lambing Cycles 47**



Best Practices to Increase Your Lamb Crop

Introduction

The landmark American Lamb Industry Roadmap Project established productivity improvement as one of four goals which must be accomplished in order to strengthen the short-term and long-term competitive advantage of the American lamb industry and return it to consistent profitability.

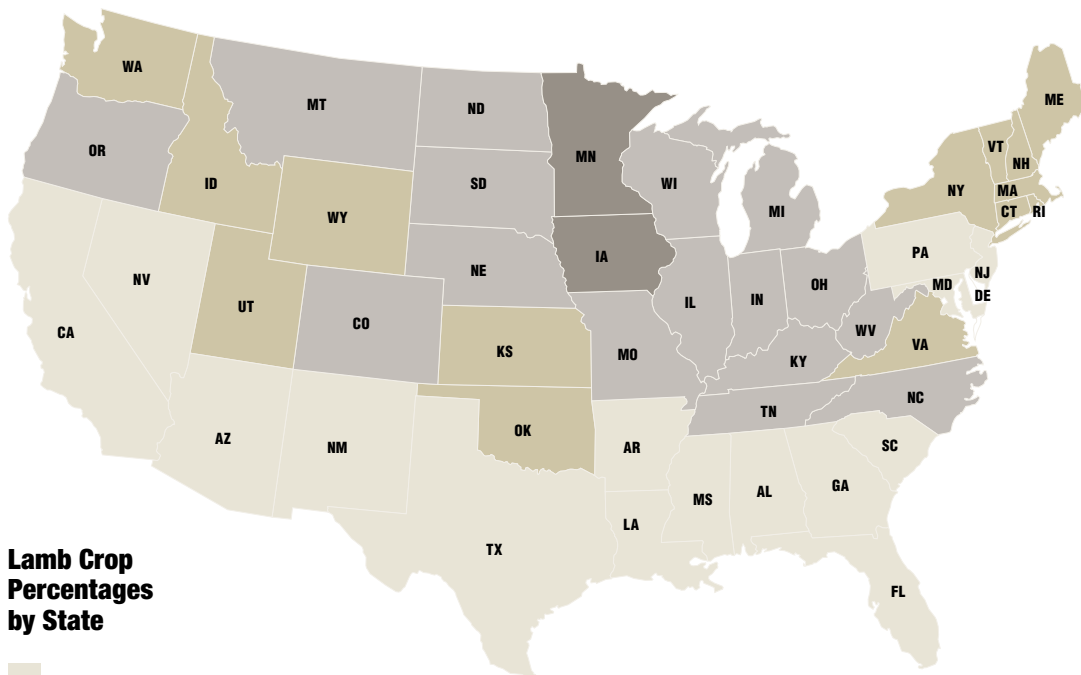
As demand is created for U.S. lamb, additional supply will be necessary. If there isn't sufficient domestic quantity and quality, demand could be filled by imported lamb. Increasing the reproductive efficiency of U.S. sheep flocks has been identified as the best way to meet growing supply needs. It also has a direct link to profitability.

This set of Productivity Best Practices, which focus on increasing the U.S. lamb crop, are based on sound research and time-tested practical experience. Because production methods vary across the U.S. and among producers within the same production system, not all of these "best practices" are applicable to a particular sheep operation. However, most sheep producers should be able to identify at least three of the 12 Lamb Crop Best Practices that will help them gain efficiency and improve profitability.

Each of the Lamb Crop Best Practices will be the focus of a more detailed fact sheet which will be available on www.LambResourceCenter.com during 2016.

Current Lamb Crop Production

PERCENTAGES BY STATE



Lamb Crop Percentages by State

- Less than 100%
- 100-124%
- 125-149%
- 150-175%

THE 150% CHALLENGE


According to the Roadmap Implementation Committee, the U.S. lamb crop will need to increase from 111% in 2014¹ to 150% by 2020 to meet anticipated domestic demand. Put another way, the national lambing rate will need to increase from 1.1 lambs per ewe to 1.5.

Based on lambs per 100 ewes as reported in the USDA National Agricultural Statistics Services Sheep and Goats Report (January 2015)

12 Lamb Crop Best Practices

- **Optimal Nutrition.** Prior to breeding, ewes should be fed a ration that puts them on track for appropriate weight gain. When breeding ewes, they should have a body condition score of 3 or slightly less. Throughout gestation, be sure to meet the nutritional requirements of your bred ewes. Following lambing and through weaning, maintain ewes on quality feed that takes into account factors such as the number of lambs they are rearing. At any stage of production, consider sorting ewes into groups based on body condition in order to allocate feed to dietary needs.
- **Breed Ewe Lambs at 7 to 9 Months of Age.** If managed properly, ewe lambs should be able to lamb at or near their first birthday. Ewes that give birth to their first lamb before they are yearlings tend to be more productive throughout their lifetime compared to those that first lamb as yearlings. When considering this best practice, keep in mind that different breeds of sheep vary in age of puberty.
- **Select for Prolific Genetics.** Select for prolific genetics within rams that produce offspring you will be considering for replacements. Similarly, replacement ewe lambs should be selected from high performing dams. Estimated breeding values (EBVs) produced by the National Sheep Improvement Program (NSIP) are an excellent tool to accomplish this goal.
- **Use Crossbreeding.** First-cross lambs tend to have a 5% higher survival rate than straight-bred lambs, given that genetics are matched with environment. In addition, first-cross ewes tend to have higher lamb crops than purebred sheep.
- **Cull Underperforming Ewes.** Identify and cull ewes that fail to rear a lamb, rear a single-born lamb that is below average in quality and/or weight, fail to rear twins, or lamb outside the first or second heat cycle. Exceptions may be made for reasons outside the ewe's control.
- **Reduce Lamb Loss.** Postnatal lamb loss should be kept below 10% of all lambs born. Identify best management practices for flock health, predator prevention, protection from severe weather conditions, and other factors that will improve lamb survival. Most non-predator lamb loss occurs within the first week, so management decisions during this time period can have large impacts on flock profitability.
- **Test for Pregnancy Status.** Determine pregnancy status via ultrasound. Cull open ewes or market ewe lambs prior to lambing season. Group and feed ewes according to the number of lambs they are raising and stage of pregnancy.
- **Disease Prevention and Treatment.** Work with your veterinarian or consultant to develop an overall health management plan to prevent or eradicate disease, such as aborting agents or chronic disease, which have a negative impact on reproductive efficiency.
- **Match Reproduction to Management.** Your goals for flock reproductive efficiency will vary depending on nutritional and labor resources. However, increasing reproductive efficiency should be a primary goal for most flocks.
- **Test Rams.** Don't overlook ram fertility. Check all rams using a general breeding soundness exam 30 to 60 days prior to breeding. Semen test all rams, or at least any rams that are suspect following a physical exam. Observing rams for breeding activity is another consideration.
- **Manage for Seasonal Changes in Reproduction.** Pregnancy and lambing rate are reduced in ewes that are bred outside the normal breeding season. Ovulation rates peak during October and November in the northern hemisphere. Genetics, improved nutritional management, ram effect, light treatment, and/or hormone therapy can assist in meeting aseasonal breeding goals.
- **Accelerate Lambing Cycles.** For flocks with management practices which allow for more than one lambing season per year, accelerated lambing can improve reproductive efficiency. There are multiple accelerated lambing programs. Identify the program that fits your flock and resources.

New Lamb Resource Center



The new Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.



Which Best Practices Will Benefit You?

Reproductive Key Indicators have been developed to help you identify and prioritize which of the Lamb Crop Best Practices you should implement. These key indicators are generalized, yet realistic, goals for both range and farm flocks so that you can assess which best practices will be of greatest value to you. Levels are included for high and low input flock management.

- High input flocks have these characteristics:** shed lambing, herded, multiple management groups, strategic supplementation and improved pastures
- Low input flocks have these characteristics:** range/pasture lambing, fenced pastures, simple management groups and limited supplementation

First, identify which Key Indicator(s) you need to improve. Then, refer back to the Lamb Crop Best Practices and pinpoint which ones you need to adopt in order to reach your flock goals.

Reproductive Key Indicators^a

KEY INDICATOR	RANGE FLOCK		FARM FLOCK		MY FLOCK	
	High Input	Low Input	High Input	Low Input	Current	Goal
Dry Ewes	< 7%	< 10%	< 5%	< 7%		
Lamb Crop						
Born	150%	NA	200%	175%		
Docked	NA	120%	NA	NA		
Lamb Losses^b	15%	17% ^b	11%	15%		
Lambs Weaned	127%	100%	178%	148%		
Ewe Lambs Lambing	50% ^c	30%	85%	65%		

a Data for the Key Reproductive Indicators were generated by the Reproductive Efficiency Task Force based upon research, surveys and industry experience

b Lamb losses between docking and weaning

c Generally, ewe lambs are not bred in range flocks but this may provide a great opportunity to increase overall productivity

What are Best Practices?

A best practice is a **technique** or method that, through **experience** and research, has proven it will reliably **lead** to a desired result. A **commitment** to using best practices is also a commitment to using all the **knowledge** at your disposal to ensure **success**. The term is used frequently in the fields of health care, **education**, computer product development and other segments of agriculture. Best practices can **help** sheep producers **grow**, improve **profitability** and reach industry-wide roadmap **goals**.

Reproductive Efficiency Task Force Members

Reid Redden, Ph.D. (Chair)

Texas A & M University

Kathy Bielek

Ohio sheep producer

Paul Lewis

Oregon sheep producer

Rodney Kott, Ph.D.

Montana State University (retired)

Dan Morrical, Ph.D.

Iowa State University

This fact sheet was also reviewed by the Productivity Best Practices Advisors.

More Information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

A more extensive fact sheet on each of the Lamb Crop Best Practices will be available on the U.S. Lamb Resource Center website's Production Resources section in 2016.

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>

¹ USDA National Agricultural Statistics Service (NASS) Agricultural Statistics Board Sheep and Goat Inventory Report, January 30, 2015, accessible online at: <http://usda.mannlib.cornell.edu/usda/current/SheeGoat/SheeGoat-01-30-2015.pdf>.





Increasing Your Lamb Crop Series Optimal Nutrition

Introduction

Sheep are seasonal breeders with the highest ovulation rates occurring during the middle portion of the breeding season. Successful reproduction of the ewe requires that she has a normal estrous cycle, ovulates one to four eggs, is mated by a fertile ram, and then maintains the fertilized embryos until she delivers healthy, vigorous lambs. This is a very complex reproductive process that becomes more challenging once flocks begin to push the level of productivity to higher and higher levels. Nutrition plays a critical role in the successful reproductive rates that are accomplished in ewe flocks. Figure 1 shows protein and energy changes through the various production phases. Ewes cannot make these nutrient modifications on their own; it is up to the manager to provide rations that meet animals' needs.

Energy and protein requirements by stage and level of production for 150-pound ewes

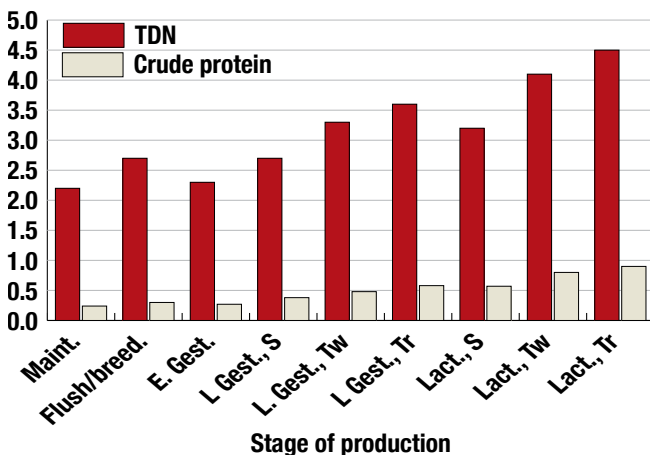


Figure 1. Protein and energy requirement by stage of production. (TDN is total digestible nutrients)

Increasing weight, improving body condition

The most common nutrient required by the ewe is energy. Sheep with a shortage of energy intake will lose weight. This may happen with un-supplemented ewes grazing native range. The ewes cannot consume adequate amounts of forage due to low

Sheep are **seasonal breeders** with the highest **ovulation rates** occurring during the middle portion of the breeding season. **Successful reproduction** of the ewe **requires** that she has a normal **estrous cycle**, **ovulates** one to four eggs, is mated by a **fertile ram**, and then **maintains** the fertilized **embryos** until she **delivers** healthy, vigorous **lambs**.

availability of forage or the slow rate of digestion by poor quality forage. Ewes will respond to improved nutrition by gaining weight and/or body condition. The process of providing this improved nutrition prior to and through breeding season is commonly referred to as flushing.

Flushing works best on ewes that are slightly under conditioned (CS<3) or early in the normal breeding season. Flushing can increase the lambs born by 10 to 30%. Ewes that are already in above average body condition (CS>3.5) do not respond to flushing. Figure 2 demonstrates the response in terms of number born with improved ewe body condition.

Flushing can be accomplished by supplemental feeding of concentrates, which is the standard practice for most farm flock operations. The amount of supplemental grain is dependent on the size of the ewes and the quantity and quality of the forage portion of the diet. The National Research Council (NRC) suggests at least a 10% increase in energy intake. This can be accomplished with .5 to 1.0 pound of grain per day.

The other means of improving the flock's overall body condition prior to breeding is to allow more forage availability to achieve maximum voluntary intake. With more forage available, ewes can increase selective grazing to consume a higher energy and protein diet. Improved nutrition is normally continued through the first three weeks of breeding. Supplemental feeding may need to continue if the breeding season coincides with decreasing forage quality at the end of the growing season.

► Lambs born per ewe exposed

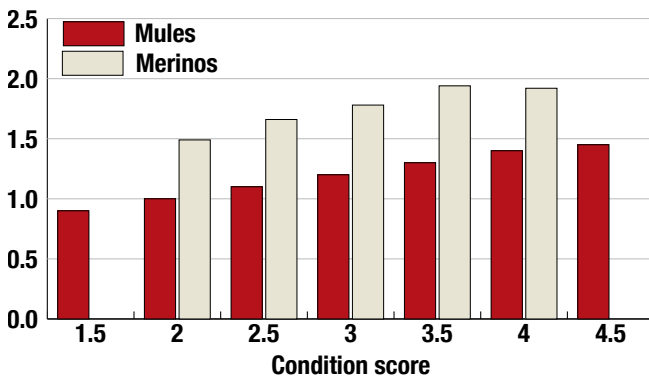


Figure 2. Impact of condition score and lambs born (lifetimewool.com.au and MLC 1983)

► Supplementing to meet needs

Ewes bred on dormant range may need protein and/or energy supplementation to meet their nutrient requirements. The quality of dormant range is dependent on the amount of weathering and the quality stage when growth stopped. Active, vegetative growth would be much higher in both energy and protein content compared to plants that were mature at the end of the growing season. The other critical nutrients are minerals and vitamins. Specifically, phosphorous and selenium deficiencies can reduce reproductive rates. Ewes should have access to free choice minerals throughout all stages of production. The mineral source should be formulated to meet the needs of the animals based on the local feed provided. Producers should contact their extension specialist or consulting nutritionist for input regarding a mineral supplementation program.

Vitamins A and E are both associated with reproduction. In general, if ewes have access to green feed during breeding, then supplementation of A and or E is probably not required. Ewes bred in a dry lot system or on dormant range probably need supplemental E at 200 IU per day. This level would require the mineral source to contain 3200 IU of E, with a one-ounce daily consumption level. The majority of sheep minerals available are formulated with much lower levels of vitamin E.

Lamb Resource Center



The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.

► Monitoring gestational condition

During mid-gestation the placenta is developing and inadequate feeding can retard development resulting in smaller birthweights. Research has shown that younger ewes are more prone to fetal loss during mid-gestation (Raasch 1997). Since most ewes will be in full fleece during this stage of production, it is critical that they are closely monitored to prevent excess losses in body condition. Condition score changes should be held to less than one half condition score. For example, a ewe in BCS of 3 should not lose more than 0.5 BCS during gestation, as this increases the risk of twin lamb disease. Ewes in light condition at birth do not lactate well, regardless of nutrition. One condition score is approximately 11% change in bodyweight. For 150 pound ewes, a half a condition score would be equivalent to losing eight pounds, which is not very much weight loss. And, be aware that ewes can lose BCS and still gain weight during gestation.

It is likely that there will be more ewes carrying twins and triplets. This requires better feeding in late gestation to ensure ewes are in good body condition (CS>3) for lactation and adequate birthweight of the multiples. Fetal counting can be used to subdivide the flock into high and low feeding groups depending on multiples or singles.

Flocks that are really pushing their reproductive capacity may see an improvement with the inclusion of omega-3 fatty acids in the flushing ration. This work was conducted in the United Kingdom and found providing omega-3 fatty acids, such as flax oil, increased both embryo quality and survival (Smith 2013).

► Late gestational needs

Late gestation nutrition requires increased energy intake to allow for the rapid fetal growth. Fetal scanning and aging can be used to allot increased nutrients to ewes carrying multiples. If sorting the flock into drop groups by fetal count is not possible, then they should be phased in to a late-gestation ration. Ewes carrying triplets could be fed the late gestation ration starting 6 to 8 weeks ahead of lambing; ewes carrying twins, 4 to 6 weeks ahead; and singles, 2 to 3 weeks ahead of lambing. Nutrient intake in late gestation requires grain feeding for winter lambing flocks. Pasture or range lambing flocks can generally meet the nutrient demand with lush spring growth.

► Demand increases during lactation

The greatest nutrient demand for the ewe is during lactation. Twin-rearing ewes require 50% more energy and protein to ensure adequate milk production for growth and survival of the lambs. Peak milk yield occurs around week four of lactation and begins declining after week eight of lactation. Nutrient requirements are drastically reduced in late lactation. Underfed lactating ewes will wean lambs with 10% lighter weaning weights. Ewes should not lose more than one half condition score during lactation. During the drying off period, the last week before weaning, additional weight loss can occur without lamb weaning weights.



crossbred ewes in the Midwest appear in good body condition at the end of breeding season.

► Author & reviewers

Author: Dan Morrical, Ph.D., Iowa State University, Ames, Iowa

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

► More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>

► Literature cited

Lifetimewool, Ewes in better condition at joining conceive more lambs, lifetiemoor.com.au

Meat and Livestock Commission Sheep Improvement Services, 1983. Feeding the ewe, page 14.

NRC. 2007 Nutrient requirements of small ruminants. National Academies Press, Washington, D.C.

Raasch, G., D. Morrical and C. Youngs, 1998, Effect of supplemental vitamin E and A reproductive performance and serological profiles of ewes managed in dry lot. ASL R1468

Smith, M. 2013, Omega 3 for sheep – boost embryo survival to boost margins, "Farmers Guardian." August 2013



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change



Increasing Your Lamb Crop Series

Breeding Ewe Lambs at 7-9 Months

Introduction

A well-planned ewe-lamb breeding program will increase overall flock lamb production. Breeding ewe lambs at 7 to 9 months of age is common among farm-flock and small-pasture sheep operations. However, for range-based wool-type operations, producers are more likely to wait until ewes are yearlings before breeding. This is understandable given the many variables and extensiveness of rangeland systems that make it challenging to answer the question, “Can a ewe lamb breeding program work?” We will consider several factors about ewe lamb breeding programs to help producers to answer this question.

Improve flocks by breeding 7- to 9-month-old ewes

Many assume that an extra year of production is the main benefit of breeding ewe lambs. However, this is more of a distraction from the real value, which is the “early-puberty ewe.” Consider this study that Dr. Clarence Hulet and colleagues (1969) conducted at the US Sheep Experiment Station (Sheep Station) in the 1960s. In this study, wool-type ewes that displayed standing heat as lambs weaned nearly 10% more weight of lamb over their lifetime compared with ewes that did not display heat as ewe lambs. It is very important to note that all ewes in this study lambed for the first time as 2-year-olds; no ewes were allowed to lamb as 1-year-olds. We learned from this study that an early-puberty ewe flock will have greater lifetime productivity whether or not ewes are bred as lambs or yearlings. But, where does the increased production come from? Based on the evidence, early-puberty ewes seem to be more likely to twin throughout their productive life.

What about the longevity of early-puberty ewes? Does lambing for the first time as a 1-year-old affect a ewe’s productive years in the flock? When studying the early work of Briggs (1936), Spencer et al. (1942), and Hohenboken et al. (1977), we find the culling rate among ewes greater than 5-years-old appears to be slightly higher for ewes that lambed for the first time as 1-year-olds. Is this something that we should worry about? It depends on the proportion of the flock that is older than 5 years. For range flocks, “old” ewes account for a very small percentage of the flock. Therefore, any production improvement achieved for the majority of the flock (in this case, younger ewes) would overshadow the slight negative effects found in the smaller portion of the flock.

This fact sheet builds on Dr. Dave Thomas’ (2002) “**Should we breed ewe lambs?**”, which can be accessed at www.ansci.wisc.edu/extension-new%20copy/sheep/etn_01/feb/ewelambs.doc. This is a must-read for a more in-depth and thorough evaluation of ewe-lamb breeding and management. In addition to his own discussion, Dr. Thomas highlights important pioneering recommendations for ewe-lamb breeding management of Dr. William Hohenboken and colleagues (1978).

Moving flock toward an early-puberty ewe base

Record and data management. The success of any ewe lamb breeding program is highly dependent upon tracking ewes over their lifetime. Record keeping is extremely important. Fortunately, radio frequency identification (RFID) technology, hand-held computers, and data-management systems for sheep producers are functional, simple, and most importantly, affordable. Please take time to investigate what is out there. As burdensome as data management may sound, it will be worth it, especially when transitioning from a yearling to a ewe-lamb breeding program.

Genetics. The heritability of lambing as a 1-year-old is about 0.18 (Kirschten et al., 2013). Not too great, but similar to the heritability of weaning weight and something we can progressively capitalize upon. Therefore, we must give considerable thought to the rams we are buying. Foremost, look for rams with National Sheep Improvement Program (NSIP) data. Currently, estimated breeding values (EBVs) that directly address early puberty in ewes are not available. But, there are a few EBVs that can possibly contribute. For example, number of lambs born (NLB) and scrotal circumference (SC) are estimates that focus

Continued on next page

► Moving flock toward an early-puberty ewe base (cont.)

on prolificacy and “improving reproductive performance in ewe lambs...via desirable effects on rate of sexual maturation” (Notter, 2011). For more information on EBVs, please take time to read “The NSIP EBVs” by Dave Notter, Ph.D., which can be accessed on the NSIP website (www.NSIP.org).

If it is not practical to use NSIP rams (availability is limited in the breed or area), focus on how ewes are managed in the flock where the rams originate. For example, does the flock have a ewe lamb breeding program and a high twinning rate? Also, did the ram’s dam give birth as a ewe lamb and is the ram a twin? Attention to these elements of the breeding program can help your goal of earlier lambing, more productive ewes.

An EBV that directly addresses lambing at one year of age is not far away. Recently, Kirschten et al. (2013) developed and tested a lambing percentage EBV for Sheep Station Targhee rams. When using “high-lambing-percentage” EBV rams to develop a line of Targhee ewes that are capable of lambing as 1-year-olds, Kirschten reported a 20% numerical increase in pregnant ewe lambs compared with an unselected Targhee control flock. These results indicated a reasonable value for further development of EBVs to increase lambing percentage of ewe lambs.

Although the right ram is very important, producers should not forget about the ewes in their flock. They may be close to having ewes that are capable of breeding as ewe lambs. We learned from Hulet et al. (1969) that early-puberty ewes seemed to be more likely to twin each year. So, are producers selecting for ewes that are from twin or better litters? Most likely they are. This, by no means, is a guarantee that they are selecting for early-puberty ewes, but it is one step forward in incorporating traits associated with early puberty. The most definitive way to



Even though the correct ram is very important, producers should not forget about the ewes in their flock.

identify early-puberty ewes is to expose ewe lambs to rams and focus retention efforts on those that become pregnant.

The question of the big ewe lamb.

Ewes must achieve an appropriate age and body weight to become pubertal. Therefore, human nature pushes us towards selecting for the biggest ewe lambs at weaning. However, this method does not guarantee that producers will identify ewes that will be pubertal at

7 to 9 months of age. Kirschten et al. (2015) found that age-adjusted weaning weight of Sheep Station Targhee ewe lambs only explained 3% of the phenotypic variation for lambing rate among ewes bred as ewe lambs. Furthermore, if we select the biggest ewe lamb without regard to the lamb’s actual age and type of birth, we may be biasing our selection towards lambs that were born first and/or from single births. Based on the Genetics discussion, this would be contrary to selecting the “right” ewe. It is important to focus on age-adjusted weaning weights when selecting ewe lambs, but *only when other traits associated with high-producing ewes are considered.*

Good nutrition and steady growth. Level of nutrition should be targeted towards maintaining a gain of at least 0.4 lbs./day before and throughout breeding. Thomas (2002) suggested gains of around 0.5 lbs./day. Keep in mind that breed, weight and age at weaning, and production environment influences targeted daily gain. Regardless of the circumstance, the level of nutrition, which drives gain,

can have a profound effect on the number of ewe lambs that become pubertal at 7 to 9 months of age. For example, nutrition provided at levels to achieve either 0.22 or 0.42 lbs./day gain resulted in the same percentage (~45%) of Sheep Station Targhee ewe lambs that were pubertal at 8-months-old (Figure 1). However, at one month earlier, nearly twice as many ewes gaining 0.42 lbs./day were pubertal compared with ewes gaining 0.22 lbs./day. The take-home message is that adequate nutrition is essential to ensure ewes are gaining consistently before, during, and after breeding.

The take-home message is that **adequate nutrition is essential** to ensure ewes are **gaining consistently** before, during, and after breeding.

Lamb Resource Center



The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.



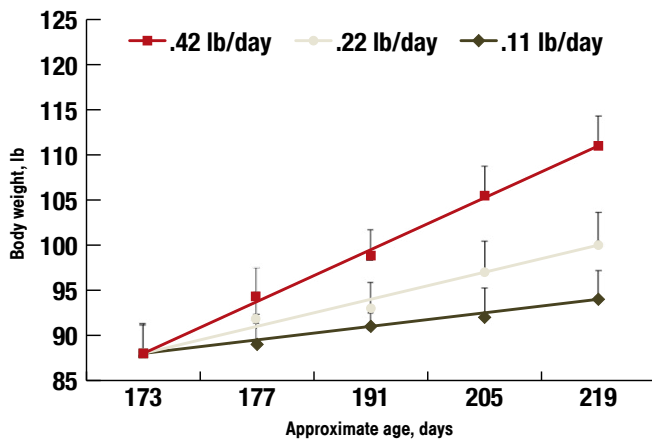
Breeding 7- to 9-month-old ewes

HIGHLIGHTS FOR CONSIDERATION

- Consider retaining more replacement ewes than usual. How many will depend on if producers are able to cull soon after breeding, which will require access to ultrasound services, or if they are culling after the first lambing at weaning. Consider retaining lambs from multiple-birth litters, from high-production dams and that have a good age-adjusted weaning weight.
- Commit to a solid growth program with sufficient nutrition to achieve steady gains of better than 0.4 lbs./day before and during breeding.
- Do not mix mature ewes with ewe lambs during breeding. Experience favors the mature ewes, which can dominate the rams' efforts. As a classic example, average fertility in Sheep Station ewe lambs mixed with mature ewes vs. ewe lambs only during breeding was 43% vs. 70% for Rambouillet, and 37% vs. 45% for Targhee, respectively.
- Maintain a steady nutrition program for ewe lambs after breeding. Whether provided as feed in a bunk or supplement on range, ewe lambs require additional nutrition to support growth and pregnancy. Milk production can be a problem in ewe lambs. Cheating on nutrition during breeding and pregnancy can result in a ewe being unable to support its offspring after lambing.
- Be ready to assist at lambing. Due to lack of experience, first-time "lambers," whether 1- or 2-year-olds, can be poor mothers. It is interesting to note that ewes that give birth at 1-year-old and successfully raise a lamb will be better mothers the next year compared to ewes who lamb first as 2-year-olds.
- Consider weaning lambs from 1-year-old ewes earlier than mature ewes. However, this may not be necessary if summer nutrition is good. At the Sheep Station, lambs are weaned from 1-year-old ewes the same time as with mature ewes.
- Consider not retaining any offspring weaned from 1-year-old ewes as replacements.

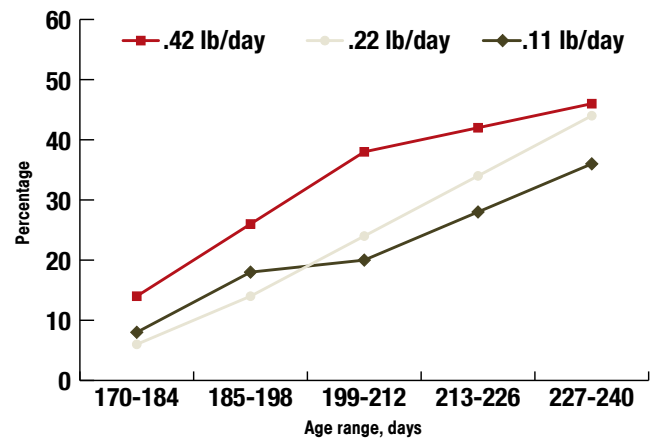
Good nutrition and steady growth

Body weight (lb) of ewes by age, rate of gain



Panel A

Cumulative percentage (%) of pubertal ewes by age, gain



Panel B

Figure 1. The data presented in Panels A and B demonstrate the importance of nutrition and gain in preparing ewe lambs for breeding. A study was conducted at the Sheep Station to establish the optimal level of nutrition needed for 45% to 50% of the Targhee ewe lamb flock to achieve puberty by 8 months of age, which corresponds with the long-term pregnancy rate in Sheep Station Targhee ewe lambs. Presented in **Panel A** (left) are three rates of gain, 0.11, 0.22, and 0.42 lbs./day, resulting from feeding three different levels of nutrition before and during breeding. Presented in **Panel B** (right), is the cumulative percentage of ewes, at the three rates of daily gain, that reached puberty at defined age ranges.

Author & reviewers

Author: J. Bret Taylor, Ph.D., USDA, Agricultural Research Service; Dubois, Idaho

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>

Literature cited

- Briggs, H. M. (1936). Some effects of breeding ewe lambs. North Dakota Agric. Exp. Sta. Bull. 285.
- Hohenboken, W., Vavra, M., Phillips, R., & McArthur, J. (1977). The effects of age at first lambing on production and longevity of Columbia and Targhee ewes. Oregon Agric. Exp. Sta. Spec. Tech. Bull. 138.
- Hohenboken, W. D., Vavra, M., Levine, J.M., Phillips, R.L., & Cedillo, R.M. (1978). Reports on breeding ewe lambs. Oregon Agric. Exp. Sta. Spec. Rpt. 502.
- Hulet, C. V., E. L. Wiggins & S. K. Ercanbrack. 1969. Estrus in range lambs and its relationship to lifetime reproductive performance. J. Anim. Sci., 28:246-252.
- Kirschten, D. P., Notter, D.R., Gilmour, A.R., Lewis, G.R., & Taylor, J.B. (2015). Genetic evaluation of weaning weight and the probability of lambing at 1 year of age in Targhee lambs. Sheep Goat Res. J., 30:1-5.
- Kirschten, D. P., Notter, D.R., & Lewis, G.S. Genetic evaluation of the probability of lambing in yearling Targhee ewes. Proc. West. Sec. Amer. Soc. Anim. Sci., 64:161-164.
- Notter, D. R. (2011). The NSIP EBVs. <http://nsip.org/wp-content/uploads/2015/03/NSIP-EBV-Descriptions-FINAL-1.16.15.pdf> (Accessed 16 April 2016)
- Spencer, D. A., Schott, R.G., Phillips, R.W., & Aune, B. (1942). Performance of ewes bred first as lambs compared with ewes bred first as yearlings. J. Anim. Sci., 1:27-33.
- Levine, J. M., Vavra, M., Phillips, R., & Hohenboken, W. (1978). Ewe lamb conception as an indicator of future production in farm flock Columbia and Targhee ewes. J. Anim. Sci., 46:19-25.
- Thomas, D. L. (2002). Breeding ewe lambs or getting the most out of ewe lambs. www.ansci.wisc.edu/extension-new%20copy/sheep/etn_01/feb/ewelambs.doc (Accessed 12 March 2016)



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change



Increasing Your Lamb Crop Series

Select for Prolific Genetics

Introduction

Increasing prolificacy is one of the most effective strategies for improving production efficiency and profitability. Prolificacy is the number of lambs produced per ewe per year in a management system where each ewe has one opportunity to lamb. Spreading the ewe’s cost across more lambs increases profit. Prolificacy is generally measured in percentages. A 140% lamb crop means that 100 ewes produced 140 lambs.

There are ewes that can raise twins, even in challenging environments. Figure 1 shows the distribution of number of lambs weaned per ewe from ages 2 through 4 in a pasture lambing research flock with an average lamb crop of 140% born and 120% weaned. The most productive 25% of the ewes weaned 4 or more lambs over the 3-year period. The least productive 37% weaned 2 or fewer lambs over the 3-year period. Selection for greater prolificacy can lead to an increase in lamb production over the current average in a given environment. The aim of selection is to have a flock that has more ewes in the top end of the distribution.

Genetics and environment

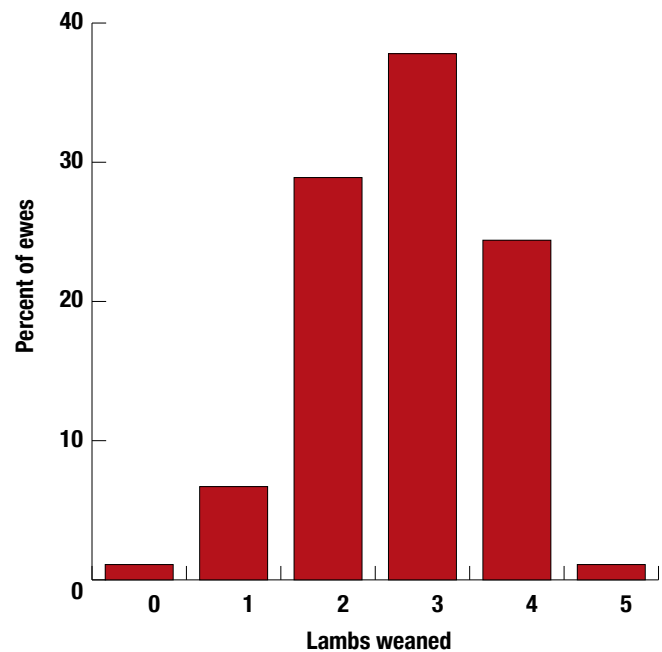
Prolificacy is affected by genetics and environment. Effective selection for prolificacy is challenging because the number of lambs produced can only be observed in breeding-age ewes and is affected by a combination of genetic and non-genetic factors. Some of the non-genetic, or environmental, factors are nutrition, age, season of year and health. Effective selection must separate the genetic and environmental factors.

Breeders who want to improve prolificacy, but do not have comprehensive records, have practiced a selection method of choosing replacements born as twins. Because of the environmental factors that affect prolificacy, selecting twins is less accurate at identifying genetic merit than a method which takes environmental conditions into account. Therefore, progress from selecting only replacements born as twins is limited.

Using estimated breeding values

The U.S. lamb crop increased by only .04 % per year from 1966 to 2015 (USDA National Ag Statistics Service). In contrast, the genetic trend among Targhee flocks using National Sheep Improvement Program’s (NSIP) estimated breeding values

Figure 1. Distribution of number of lambs weaned per ewe from 3 lambings.



(EBVs) was .7% per year from 2006 to 2015. Even greater rates of progress are possible when more emphasis is placed on increasing prolificacy by selection. Even though .7% per year may seem small, when selection is practiced over several years, the gains accumulate. The cumulative increase can make a substantial difference in flock production. The use of EBVs gives flock owners the opportunity to identify genetic merit by using performance and pedigree records.

Selection for prolific genetics in a flock can be accomplished by obtaining breeding stock from flocks with superior genetic merit for prolificacy, or a producer can select from within his own flock.

Pedigree records

Most genetic improvement in a flock comes through ram selection, because a ram can produce several times as many offspring as a ewe will produce in her lifetime. However, prolificacy is only observed as a trait of the ewes. Therefore, pedigree records are

Continued on next page

► Pedigree records (cont.)

essential to identify genetic superiority for prolificacy for potential breeding rams. If a management system does not maintain pedigree records, selection for increased prolificacy will be limited. Selection for prolificacy in this instance can be accomplished by obtaining breeding rams from breeders who use NSIP for calculating breeding values. Using rams that are genetically superior for prolificacy will increase the flock's prolificacy when their daughters make up a larger share of the flock.

If pedigree records are maintained for the flock, selecting for prolificacy from within this flock can be effective. Because there are several environmental factors that affect the number of lambs a ewe produces, estimating genetic merit for prolificacy involves a process to separate genetic merit from environmental factors. Combining multiple years of lambing records and pedigree records allows for the separation of environmental effects from genetic effects. The genetic merit of young rams can be predicted from the performance of all his female relatives that have records. The complex calculations result in the best prediction of each animal's genetic merit. NSIP has a system in place to calculate genetic merit for prolificacy. Such calculations are better predictors of genetic merit than merely knowing if a ram was born as a twin or a single.

► Selecting or purchasing stock

Determining whether to buy superior breeding stock, or select from within a home flock, depends on several factors, including:

- The ability to identify genetic superiority in young males
- The availability of genetically superior males with suitable genetic merit for other economically important traits
- The potential for selling breeding stock

Producers may prefer to select breeding stock from within their own flocks when their sheep have desirable performance for other traits and prolific genetics may not be available to purchase from other breeders. Selection within a flock leads to genetic improvements that accumulate and are passed on to the next generations.

Selection within a population does not produce an abrupt change. Therefore, management can evolve as the prolificacy increases. An abrupt change in prolificacy frequently requires an abrupt change in management.



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change

Lamb Resource Center



The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.

Prolificacy can also be changed via crossbreeding, managing environmental factors, such as increased nutrition or treatment with hormones. Each of these factors requires continued inputs.

► Author & reviewers

Author: Daniel F. Waldron, Ph.D., Texas A&M AgriLife Research, San Angelo, Texas

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

► More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>

► Literature cited

Amer, P.R. and L. Bodin. 2006. Quantitative genetic selection for twinning rate in ewes. *NZSAP* 66:429-433.

Rao, S. and D.R. Notter 2000. Genetic analysis of litter size in Targhee, Suffolk, and Polypay sheep. *J. Anim. Sci.* 78: 2113-2120.

Dickerson, G.E. 1996. Economic importance of prolificacy in sheep. In: *Prolific Sheep*, (Fahmy, Ed). University Press, Cambridge, UK.



Increasing Your Lamb Crop Series

Use Crossbreeding

Introduction

Crossbreeding is a predictable and cost-effective method to genetically increase lambs raised per ewe (lamb crop) by mating sheep of two or more breeds. The practical objective of crossbreeding is to increase lamb crop relative to the pure breed that performs best in a given production system and environment.

Genetic basis for crossbreeding

Sheep have evolved over thousands of generations to adapt to specific environmental conditions by the natural selection of roughly 30,000 genes. All sheep have two copies of each gene, one inherited from each parent. Each gene typically has two or more forms. Sheep with two copies of the same form of a particular gene are said to be homozygous for that gene, whereas sheep with two different forms are heterozygous. As a result of evolution and selection by shepherds, each breed has unique genetic information that produces characteristics that distinguish it from another breed.

Purebreeding creates sheep that have a relatively high level of homozygosity, whereas crossbreeding produces sheep with less homozygosity and more heterozygosity than the purebreds used to make the cross. The increased heterozygosity of crossbred sheep relative to purebred sheep is the basis for heterosis effects – also called hybrid vigor. Crossbreeding systems combine genetic effects of breeds and heterosis, while complementarity is also used in terminal crossbreeding systems. These three aspects of crossbreeding systems are addressed below.

Choice of breeds

The most important genetic considerations to increase lamb crop are to use breeds and crossbreds that are suitable for the production system and also well adapted to environmental conditions. Sustainable production systems are rather complex, integrating resources such as land usage, labor supply, feed costs, facility accessibility, marketing options and managerial skills. The production system essentially establishes which traits have the most impact on profitability and determines target levels of performance for these key traits.

Lamb crop is the key trait affecting profitability in most production systems. For example, farm flocks intensively-managed in confinement need highly productive ewes to

offset substantial production costs, whereas a low-input range operation may depend on less productive ewes which are very well adapted to extensive environmental conditions.

Breeds differ greatly for number of lambs born, allowing producers to use purebred or crossbred ewes to achieve their lamb crop goal for their production system and environmental conditions. Assuming that the optimal number born for an intensively-managed farm flock is about 2.5 lambs for mature ewes, roughly equivalent to an overall flock average of 2.2 lambs born. Mature Rambouillet ewes produce about 1.8 lambs at birth, whereas mature Finnsheep ewes average about 3.2 lambs. If Finnsheep rams are bred to Rambouillet ewes, one intuitively expects the crossbred daughters to achieve the target of 2.5 lambs at maturity; 2.5 simply being the average of the two parental breeds.

A more pasture-based production system might target fewer lambs born. Perhaps the production system dictates that quarter-Finnsheep ewes are suitable and therefore a producer breeds Finnsheep x Dorset crossbred rams to Rambouillet ewes. Assume that mature Dorset ewes average 2.0 lambs born. What should the producer expect the resulting daughters (¼ Finnsheep, ¼ Dorset, and ½ Rambouillet) to average for number born at maturity? The intuitive answer, 2.2, is the weighted average of the three parental breeds ($2.2 = (0.25 \times 3.2) + (0.25 \times 2.0) + (0.50 \times 1.8)$).

So, breed diversity for number born can be used to achieve virtually any goal. The importance of maternal ability, both behavior and milk production, must also be considered in choosing breeds. For example, lamb survival can be improved by creating crossbred ewes with intermediate optimums to balance number born and maternal ability.

Information about trait performance of many breeds is provided in the Breeding and Selection chapter of the *Sheep Production Handbook*.

Author & reviewers

Author: Kreg Leymaster, Ph.D., Estes Park, CO
Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

► Heterosis effects

Crossbreds often outperform the average of the pure breeds used to make the cross, a phenomenon known as heterosis. Heterosis is caused by the increased heterozygosity of crossbred sheep relative to purebred sheep. Heterosis effects tend to be greatest for lowly heritable traits such as reproduction, survival and health. Effects of heterosis on lamb crop can be realized through crossbred ewes, lambs and, to a lesser extent, rams.

Let us use Rambouillet and Finnsheep to demonstrate effects of ewe heterosis on number born. Again, assume number born averages 1.8 and 3.2 for Rambouillet and Finnsheep ewes, respectively. The average for the two breeds is 2.5 lambs born. If Rambouillet x Finnsheep crossbred ewes actually average 2.58 lambs born, then the ewe heterosis effect for number born is $2.58 - 2.5$, or 0.08 lambs. Heterosis effects can also be expressed as a percentage of the purebred mean. For this example, percentage ewe heterosis for number born is 3.2% ($0.08/2.5 \times 100$).

Breeding ewes to produce crossbred lambs rather than purebred lambs also increases lamb crop raised. This is an example of lamb heterosis, whereby crossbred lambs have a higher survival rate than purebred lambs.

Less is known about effects of ram heterosis than lamb and ewe heterosis. Ewes exposed to crossbred rams for spring breeding tend to have greater pregnancy rates than ewes exposed to purebred rams.

Lamb crop is determined by three component traits: pregnancy rate, number born and pre-weaning survival. Estimates of lamb and ewe heterosis effects on these reproductive traits are summarized in Table 1. Lamb heterosis effects are favorable for each component trait, but greatest for pre-weaning survival. That is, crossbred lambs have a better chance of survival than purebred lambs. Effects of ewe heterosis on component traits are greatest for pregnancy rate, indicating that crossbred ewes are more likely to lamb than purebred ewes. Note that heterosis effects of component traits accumulate so that the combined effect on lamb crop is greatly increased.

On average, crossbred lambs increase lamb crop by 15.2% relative to the pure breeds used to make the cross. Crossbred ewes have a similar effect, increasing lamb crop by 14.7% on average. Crossbreeding systems that fully exploit both lamb and ewe heterosis effects can increase lamb crop by roughly 30%. In summary, favorable effects of lamb and ewe heterosis greatly increase overall productivity of crossbred sheep.

Sheep Production Handbook

The *Sheep Production Handbook*, updated in 2015, is an excellent resource to learn more about this topic. A fully searchable USB drive is included with each book. This newest edition has chapters on reproduction, management, breeding/selection, forages, nutrition, lamb quality, marketing, predator damage control, health and wool. It is available for purchase from the American Sheep Industry Association, 303-771-3500, or www.sheepusa.org.

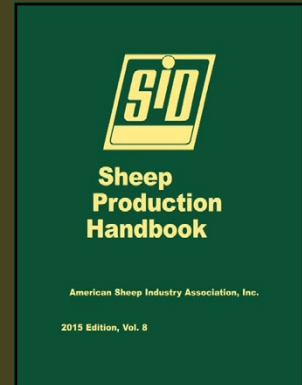


Table 1. Lamb and ewe heterosis effects on reproductive traits as a percentage of purebred average.

Trait	Lamb	Ewe
Pregnancy rate	2.6	8.7
Number born	2.8	3.2
Pre-weaning survival	9.8	2.7
Lambs weaned per ewe exposed	15.2	14.7

► Complementarity

In addition to breed and heterosis effects, terminal crossbreeding systems also take advantage of complementarity. Complementarity improves production efficiency by mating ewes of maternal breeds to rams of terminal sire breeds. Maternal breeds excel in adaptability and reproductive traits and have moderate feed requirements. In contrast, terminal sire breeds are superior for growth and carcass traits. By separating maternal and terminal sire roles, complementarity allows favorable traits of breeds to be expressed while minimizing less desirable traits. Mating Rambouillet-Targhee crossbred ewes to Hampshire rams is an example of matching complementary strengths of breeds to optimize efficiency in an extensive production system.

Lamb Resource Center



The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.



General purpose crossbreeding systems

Four genetic types of sheep can be used in general purpose crossbreeding systems:

- Purebreds provide the genetic resources that drive crossbreeding systems.
- First-cross (F1) sheep are produced by mating ewes and rams of different breeds.
- Two-breed rotational sheep are produced by using rams of two breeds in alternating generations. The addition of a third breed to the rotation results in three-breed rotational sheep.
- Composite sheep are produced by crossing two or more breeds in the foundation generation, with subsequent generations descending from the original crossbred sheep.

Levels of heterosis expressed by these genetic types are listed in Table 2. By definition, purebreds do not show heterosis effects whereas heterosis is maximized in first-crosses. Intermediate

Table 2. Percentages of first-cross (F1) heterosis expressed by different genetic types.

Genetic type	Percentage heterosis
Purebred	0
First-cross (F1)	100
Two-breed rotation	67
Three-breed rotation	86
Two-breed composite	50
Three-breed composite	62
Four-breed composite	75

levels of heterosis are realized by rotational and composite sheep, with values increasing as additional breeds are added to each genetic type.

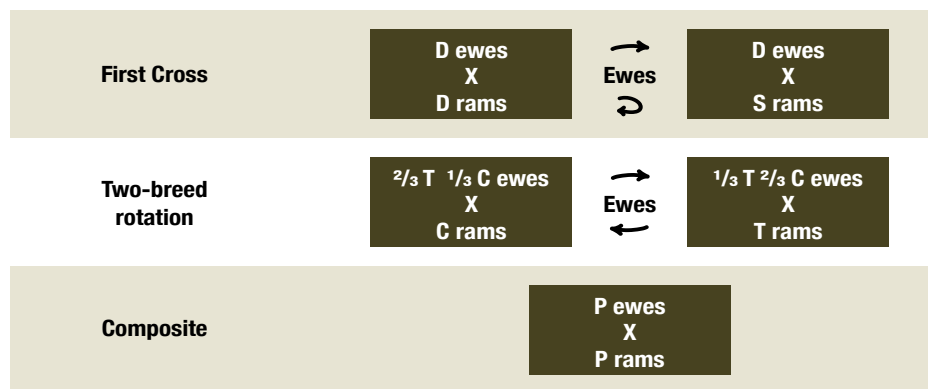
Types of crossbreeding systems

Three types of general purpose crossbreeding systems are shown in Figure 1. In the first-cross system, purebred ewes are bred to produce purebred replacement ewes and also to rams of a different breed to produce first-cross market lambs. In the rotational system,

ewes are mated to rams of the least-related breed, producing both replacement ewes and market lambs. The composite system is the simplest, as composite ewes are mated only to composite rams to produce replacement ewes and market lambs.

Figure 1. Diagram of three types of general purpose crossbreeding systems:

- D = Dorset**
- S = Shropshire**
- T = Targhee**
- C = Corriedale**
- P = Polypay**



The first-cross system is the least efficient because all ewes are purebred and do not benefit from ewe heterosis. Both the rotational and composite systems use ewe and lamb heterosis effects quite effectively. Although rotational systems achieve higher levels of heterosis than composites for a given number of breeds (Table 2), they require more breeding groups, each

differing in breed composition. In contrast, composites are managed as a single breed, maintain very beneficial levels of heterosis, and have stable breed composition. *Fundamental Aspects of Crossbreeding in Sheep* (Leymaster 2002) provides more detailed information about crossbreeding systems.

Terminal crossbreeding systems

Terminal crossbreeding systems use maternal breeds and terminal sire breeds to complement each other. Depending on reproductive and attrition rates of the breeding flock, only 15 to 40% of ewes are needed to produce replacements. The remaining ewes can be bred to rams of terminal sire breeds. Growth and carcass traits are strengths of terminal sire breeds and all terminally-sired lambs realize 100% of lamb heterosis effects.

Three types of terminal crossbreeding systems are illustrated in Figure 2. These systems are similar to general purpose systems except maternal breeds are used to produce replacement ewes, while rams of terminal sire breeds are bred to an additional flock of maternal ewes. These genetic advantages cause terminal crossbreeding systems to increase lamb crop substantially relative to corresponding general purpose systems.

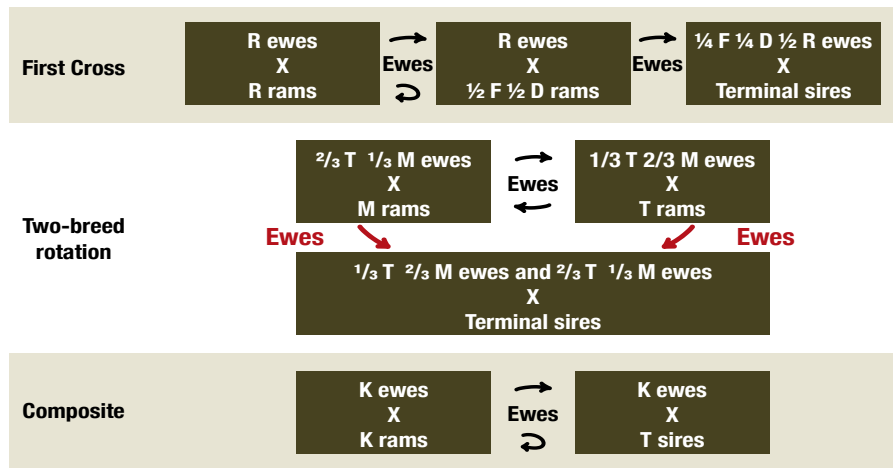


Figure 2. Diagram of three types of terminal cross-breeding systems:

R = Rambouillet F = Finnsheep D = Dorset T = Targhee
M = Montadale K = Katahdin

In terminal crossbreeding systems, the productivity is similar for first-cross (F1), two- and three-breed rotations, and three- and four-breed composites due to effective use of ewe and lamb

heterosis. The use of breed, heterosis, and complementarity effects in terminal crossbreeding systems can increase lamb crop by roughly 35% compared to the average of purebreds.

Conclusion

Crossbreeding systems vary in complexity and use of breed, heterosis and complementarity effects. Lamb crops can be increased most effectively by use of maternal breeds and terminal sire breeds to complement each other in terminal crossbreeding systems. Producers should carefully weigh the long-term practical ramifications of different crossbreeding systems before embarking on a specific plan.

More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>

Literature cited

Simm, G. (1998). Genetic Improvement of Cattle and Sheep. CAB International, Wallingford, Oxfordshire, United Kingdom.

Leymaster, K. A. (2002). Fundamental aspects of crossbreeding in sheep: Use of breed diversity to improve efficiency of meat production. *Sheep and Goat Research Journal*, 17, 50-59.

Sheep production handbook, Seventh Edition. (2002). C&M Press, Denver, CO.

Casas, E., Freking, B. A., & Leymaster, K. A. (2004). Evaluation of Dorset, Finnsheep, Romanov, Texel, and Montadale breeds of sheep: II. Reproduction of F1 ewes in fall mating seasons. *J. Anim. Sci.*, 82, 1280-1289.

Casas, E., Freking, B. A., & Leymaster, K. A. (2005). Evaluation of Dorset, Finnsheep, Romanov, Texel, and Montadale breeds of sheep: V. Reproduction of F1 ewes in spring mating seasons. *J. of Anim. Sci.*, 83, 2743-2751.

Thomas, D.L. (2010). Performance and utilization of Northern European Short-Tailed breeds of sheep and their crosses in North America: A review. *Animal*, 4, 1283-1296.



AMERICAN SHEEP INDUSTRY ASSOCIATION
 YOUR INDUSTRY ADVOCATE SINCE 1865





Increasing Your Lamb Crop Series

Culling Underperforming Ewes

Introduction

Lamb crop is one of the most important factors affecting profitability of a sheep enterprise. Increasing the lamb crop, so long as it is in balance with the environment and production system, should be the goal of every sheep producer.

Many factors affect lambing percentage, and management is a key contributor. Culling underperforming ewes is one of 12 best management practices that has been identified by the American sheep industry for improving lambing percentage.

However, unlike some of the other best management practices, such as breeding ewe lambs or pregnancy scanning, culling underperforming ewes is something all producers, regardless of flock size or production system, can and should do.

Culling underperforming ewes will reduce the cost of maintaining the flock. Underperforming ewes consume feed, take up space, and require labor, while producing less profit than their contemporaries; maybe, even costing the farm money. Thus, culling underperforming ewes is a way to help make sheep production more profitable, sustainable, and viable.

At the same time, overzealous culling is discouraged, as there are numerous costs associated with culling. The value of a cull ewe is considerably less than the value of the ewe lamb that is replacing her. There are also costs associated with developing ewe lambs for breeding. Depending upon the reason for culling, it may be more economical to retain a ewe and breed her to a terminal sire, such as for the production of market lambs.

In a sheep enterprise, it is customary to cull approximately 15% of the flock each year. In purebred or high producing flocks, the rate may be even higher. According to the National Animal Health Monitoring System (NAHMS), 14% of ewes were culled from the national flock in 2011, as compared to 18.3% in 2001.

Culling is when a ewe (or ram) is removed from the breeding flock. There are many reasons to cull ewes, and the reasons will vary by farm or ranch. Not all flocks will have the same breeding objectives. Ewes that are profitable in some flocks may not be profitable in other flocks. Current economic conditions may weaken or strengthen culling standards.

How to calculate lamb crop

$$\frac{\text{Number of Lambs Sold + Retained}}{\text{Number of Ewes Exposed}} = \text{Lamb Crop}$$

In a sheep enterprise, it is **customary to cull** approximately **15% of the flock** each year.

Reasons for culling ewes among all US sheep flocks

Primary reason for culling	% of sheep	% of sheep operation
Age	55.6	69.7
Failure to lamb	7.7	22.0
Teeth problems	7.6	8.0
Hard bag syndrome	7.1	24.1
Mastitis	6.7	20.9
Poor mothering	4.7	22.3
Other	3.7	7.6
Chronic weight loss	2.1	3.6
Economic issues	1.7	2.8
Other illness	1.2	2.4
Single births	1.1	3.9
Other reproductive problems	0.9	3.3
Total	100	

USDA APHIS, National Animal Health Monitoring System, April 2014

Age

Age is usually the primary reason for culling ewes. According to the 2011 NAHMS study, almost 70% of sheep operations cited age as the primary reason for culling ewes. In 2011, 55.6% of ewes culled were culled due to age. In 2011, the average age of culled ewes was 6.3 years, compared to 5.9 in 2001.

Ewes tend to be most productive between the ages of 3 and 6. After 6 years of age, their productivity tends to decline. On average, they give birth to fewer lambs and produce less milk for their offspring, resulting in lower pounds weaned. For these reasons, it is customary to cull ewes when they reach 5 or 6 years of age, especially in range flocks where ewes cannot receive individual attention and/or nutritional resources are limited. In many of these extensive operations, productivity falls off after 5 to 6 years of age.

On the other hand, small flocks and/or farms with good feeding conditions, may keep ewes in flocks for much longer. Some ewes are productive well beyond 6 years of age. In fact, ewes that can maintain productivity for a longer period of time should be favored in selection and culling decisions. In many instances, their offspring are some of the most productive ewes in the flock. For some flocks, keeping older, productive ewes could be a way to increase productivity, while simultaneously reducing replacement costs.



Photo by Lisa Stuber

Health issues are a major reason why ewes are culled.

Lamb Resource Center



The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.

Health

According to the NAHMS study, health issues are the other major reason why ewes are culled. In fact, they are the major reason for involuntary or premature culling of ewes before they reach their productive life spans.

Udder health – In the NAHMS study, hard bag and mastitis were identified as primary reasons for culling ewes. In 2011, 7.1% of ewes were culled due to hard bag syndrome. Another 6.7% were culled as a result of mastitis. Hard bag, which affects both udder halves, can be caused by ovine progressive pneumonia (OPP) or mastitis. Mastitis is an infection of the udder. Both conditions result in little or no milk being produced by the affected gland(s), causing lambs to starve, or grow poorly.

Only ewes with healthy, sound udders should be kept in flocks. Udders should be palpated to make sure there are not any lumps, hardness, or fibrous material. Udder halves should be relatively equal. Both teats should be functional and of normal size, as newborn lambs may have difficulty nursing oversized teats. Ewes with long, pendulous udders should be culled, as lambs may have difficulty finding the teats. Such udders are also more prone to injury. Ewes that have lost all or part of their udder function should be culled.

Prolapses – A prolapse is when structures fall out of their normal positions. Ewes that prolapse their vaginas should be culled, as they may repeat the problem in subsequent years. Their offspring should not be kept for breeding, as vaginal prolapses are believed to be an inherited problem. Ewes that experience a uterine prolapse, may be retained for breeding, depending upon the circumstances; however, most producers wisely cull these ewes.

Hoof health – Footrot, a bacterial infection of the hooves, is one of the most difficult diseases to control and eradicate from sheep farms. It has caused many sheep producers to liquidate their flocks. Footrot is costly to treat, especially in terms of labor. It can also be an animal welfare issue and negatively impact productivity.

Culling is one of the most powerful tools for dealing with footrot. Ewes that are chronically infected with footrot or scald, or fail to respond to treatment, should be removed from the flock. Ewes that have abnormal and/or excessive hoof growth should be culled. It is possible to select for footrot resistance in a flock.

Internal parasites – In situations in which internal parasites (worms) are a major obstacle to profitable production, parasite resistance should be a selection and culling criteria. Ewes which require frequent or regular deworming should be culled. If fecal samples are not obtained from ewes, the FAMACHA© system can be used to identify susceptible ewes, as there is a correlation between FAMACHA© scores and fecal egg counts.

Continued on next page

Internal parasites (cont.) – It is possible to select for parasite resistance in sheep, as 20% to 30% of the flock is usually responsible for 70% to 80% of the output of worm eggs. Parasite resistance (fecal egg counts) is a moderately heritable trait. The National Sheep Improvement Program (NSIP) currently provides estimated breeding values (EBVs) for parasite resistance in Katahdin sheep. The same can be done for other breeds once data are submitted.

Other health issues – There are numerous other physical problems for which ewes should be culled. Ewes should be evaluated for soundness on a yearly basis, preferably at the time of lambing, marking or breeding. Ewes with unidentified weight loss or ill thrift should be culled. Old, thin ewes that cannot maintain their body condition should be culled. Teeth or other problems may interfere with chewing. Only ewes with sound mouths should be kept. All of the ewe's incisors should be present. Ewes with genetic defects or predisposition to disease should be culled.

► Performance

Performance is another important criteria that should guide selection and culling decisions. Many of the factors already discussed account for the differences in performance among ewes. For example, sub-clinical mastitis may be the reason that a ewe weans lambs with below-average weights.

► Fertility

It is generally recommended that the breeding season be limited to two or three heat cycles, preferably only two (34 days). Mature ewes which fail to breed and maintain pregnancy should be culled. Pregnancy scanning can be used to determine which ewes are open. Pregnancy testing is especially useful for ewe lambs, as open ewe lambs, can be sold for higher prices than yearling ewes that fail to lamb.

Ewes that lamb late in the season may be another target for culling, as ewes that lamb early in the lambing season are usually the most productive. If out-of-season or accelerated lambing is the goal, ewes which fail to breed out-of-season and/or miss one or more breeding opportunities should be culled.

► Lambing

While dystocia (difficult birthing) is complex, research has shown that producers can reduce the incidence of dystocia by culling ewes that require assistance at lambing. Some producers will even cull lambs from assisted deliveries. Ewes that reject or harm their lamb(s) should be culled. Ewes whose lambs are small, weak, and/or slow to suckle should be discriminated against.

Ewes that fail to raise a lamb should be culled. No ewe can return a profit if she fails to produce a lamb. It is easy to identify a dry

maiden ewe, as she will not have any udder development. In older ewes, it is harder to pick out dry ewes; however, they are usually in better body condition and have smaller udders.

In some production systems, ewes that raise single lambs should be candidates for culling, as more costly production systems require higher lambing percentages. Two single births in a row may be the culling standard for some sheep operations. If the single lamb is of poor quality or weight, this compounds the reason for culling.

When lamb losses are beyond the ewe's control, such as predation or accidental death, exceptions can be made for keeping a ewe that fails to raise a lamb or fails to raise twin lambs. However, if a producer makes too many excuses for a ewe, this should be sign that the ewe is better off being put in the cull pen.

The importance of animal ID and records



Identification and record keeping are tools that assist in identifying cull ewes. Ideally, all ewes are identified with ear tags or similar identification. If this is not the case, ewes can be ear tagged or ear notched at the time of lambing, marking, weaning, or whenever something is noticed that is a reason for culling.

Ear notching can be an especially useful system for identifying cull ewes. Ewes that fail to breed or produce a lamb (or a good quality lamb) can be ear notched. Ewes that require assistance at lambing, reject their lambs, or give birth to small, weak lambs that are slow to suckle can be notched. Ewes that have mastitis, vaginal prolapses, or other health problems can be ear notched. Ewes that require extra work, such as routine hoof trimming or deworming, can be notched. One standard of culling would be to cull any ewe with two ear notches. Culling ewes with one ear notch would result in a stricter culling standard.

If ewes are individually identified and individual records are kept, it is much easier to identify ewes for culling. Records can be used to rank ewes for productivity and identify those which are underperforming. Litter weight at weaning is a good composite trait that can be used to evaluate productivity. At the same time, it is important to combine records with visual appraisal, as records may not document poor udder conformation, chronic hoof disease, or other problems that should be eliminated from the flock.

Other reasons for culling ewes

Various other criteria may be used to make culling decisions.

In hair sheep flocks, failure to adequately shed may be a reason for culling. Similarly, woolled sheep flocks should cull ewes with fleece defects or wool quality issues.

Temperament can be another reason for culling. Fence jumpers should be culled. Flighty ewes are more difficult to handle and can get the entire flock excited. Calm ewes should be favored over nervous ewes, as their behavior has been associated with lower lamb mortality.

Literature cited

Sheep (2011). Part IV. Changes in Health and Production Practices in the US Sheep Industry 1996-2011. USDA APHIS National Animal Health Monitoring Service (NAHMS).

Author & reviewers

Author: Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change



Increasing Your Lamb Crop Series

Reduce Lamb Loss

Introduction

Most sheep producers strive to reduce lamb crop mortality associated with late gestation and newborn lambs. Some consistently keep losses between 5 to 10%, while others in a similar production system are 15% or greater year after year. Sheep respond to management more than any other domestic specie, which is apparent during the critical periods that effect lamb mortality. Keeping detailed flock records during lambing season can document the sources of lamb mortality.

The most important step to reduce lamb mortality is to evaluate key production records from current and past lambing seasons. The key benchmarks to monitor are:

Pre-Lambing to Late Gestation (last 6 weeks)

- Percent abortion rate
- Percent pregnant ewe death loss
- Percent pre-term stillborn lambs

Post-Lambing to Newborn Lambs (0-2 weeks)

- Percent lamb crop born per ewe lambing
- Percent full-term stillborn
- Percent newborn lamb mortality

Pre-lambing to late gestation (last 6 weeks)

Preventative flock health care and a sound nutrition management plan promote higher lamb vigor and increased lamb survivability, and reduce pregnant ewe death. Based on data collected on lamb mortality, stillborn births often account for 25% of losses that occur at or near the time of lambing. Stillborn mortality can be divided into two categories: pre-term and full-term delivery.

Pre-term stillborn: In many flocks, the majority of pre-term losses are associated with abortion diseases. The top three abortion diseases include: *Campylobacter*, *Chlamydia*, and *Toxoplasmosis*. In most flocks, the incidence of pre-term delivery associated with natural causes, non-bacterial, is expected to be 2 to 4%. When exceeding this threshold, producers are advised to contact a veterinarian to submit fetal and placental tissues

to a diagnostic laboratory in order to identify the cause of the abortions. Preventing abortions is a high priority in sheep flocks. If diagnostic results identify infectious agents, then appropriate management steps can be adopted to reduce lamb mortality.

Pregnancy toxemia (ketosis) is a common nutritional disorder in sheep, generally associated with undernourished and over-conditioned ewes carrying multiple lambs, resulting in stillborn lambs and potentially ewe death. For a gestating ewe with adequate body condition carrying twin lambs, her nutritional needs can be met with good quality forage and supplemental energy (grain) equivalent to 3% of her body weight. Plane of nutrition during this period is very important to maintain a healthy pregnancy and result in sufficient fat reserves to support lactation.

Full-term stillborn: For full-term stillborn mortality, both nutrition and health are important, along with lamb delivery abnormalities. A full-term stillborn delivered in a litter of triplets or resulting from a backward presentation at birth are common. However, if entire lamb litters arrive stillborn, or there is a stillborn along with low vigor litter mates, contact a veterinarian for a diagnosis.



Photo by Lisa Surber

Successful sheep operations develop and follow a lambing management plan focused on reduced lamb mortality.

► Post-lambing to newborn lambs (0-2 weeks)

The majority (up to 80%) of all lamb crop mortality (including full-term stillborn) occurs in newborn lambs under 2 weeks of age. For live newborn lambs, the primary causes of mortality can differ by the type of production system. In production systems using a shed lambing facility, the primary challenges to newborn lambs are starvation and hypothermia, as well as respiratory diseases, scours and injury. Lambs born in pasture or range lambing systems are threatened by weather conditions and predators.

The most successful sheep operations develop and follow a lambing management plan focused on reducing lamb mortality. Whether lambing occurs in a building or on pasture, management can make a difference on the percent lamb crop reared. For pasture lambing, choosing a lambing time that has more favorable weather and utilizing predator management tools could be the key steps in reducing lamb mortality. For shed lambing, management has a greater opportunity to evaluate and take action on newborn lambs at risk of starvation and experiencing hypothermia. However, for all types of sheep production systems, the key to reducing newborn lamb mortality starts with proper nutrition and health management of the ewe flock during gestation.

Lambs born with low vigor are especially susceptible to hypothermia, more prone to injury, and eventually starvation. Lambs are born with a special source of high-energy fat called “brown fat” deposited on the heart and kidneys. The energy boost from brown fat is expected to last for at least 6 hours following birth. Those born with low vigor likely have poor brown fat stores. Low vigor lambs fall into the hypothermia classification quickly after birth even in an optimal lambing environment.

► Causes of newborn lamb mortality

Starvation: Ewe milk is the sole source of nutrients for a newborn lamb, and if not available in adequate quantities to maintain and promote weight gain, the lamb will rely on its limited body reserves. Identifying whether a lamb is receiving adequate mother’s milk is important to limit lamb mortality. The ewe’s ability to feed lambs should be evaluated. Lambs should be full and ample capacity should remain in the udder. If lambs are constantly suckling, it is a clear sign that milk capacity is limited.

The opportunity to intervene and rear lambs artificially with milk replacer is limited in a pasture and range lambing system. The ewe’s ability to supply newborns with colostrum and milk without human intervention is paramount. Selecting flock replacements with excellent maternal traits, including milk production, are critical to reducing newborn loss due to starvation.

A common challenge in the U.S. sheep industry is “hard bag,” a non-mastitis condition that severely limits or renders the udder completely nonfunctional. Hard bag associated with ovine progressive pneumonia (OPP) has been a chronic problem in the industry; it is common to find a 10% to 15% incidence in flocks. Genetic screening technology for OPP resistance has been developed and adoption of this technology is expected to sharply reduce the incidence of the hard bag condition in ewes.

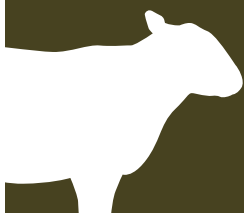
Hypothermia: Hypothermia can occur in any lambing system when the thermal regulatory capacity of the wet newborn lamb is overwhelmed. To determine whether a lamb is hypothermic, its temperature must be checked with an animal thermometer; normal body temperature is 102.5° F. Too often producers rush to supplement colostrum to hypothermic lambs resulting in death due to anaphylactic shock. Many techniques can be used to recover a hypothermic lamb; the use of artificial heat and the inter-peritoneal administration of a warm dextrose solution into the abdominal cavity to supply an immediate energy boost. To provide artificial heat, a warming barrel can be installed in a lambing pen. When the lamb’s mouth is warm, it is safe to administer 4 ounces of colostrum.



A lamb warming barrel provides artificial heat and can be installed in a lambing jug. Learn how to make your own by viewing South Dakota State University’s iGrow YouTube channel: <https://www.youtube.com/watch?v=Nr6agIDpwTO>

Predation: Wildlife, especially coyotes, prey on sheep flocks in any type of management system and geographical location in the United States. However, young suckling lambs in grazing systems with extensively managed operations are the most vulnerable. Many resources are employed to protect lambs and adult ewes from predation including state or federal animal damage control professionals, improved fencing, and the use of guard animals. Guard dogs, donkeys or llamas are often used to ward off predators.

Lamb Resource Center



The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.

Reduce lamb loss in a lambing facility

RECOMMENDATIONS FOR IMPROVEMENT

Well-designed facilities and attentive management during lambing time can improve newborn lamb survival. The following recommendations should be considered to improve the care and well-being of newborn lambs.

Temperature and ventilation: The location of the receiving pen and lambing jugs/pens should be temperature controlled at 35 to 40° F. Natural or mechanically supported ventilation is important to maintain temperature and reduce the moisture in the facility housing the newborns. These actions reduce the incidence of common causes of newborn lamb mortality including hypothermia, respiratory diseases and scours.

Drop pen: Allowing ewes to deliver lamb(s) in designated receiving pens with familiar surroundings will reduce stress. Ewes should complete the lambing process before moving to a lambing jug/pen, unless environmental conditions require sooner action. Teats should be stripped at this time to remove the wax plug and to evaluate milk production. Afterbirth material should be properly disposed to minimize disease transfer.

Lambing jugs: Jugs/pens should be a minimum of 5' x 5' or 6' x 6' for larger framed ewes. Immediately after the ewe is brought into the lambing jug, the lamb's navel is clipped to about one inch and dipped with strong iodine (7%). Teats should be stripped to ensure the lamb can suckle colostrum and that no udder dysfunction exists. Supplemental Vitamin E can be given to newborn lambs using an oral or injectable product.

Colostrum intake: Nothing is more important following lambing than a lamb's consumption of the ewe's colostrum or "first milk." This liquid is extremely nutritious with high levels of fat, but most importantly, it contains critical antibodies that enable lambs' immune systems to function properly. Absorption of antibodies by the lamb gut declines to less than 50% capacity at 12 hours. If administered using a lamb saver tube, it is recommended to deliver 0.5 ounces per pound of body weight, generally 4 to 8 ounces per feeding, and repeated every 4 to 6 hours until the lamb suckles voluntarily. By 24 hours, a 10-pound lamb should have consumed 20 to 30 ounces of colostrum.

Photo by Lisa Straber



Nothing is more important following lambing than a lamb's consumption of the ewe's colostrum or "first milk."

Colostrum shortage is common. Supplements have been shown to be helpful but the source from a ewe is preferred. At least 4 to 6 ounces of ewe colostrum should be given to newborns before relying on milk replacer or other milk based supplements. Hypothermic lambs must be warmed to normal body temperature (102.5° F) before delivery of colostrum to avoid anaphylactic shock.

Lamb saver tube competency: Using this device will save more newborn lambs and valuable time than any other consideration or investment during lambing season.

Daily health observation routine: Lambs must be observed every 2 to 3 hours for general health, vigor, and to evaluate ability to suckle. Lambs may require assistance with suckling. The use of a lamb saver tube can be implemented and repeated every 4 hours until lambs succeed without shepherd intervention. If lambs show signs of scouring or dehydration, e.g., hunched up, gaunt, loss of vigor, a veterinarian should be consulted. Ewes should be offered good quality forage and an increasing amount of supplemental grain. A good appetite and observed cud-chewing are positive signals on her health status.

Wet grafting adoption: Grafting, or fostering, is the transfer of a lamb from one ewe to another ewe that is not its mother. Adoption to a ewe with adequate milk is most successful at delivery. This practice is implemented with triplet born lamb transferred to a ewe without a lamb or a fresh born single.

Artificial rearing: Evaluation of the ewes' ability to supply adequate milk is important. Decisions on artificial rearing lambs using lamb milk replacer should be done in the first 24 hours. The automated commercial lamb milk replacer delivery technology (for example, Lac-Tek or Nursotek) have made artificial rearing an easy choice resulting in lower lamb loss.

Bonding time: The ewe and lamb(s) should remain in a jug for a minimum of 48 hours, if space allows, to create a necessary bond. Once the

Continued on next page

Reduce lamb loss in a lambing facility (cont.)

pair has bonded, they can be moved to a community pen with no more than 10 ewe-lamb pairs. Gradually, the number of pairs can increase until a lactating group reaches 25 to 35 ewes, while ensuring at least 25 square feet per pair. Lambs showing weakness or illness should be held back.

Identification: Individual identification ear tagging and paint-branding (optional) for the ewe and her offspring is an important component in reducing lamb mortality especially in the case of starvation. Paint branding both the ewe and her offspring is a common practice to aid in health observations especially when the ewe and her lamb(s) reach the community pens. The entire family gets the same paint brand number on both sides of their bodies. Industry adoption of electronic identification based on radio frequency identification (RFID) technology offers an upgrade in tracking ewe and lamb pairs.

Recording lambing data: A lambing notebook is a permanent treasure of information on the lambing season and serves as the template to make improvements in future lambing seasons. It is always better to have too much written information than not enough. Recommendations of record information to collect:

- Ewe and lamb(s) paint brand or ear tag numbers
- Date and time of birth
- Any assistance given
- Any problems with the lamb(s) or the ewe
- Any treatment given
- Any special needs
- Mothering ability score
- Lamb vigor score
- Lamb losses with any information available, include a suspected cause of death

Author & reviewers

Author: Jeffrey Held, Ph.D., South Dakota State University, Brookings, South Dakota

Contributors: Heidi Carroll, M.S., South Dakota State University, Brookings, South Dakota; Jessica Reiners, South Dakota State University, Brookings, SD

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrill, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change



Increasing Your Lamb Crop Series

Test for Pregnancy Status

Introduction

Pregnancy detection in the ewe provides the opportunity to adjust nutritional and lambing management to save on feed and labor costs. The old rule of thumb that “one open ewe takes the profits of five producing ewes” may be true when all costs are calculated. Early determination of fetal numbers and gestational stage gives the option of sorting for nutritional demands in late pregnancy and early lactation. Without this information, the single bearing ewe is being fed too much, or the twin bearing ewe too little. Open ewes are robbing the pregnant ewes of necessary nutrition. Grouping according to gestational stage will also save on labor and allow for better utilization of facilities and biosecurity.

The key in any type of business is producing an end product, or more simply put, production. The economic benefit of pregnancy testing in cattle, whether it be beef or dairy, has been proven time and time again. The product at the farm or ranch level from a cow is the calf and milk. Individual production must be taken into account in those businesses and boils down to pounds of meat or milk produced per cow. This is not only looked at annually, but also over the lifetime of the cow. The earlier one can tell if there is a viable pregnancy the more potential for higher profit. So why is this so different in sheep? Or is it?

Pregnancy diagnosis in cattle is conducted via rectal palpation by a veterinarian palpating the uterine tract for the presence of a fetus and determining age based on the size of the fetus. Due to the size of the ewe, this has not been an option. This left ewes being pregnancy tested, often referred to as bagging, to some degree at shearing, with questionable accuracy. Or ewes that have not lambed with group 1 get put in with group 2, and so on, until the end of lambing season. This was the case until ultrasound technology became more affordable, making it more beneficial to utilize.

Pregnancy testing methods

Marker paint – For a smaller, more intensively managed breeding system, the use of marker paint, or a harness on a ram, can provide limited information on the pregnancy status of



Waves are transmitted from the handheld ultrasound probe to and from the specific body tissue forming the ultrasound image.

a ewe. It is not fool proof as not all ewes marked will become pregnant and remain pregnant. Recording each marked ewe is required on a daily basis and grease or chalk must be reapplied as needed, changing the color at 14-day intervals. A ewe may continue to be re-marked, even though she may already be pregnant. This is common with an aggressive ram, certain ewes and/or tight quarters. A noted benefit of using markers is the potential to see a ram breeding problem earlier if all ewes continue to re-mark.

Blood testing – Blood testing is another method for pregnancy checking ewes. Measuring blood progesterone concentration has been trialed several times. A pregnancy-specific protein B (PSPB) may also be tested for in the blood after 30 days of pregnancy with relative success. This will provide an idea of pregnancy status, but does not indicate fetal numbers or stage of the pregnancy. Some false negatives may occur if the ewe is around 30 days pregnant.

Ultrasound – Ultrasound imagery is the most reliable form of pregnancy checking the ewe. More information will be gained by the producer, giving him or her the tools to make better management decisions.

Ultrasound technologies were developed through the scientific study of sound waves. The older, A-mode ultrasound technology does not produce an image. It is widely available and, in recent years, has made a comeback in sales due to marketing. It has a beep and/or light that goes on when the pregnancy is detected. What actually is being detected is fluid, therefore, accuracy is quite variable. The B-mode ultrasound technology has the capability of producing an image. Waves are transmitted from crystals in the handheld ultrasound probe to and from the specific body tissue forming the ultrasound image in gray scale on the screen. The denser the tissue the lighter or whiter the tissue appears, such as bone, whereas liquid appears black on the image. Although ultrasound equipment was initially developed and used in human medicine, the development of equipment for use on animals has been slow because of high cost, portability and durability.

Ultrasound provides information

Pregnancy checking the ewe with an ultrasound can provide very beneficial information. The following will help producers know what can be identified and some of the ways to use this information.

- **Pregnant or open** – Save feed for the pregnant ewes; they are the ones that need it. Cull all open ewes as soon as possible to save on feed, labor and medicine costs.
 - Ewes that are consistently open should not be retained. Without a lot of medical intervention, testing or hormonal therapy, these ewes will not get pregnant. Get rid of those barren ewes now.
 - Healthy animals are less labor intensive, saving time, medicine and money. When a ewe has aborted, or is a poor doer, they often have chronic problems preventing them from getting pregnant. An ultrasound image may detect the problem, depending on the severity of inflammation and damage. Producers are encouraged to cull those ewes to clean up the herd.
 - Stop the spread of disease and cut your costs. When debilitating or reoccurring problems, such as footrot, are present, it is a great time to pregnancy test and cull open ewes.
 - **Example:** The medicine needed to treat footrot in a 170-pound ewe could be LA200, at \$1.10/injection with multiple treatments often necessary (average 4X). The generic version of Oxytet 200 is \$.50/injection. Using Draxxin is \$9.00/dose; Zactran is \$6.00/dose.
 - If producers incorporate unseasonal breeding, it is advantageous to know the pregnancy status as early as possible allowing open ewes to be put back into the breeding group sooner.
- **Fetal counts** – Efficiently manage the proper care and nutrition of the pregnant ewe depending on the number of lambs she is carrying. A ewe carrying multiple lambs requires 25% higher nutritional energy than ewes carrying a single. Proper



The portable ultrasound has been a game changer for the amount of reproductive information collected and utilized in livestock production.

nutrition can prevent fetal loss and/or prevent difficult lambing, poor colostrum, poor milk production, poor mothering and pregnancy toxemia.

- Single bearing ewes can be lambed out on the field or pasture – with or without the use of a dog or donkey - with little oversight or labor.
- Ewes with multiple lambs can lamb in a shed, getting the added care for higher lamb survival.
- Some ewes with single lambs can be utilized for grafting of a triplet.
- **Gestational dates** – The diameter of the fetal thorax or head can be used to estimate the number of days pregnant.
 - Use this information to group animals according to when they will lamb when space is limited in the shed or corral for the close up group.
 - Use the estimate to group according to nutritional needs.
 - It is useful to have estimated day pregnant when a ewe gets marked multiple times by a ram.
 - This is important information, as well, for 4-H or FFA shows and the purchase of a bred ewe.
 - The estimate will also help you to simply get a full night of sleep when you know that no ewes will be lambing until the following weekend.

Lamb Resource Center

The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.

Testing early

The earlier producers are able to pregnancy check the ewe, the earlier she can be managed correctly. Whether to cull, feed accordingly or put into a different breeding group, the advantages of ultrasound will save time and money.

The best time to schedule a flock's ultrasound is when the ram is turned out with the ewes. Timing is very important when counts and dates are needed. There are, however, limitations to the information an individual ultrasound technician can provide based on the technician's experience, the ultrasound machine used, the facility, the amount of help provided and the timing of the scanning after mating.

Producers should be prepared to follow any requests of the ultrasound technician prior to pregnancy checking ewes to ensure scanning accuracy. Fetal death loss does occur and will vary greatly between producers, which can be the result of poor nutrition. Producers should be observant and notice what and how much animals are eating. They should also watch for signs of illness, injury and stress. Helpers on the farm or ranch should also know what is going on and why.

Ultrasound technology is the most useful and practical method for pregnancy checking the ewe. The earlier in the pregnancy the ewe can be scanned, the earlier she can be properly managed to avoid problems. Pregnancy checking will save time, medicine and labor all adding to the bottom line. It will provide valuable information to help producers determine which animals to retain and which animals to cull based on lack of productivity or the presence of disease.



Photo by Lisa Surber

Ewes with multiple lambs can lamb in a shed, getting the added care for higher lamb survival.

The **earlier** in the pregnancy the **ewe can be ultrasounded**, the earlier she can be properly managed to **avoid problems**.

One producer benefits from early ultrasound

In 2002, the producer of a small farm flock in Colorado came across a "great deal" – free pasture for the late summer and fall. The grass was good quality and water was nearby.

Late that fall, the 48 head of black face ewes were ultrasounded. The ewes were in good body condition with no visible signs of illness. There was a difference in the appearance of the pregnancy on a couple of ewes noted by the sonographer. Upon a closer look, it was described as floating cobwebs; several of the fetuses were showing movement with visible heartbeats. Randomly, a ewe would come through the chute with the skeleton of the fetus appearing normal. The amniotic fluid was clear with the proper amount in proportion to the fetus. The fetuses were still, lying on the floor of the uterus and no heartbeats were detected.

The differences between this and a normal, healthy pregnancy were shown to the producer and several questions were asked regarding flock health, any early abortions, vaginal discharge, loss of wool, etc. No signs of illness were noted, nothing that alerted the producer. Only eight of the tested ewes showed completely healthy, normal-appearing pregnancies, and three others were open. The timing of scanning was early enough that the ram was turned back in with ewes that day.

Two weeks later, the producer remembered when he had removed the ram. The ram appeared more ragged than normal at the end of the breeding season with a slight respiratory problem and had some wool break. Something, potentially a bluetongue virus, had gone through the flock. No abortions or vaginal discharges were ever seen during the next month. The ewes, being in good health and on a good nutritional plan, absorbed the fetuses.

Out of the original 48 ewes, the 8 showing normal pregnancies lambled on time with healthy lambs. Luckily, the producer had ultrasound pregnancy checks and was able to cut his losses. With reintroduction of the ram, the remaining 40 ewes did go on to produce lambs in May.

► Authors, contributors & reviewers

Authors: Geri Parsons, Optimal Livestock Services, Fort Collins, Colorado, and Cleon Kimberling, Ph.D., Optimal Livestock Services, Fort Collins, Colorado, and Colorado State University Professor Emeritus, Fort Collins, Colorado

Contributors: Jay Parsons, Ph.D., University of Nebraska – Lincoln, Lincoln, Nebraska; Bill DeMoss, Mountain Vet Supply, Fort Collins, Colorado, and the awesome sheep producers we work with

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

► Literature cited

All data are from records kept by the authors including Sheep Integrated Resource Management Records. (1983-1993), Veterinary Extension Records (1993-2009) Cooperative Extension Service and Department of Clinical Sciences, Colorado State University and Ultrasound Management Records (2009-2015) Optimal Livestock Services, Fort Collins, CO.

► More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change



Increasing Your Lamb Crop Series

Disease Prevention and Treatment

Introduction

Transmissible diseases are preventable when producers implement biosecurity practices. To help prevent spread of disease, a two-week quarantine of newly purchased sheep, those returning from a show or from being bred elsewhere should be enforced. Quarantine includes keeping these sheep separate from the home flock. The stress of movement can trigger underlying diseases in sheep. Testing for Ovine Progressive Pneumonia virus (OPPV) and Johne's disease will prevent introduction to the flock.

Lamb mortality is largely responsible for limiting profitability. For decades, lambs have died due to disease that can be prevented. Lamb deaths can be categorized in three ways:

- Lambs die prior to and at birth
- Lambs die at pre-weaning
- Lambs die post-weaning, but before marketing or retention

Common sheep diseases that affect the size of a producer's lamb crop fall into categories of nutritional, infectious, management-induced and metabolic causes. Many of these diseases are preventable with best health management practices, including sound nutrition, timely vaccinations, parasite control and improved biosecurity practices. New or small flock producers should become familiar with the signs and symptoms of specific diseases.

Sheep production can be more profitable through consultation with professionals, such as a knowledgeable veterinarian. However, sheep health work often comprises only a minority of most veterinarians' practices, so there may be instances in geographic areas where interest or expertise are lacking. Additional information can be accessed on the Maryland small ruminant website, sheepandgoat.com, and the *SID Sheep Production Handbook*, vol.8.

Chronic diseases

Major diseases that negatively affect lamb crop can be chronic in nature and result in ewes or rams with poor body condition scores (BCS), thus producing fewer embryos, fetuses and, ultimately, the birth of fewer live or less vigorous lambs. Examples of chronic diseases that can influence flock productivity include foot scald,

foot rot and foot abscess. Diagnosis requires examination by an experienced individual. Treatment and prevention hinge on the correct diagnosis. For example, scald may be treated with a walk-through foot bath or individual application of 10% zinc sulfate and then moving the group to drier footing. Area around animals' water sources and feeders should be kept dry.

Foot rot treatment requires a more intensive approach involving examination of all feet of every sheep in the affected group, individual antibiotic treatment and housing on dry ground during treatment. Unresponsive sheep must be culled.

While buying sheep from foot rot-free flocks is an option, guidance is appreciated by flock owners with foot rot present in their flock. Eradication of foot rot is possible during the non-spread periods, or dry times of the year. Producers should examine every foot with minimal trimming to assess infection status. Infected sheep can be culled or treated with long-acting tetracycline or gamithromycin and kept on dry ground. The group of uninfected sheep must be re-checked to ensure they remain uninfected. Another approach is to treat all of the sheep in the flock with the antibiotic and keep sheep off contaminated areas for a minimum of two weeks. Foot abscess is an individual animal problem that may or may not respond to antibiotic treatment and foot soaking in an antiseptic solution, depending on the chronicity and extent of the abscess. Amputation of the affected claw may be necessary.

OPPV has been shown to result in a lower lamb crop through multiple factors. OPPV infected ewes can be in a lower BCS, which itself contributes to lower reproductive rates. This virus targets both halves of the udder resulting in an accumulation of cells and scar tissue, which reduces milk production. Affected ewes that lamb with twins or triplets may be unable to successfully raise them (Keen J. 1997). Thorough explanations of testing for, controlling and eradicated OPPV are available at oppsociety.org.

Bacterial mastitis is another production-limiting condition of the sheep udder. But unlike OPPV, bacterial mastitis only affects one side of the udder. The timing of infection varies in the ewe. This condition is rarely a flock problem but has a significant impact

Continued on next page

► Chronic diseases (cont.)

on milk production. Chronic low-grade mastitis infections often go unnoticed by producers until an affected ewe's lamb is found starving. There is also an acute form of mastitis where an affected ewe becomes very sick from absorption of systemic toxins from the infected mammary gland causing a high fever and generalized toxemia. The usual cause of this type of mastitis is either one of two possible bacteria, *Manheimia hemolytica* or *Staphylococcus aureus*. The affected gland is destroyed by this infection. Environment plays a role in the occurrence of bacterial mastitis. Mastitis risk increases from damp, dirty bedding in confinement housing or bedding in the same location especially under trees where limited shade concentrates animals or after wet weather. Immune function also contributes to the occurrence of mastitis. Immune function is affected by micromineral (copper, selenium, zinc, manganese) intake. Producers should routinely feel ewes' udders at lambing and weaning, for asymmetrical halves and hard lumps, record findings, and cull ewes with damaged udders. Attention should be paid to the dryness and cleanliness of the environment of lactating ewes by bedding pens or moving grazing ewes to minimize areas that are muddy or have a concentration of sheep feces.

During pregnancy, contagious infectious agents can cross the placental barrier and infect the gestating fetus, resulting in late-term abortion. If infected earlier in pregnancy, the fetus can be resorbed and the infected ewe appears open during ultrasound scanning or at lambing. The three most common agents that cause abortion in sheep are *Campylobacter* spp., bacteria; *Toxoplasma gondii*, a protozoan parasite; and *Chlamydomphila abortus*, a rickettsia bacterium. These agents are transmitted through sheep's oral consumption. Toxoplasmosis is spread by young, immunologically naïve cats eating infected rodents and those cats defecating on feed, including stored grain, hay or pasture. The other two agents are spread by infected sheep via feces or aborted material. In the face of an outbreak from Chlamydial abortions, long-acting injections of oxytetracycline may be helpful. In the face of an outbreak from *Campylobacter*, an antibiotic sensitivity should be performed as these bacteria have become less predictable regarding which antibiotic may be effective.

► Reduce risk of abortion

- Keep ewes in good BCS throughout pregnancy
- Provide access to mineral specifically formulated for sheep, every day
- Avoid overcrowding
- Use feeders to limit feeding off the ground
- Keep stored feed safe from fecal contamination by young cats
- Remove known and suspect aborting ewes from the rest of the pregnant flock

These disease agents frequently enter a previously uninfected flock via purchased ewes. When possible, ewes of different sources should be kept separate during their first pregnancy and mixed after lambing. Vaccines are available in the United States for some *Campylobacter* spp. and *Chlamydomphila abortus*. Annual vaccination against *Campylobacter* or chlamydial abortion pre-breeding and at mid-gestation is advised in at-risk flocks where the disease has been diagnosed or is suspected, or in recently purchased ewes.

Preventative feed additives, such as Deccox®, have been proven to be effective against toxoplasmosis. Veterinary assistance is critical in guiding a flock's specific approach when faced with an abortion outbreak. Aborted fetuses and placentas must be submitted to a veterinary diagnostic laboratory to diagnose the cause of abortion.

► Late gestation disease

Metabolic diseases of late gestation include pregnancy toxemia, which is also referred to as ketosis, and hypocalcemia. Pregnancy toxemia can affect multiple ewes in a flock that are usually pregnant with two or more lambs. These ewes are not eating enough energy for their needs. Regrouping the affected and at-risk ewes will reduce further cases. This can be done by sorting the late pregnant ewes with BCS of ≤ 2 into a "special needs" group. Ewes with very large bellies should also be sorted into this group as they are most likely carrying triplets. This group needs to be fed more energy, which can be accomplished a variety of ways depending on feedstuffs available.

Hypocalcemia can be seen in late pregnant ewes after a feed change or after stressful episodes. The calcium demands 3 to 4 weeks prior to lambing are high, and will continue to increase due to calcification of fetal bones. Since it takes 24 hours for calcium to be mobilized from bones of the ewe to the fetus, ewes are susceptible to developing low-serum calcium. While this condition is straight-forward to treat, producers should consult a nutritionist to determine feed changes. Rapid response to calcium treatment is a means of identifying low calcium from ketosis. Most hypocalcemia cases occur in late gestation in sheep.

Lamb Resource Center



The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.



While there are many diseases that overlap between pre- and post-weaning, the primary cause of mortality in grazing lambs is parasitism, including stomach or intestinal worms and coccidiosis. While both infections can be managed, producers should consult their veterinarian if unfamiliar with symptoms and treatment.

Pre-weaning disease

The most common pre-weaning lamb health issues are hypothermia, starvation, naval infections, pneumonia and diarrhea. The prevalence of these diseases is affected by the health status and BCS of the ewes and adequacy and management of the lambing facilities. Producers should record lamb losses to guide future management changes. Inexperienced producers should work out a base cost for lamb necropsies to be performed by their veterinarian. Recommendation of prevention options for the top three conditions diagnosed should be included with this service.

Hypothermia can be a primary cause of death when the ambient conditions are too cold and/or wet for newborn lambs. It can also be a secondary cause of death when a lamb has been milk-deprived over a few days during cooler weather. Starvation occurs due to lack of milk because of mastitis, poor genetics, udder/teat conformation or inadequate ewe nutrition. Naval infections result from exposure to a wet environment prior to umbilical cords drying and falling off. Insufficient colostral intake may be a risk factor in these infections. Pneumonia in neonatal lambs is often the result of inadequate ventilation and deficient tissue mineral levels necessary for immune function. Diarrhea in baby lambs can result from different infectious agents where contamination levels become higher because of overcrowding, poor sanitation, and poor colostral intake and absorption. Causes include bacteria such as *E. coli*, *Salmonella* spp., or *Clostridium perfringens* type C, or viruses including strains of rotaviruses which may be acting in combination with *Cryptosporidium parvum*.

Post-weaning disease

Common post-weaning diseases include acidosis and enterotoxemia. Lambs on lush pasture or free choice concentrate,

that have not received a complete series of vaccinations against *Clostridium perfringens* type D are susceptible to rapid overgrowth of this bacteria. The condition shows up as a very sick lamb that dies within a few hours of becoming ill. Often a few lambs are initially affected. The group should be re-vaccinated immediately. Half to one pound of dry hay should also be fed in addition to the lambs' regular feed. The outbreak generally stops after vaccination.

Acidosis is caused by excess intake of concentrates when:

- Lambs eat too much at self-feeders
- Varied feed consumption changes due to groups of lambs being turned in together
- Feed intake fluctuates because of dramatic changes in weather or the ration is aggressively changed to include higher percentages of concentrates

While there are many diseases that overlap between pre- and post-weaning, the primary cause of mortality in grazing lambs is parasitism, including stomach or intestinal worms and coccidiosis. While both infections can be managed, producers should consult their veterinarian if unfamiliar with symptoms and treatment.

Flock owners should employ best health practices that are specific for their region and management style. Information to guide which local practices to adopt are readily available from fellow sheep producers, local veterinarians, extension staff, and peer-reviewed websites including sheepusa.org, wormx.info and sheepandgoat.com.

Author & reviewers

Author: Cynthia Wolf, D.V.M., University of Minnesota, St. Paul, Minnesota

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>

Literature cited

Keen, J. E., L. L. Hungerford, E. T. Littledike, T. E. Wittum, and J. Kwang. 1997a. Effect of ewe ovine lentivirus infection on ewe and lamb productivity. *Prev. Vet. Med.* 30:155–169.

Sheep Medicine, 2nd ed. P. Scott, CRC Press, 2015.

SID Sheep Production Handbook, vol. 8, 2016.

American Consortium of Small Ruminant Parasite Control website: wormx.info



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change



Increasing Your Lamb Crop Series

Match Reproduction to Management

Introduction

Sheep adapt easily to their environment and readily respond with increased lamb production when appropriate management practices are applied. Sheep producers who are aware of productivity best practices can assess their present inputs of land, labor, capital and management, and then develop a plan to improve reproductive efficiency to a level that meets profitability goals. Reproductive performance may range from a low of 60% to a high of 225% within the same breed of sheep. The ewe's reproductive performance is a result of effective productive inputs and the producer's management practices.

The ewe's **reproductive performance** is a result of effective **productive inputs** and the producer's **management** practices.

The **Increasing Your Lamb Crop Best Practices** fact sheet series, of which this is just one, provide specific management practices to integrate into a sheep enterprise based on each producer's situation. The degree to which best practice is implemented varies for each producer, and with each type of management system and geographic location. A benefit to raising sheep is their responsiveness to varying degrees of management. A comparison of sheep production management models will help producers determine which one they currently operate under, and will allow them to evaluate the opportunities to modify management practices to meet reproductive efficiency goals.

Lamb Resource Center

The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.

Production varies with management, resources, locale

The farm flock production model experiences a completely different level of demands on management, labor and feed resources versus a range flock production model. As these models are considered, it is important to understand that in no situation should animal health and welfare be compromised for the sake of economic gain. Some production systems may experience higher levels of lamb mortality than others. It is always in the best interest of the producer to make certain appropriate management practices are being conducted to ensure the best outcomes for the livestock and the producer. Environment and weather influence reproductive success and producers need to practice due diligence through their management to lessen any negative impacts.

Farm and range flocks can be categorized into low input or high input flock management systems. Lambing and weaning percentages are directly related to the level of management, land, capital and labor invested. Sheep producers who have access to large land resources can expect ewes to meet their nutritional needs for maintenance, breeding, gestation and lactation by grazing standing forage through most of the year. Input costs are lower with less labor involved and less need for physical structures. However, the variability of the weather has greater year-to-year influence on reproductive performance.

Lambing and weaning percentages are directly related to the level of **management, land, capital** and **labor invested**.

Range lambing holds less opportunity to control and manage environmental challenges, but can take advantage of the ewes natural reproductive and maternal instincts. Many range flock producers use shed lambing to reduce lamb loss due to extreme weather, allowing the producer to take advantage of best management practices to improve the ewe's reproductive

Continued on next page

Production varies with management, resources ... (cont.)

efficiency. This also allows producers to identify parentage of lambs, so that culling and ewe lamb replacement decisions are based on yearly productivity. When lambs are bonded with ewes and are performing well, the flock is returned to grazing.

Competition for land resources can reduce availability and increase cost of this productive input. Farm flock production systems lessen the need for land resources and the impact of weather by reducing those challenges through greater investment in productive inputs such as labor, capital and higher levels of management. Greater investment in productive inputs requires a greater reproductive performance in order to profit. This system allows sheep producers to lamb out of season and possess a marketing advantage by providing finished lambs when inventories are lowest.

No one best production system

The most appropriate production system varies from operation to operation. The key is to match lambing rate to the available resources. As lambing rates increase from implementation of key management practices, additional planning should be given to the increased prolificacy. Providing additional nutrition for ewes with multiple lambs, methods of rearing orphan lambs and determining optimal weaning dates become priorities for the producer's flock management.

Sheep producers can compare their current reproductive efficiency against the Reproductive Key Indicators. This activity will provide an objective assessment of the current production system's reproductive efficiency. Initially, sheep producers are able to identify key indicators that can be targeted for immediate improvement without greatly altering the current production system. For example, a low input farm flock's "ewe lambs lambing" rate is below 65%, so this farm flock's producer can address this key indicator by developing ewe lambs through a different management group. Likewise, a low input range flock that does not meet the low input "lambs weaned" key indicator can easily incorporate a number of productivity best practices from available fact sheets such as, "Culling Underperforming Ewes," by identifying and removing dry ewes at end of the lambing season and/or providing optimal nutrition during breeding, gestation and lactation.

When setting realistic reproductive efficiency goals, producers need to assess the strengths and limitations of the available productive inputs that are dedicated to the current sheep production operation. This assessment will indicate how some inputs are underutilized and how the lack of an input limits the reproductive efficiency. An investment in a specific productive

Record Keeping



Information is fundamental for making improvements, and the cornerstone is keeping flock production records. The record system can include paper-based or computerized records, or a combination of both. What's important is that producers find a system that allows them to make decisions based upon what is actually happening day-to-day.

Date	Ewe Name	Lamb Name	Sex	Weight	Remarks
10/15/17	10334	10334	F	12.5	
10/15/17	10335	10335	M	13.0	
10/15/17	10336	10336	F	12.8	
10/15/17	10337	10337	M	13.2	
10/15/17	10338	10338	F	12.9	
10/15/17	10339	10339	M	13.1	
10/15/17	10340	10340	F	12.7	
10/15/17	10341	10341	M	13.3	
10/15/17	10342	10342	F	12.6	
10/15/17	10343	10343	M	13.4	
10/15/17	10344	10344	F	12.5	
10/15/17	10345	10345	M	13.5	
10/15/17	10346	10346	F	12.8	
10/15/17	10347	10347	M	13.6	
10/15/17	10348	10348	F	12.9	
10/15/17	10349	10349	M	13.7	
10/15/17	10350	10350	F	13.0	
10/15/17	10351	10351	M	13.8	
10/15/17	10352	10352	F	13.1	
10/15/17	10353	10353	M	13.9	
10/15/17	10354	10354	F	13.2	
10/15/17	10355	10355	M	14.0	
10/15/17	10356	10356	F	13.3	
10/15/17	10357	10357	M	14.1	
10/15/17	10358	10358	F	13.4	
10/15/17	10359	10359	M	14.2	
10/15/17	10360	10360	F	13.5	

input can overcome the limitation of another input. For example, a sheep producer lacking land resources to provide ewe nutrition with grazing can compensate this limited input by developing a dry lot system to house and feed ewes, provided that knowledge, labor and capital inputs were available to develop and operate a dry lot facility. The level at which the productive inputs are available will dictate which input category, high or low, the producer is able to apply. When considering productive input investment, expected reproductive efficiency must provide enough return to recover the expense and add profitability to the operation. For example, there are management tools available to change a flock's weaning rate from 85% to 125%. This is a 47% increase in gross flock return. However, failing to invest 25% more inputs (feed, labor, services) to attain a 50% increase in revenue is not uncommon. There is a cost to increasing productivity and, ultimately, profitability. Remember the quote, "nothing ventured, nothing gained"? It applies to increasing reproductive efficiency, too.



Develop an action plan

After completing the “Reproductive Key Indicators” assessment and identifying the level each productive input can be committed to the enterprise, sheep producers should develop an action plan toward achieving realistic reproductive efficiency targets.

Each of the 12 *Increasing Your Lamb Crop Best Practices* fact sheets provide specific recommendations to implement the practice. Producers should:

1. Select and implement the practices that will have the most immediate and greatest impact to reproductive efficiency.
2. Identify and plan the steps to implement future productivity best practices that require greater consideration of productive input investment.

Resources and support for development and implementation of the 12 lamb crop best practices, and other productivity

best practices as they are developed, can be found through the Lamb Resource Center at www.lambresourcecenter.com.

When reproductive efficiency consistently meets or exceeds the key indicator targets within an input category, then those management practices should become standard operating procedures. The addition of other management practices or other productive inputs should be evaluated based on costs and benefits to discover if there is potential for further improvement. Using best practices key indicators to match management to reproductive efficiency will ensure producers are the most successful in their sheep operations.

When **reproductive efficiency** consistently meets or exceeds the key **indicator targets** within an input category, then those management **practices** should become **standard** operating procedures.

Reproductive Key Indicators^a

Which best practices will benefit you?

Reproductive Key Indicators have been developed to help you identify and prioritize which of the Lamb Crop Best Practices you should implement. These key indicators are generalized, yet realistic, goals for both range and farm flocks so that you can assess which best practices will be of greatest value to you. Levels are included for high and low input flock management.

- **High input flocks have these characteristics:** shed lambing, herded, multiple management groups, strategic supplementation and improved pastures
- **Low input flocks have these characteristics:** range/pasture lambing, fenced pastures, simple management groups and limited supplementation

First, identify which Key Indicator(s) you need to improve. Then, refer back to the Lamb Crop Best Practices and pinpoint which ones you need to adopt in order to reach your flock goals.

KEY INDICATOR	RANGE FLOCK		FARM FLOCK		MY FLOCK	
	High Input	Low Input	High Input	Low Input	Current	Goal
Dry Ewes	< 7%	< 10%	< 5%	< 7%		
Lamb Crop						
Born	150%	NA	200%	175%		
Docked	NA	120%	NA	NA		
Lamb Losses ^b	15%	17% ^b	11%	15%		
Lambs Weaned	127%	100%	178%	148%		
Ewe Lambs Lambing	50% ^c	30%	85%	65%		

a Data for the Key Reproductive Indicators were generated by the Reproductive Efficiency Task Force based upon research, surveys and industry experience

b Lamb losses between docking and weaning

c Generally, ewe lambs are not bred in range flocks but this may provide a great opportunity to increase overall productivity

Author & reviewers

Author: Dave Ollila, M.Ed.

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

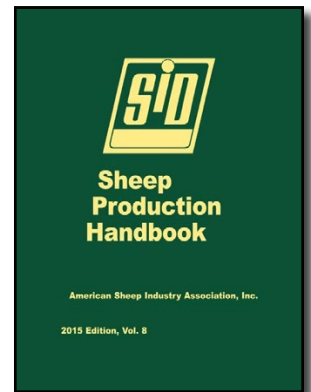
<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>

2015 Sheep Production Handbook Volume 8

This sheep industry reference book includes chapters on reproduction, management, breeding/selection, forages, nutrition, marketing, predator damage control, health, wool and dairy sheep. The cost is approximately \$90. Order from the American Sheep Industry Association at 303-771-3500, ext. 108, or go online: <http://sheepusa.org/test-sph>



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change



Increasing Your Lamb Crop Series

Testing Rams for Breeding Soundness

Introduction

A breeding soundness examination (BSE) is an overall assessment of a male’s potential ability to service and impregnate a given number of females during a given period of time. It is a picture-in-time of the male’s reproductive potential. The evaluation includes:

- A thorough physical exam
- A body condition score (BCS)
- A scrotal circumference (SC)
- A thorough microscopic semen evaluation

Rams contribute up to 75% of the genetic change in a flock, therefore, it is very important to not short cut the selection or

care of the ram. A breeding soundness exam prior to purchase should be part of buying criteria. Producers must also remember that things change; a ram can acquire a disease, such as bluetongue, pneumonia, or get injured. Additionally, any major stressor may cause a change in breeding ability and semen quality.

Rams contribute up to **75% of the genetic change** in a flock.

A BSE should be performed annually on all rams six months of age or older in a flock, allowing producers to cull less productive rams, provide adequate feed to increase or decrease body condition, provide any care or treatment as needed and purchase any replacement(s) prior to mating.

The First Steps

As a BSE is performed, the ram should be bright, alert, walk with a sound gait and have no physical lesions or signs of illness. Each individual ram must have a unique identification. All information pertaining to that ram should be recorded on a breeding soundness form.

Body condition score (BCS)

A BCS is assessed by feeling along the ribs and lumbar spine. It is based on a scale of 1 to 5. A score of 1 means a ram is very thin and under conditioned. A BCS of 5 is a very fat, over-conditioned ram that is unable to be palpated on the individual lumbar spine or dips along the vertebrae. Both a score of 1 or 5 are unsatisfactory and require feeding changes to modify the score prior to the breeding season. A BCS in between these is considered satisfactory, with a 3 or 4 ideal going into the breeding season.

Rams have a job to do and often will forego eating enough to maintain their physical condition, thus thin rams may not make it through the breeding season. Meanwhile, an over-conditioned ram will often have very poor semen quality, cause interference with other rams while they are breeding ewes, and be lazy and not perform – these are referred to as the “couch potatoes.”

Scrotal circumference (SC)

The genitalia are examined next.

The scrotal exam includes palpation of the testes and epididymi. These should be firm, with no lumps, lesions, swellings, hard or soft spots, no difference in size and no atrophy. Out of breeding season, they may be slightly flaccid.

Scrotal circumference relates to the capacity to service more ewes per breeding cycle, earlier maturing female offspring and the increase in number of multiple births produced. The heritability of SC is estimated at 35% (SID 2002). A SC is measured in centimeters.

Acceptable scrotal circumference

	Rams 6 to 14 months	Rams > 14 months
Unsatisfactory	< 26cm	< 29cm
Questionable	27 to 29cm	30 to 32cm
Satisfactory	30 to 36cm	33 to 40cm
Exceptional	>36cm	>40cm

Source: *Guidelines for Ovine Breeding Soundness Examination*

➤ Scrotal circumference (SC) (cont.)

Seed stock producers should set higher SC standards for their own flock. As part of the genitalia exam, the penis is extended fully. The penis and prepuce are examined to ensure there are no lesions, e.g., pizzle rot), injury, strictures or adhesions. Having the penis extended also allows for a clean semen collection.



A scrotal circumference is measured in centimeters.

➤ Semen evaluation

A semen sample is collected via artificial vagina (AV) or electro-ejaculation (EE). The use of AVs requires a ewe being in heat at time of semen collection and is often used when collecting for artificial insemination (AI) and/or freezing as a larger volume of semen is often collected.

EE is more often used when time is a constraint, such as with the annual breeding soundness exam, especially with multi-sire flocks. A modified calf table may be used to hold the ram during this procedure. The semen motility, or sperm showing forward progressive movement, is evaluated. The sample is diluted to show individual cell motility and the non-diluted sample should be scanned for swirling. Motility is easily influenced by poor technique, improper diluent and temperature; therefore, it has a lower threshold of 30% and above normal motility for a satisfactory rating.

The size and shape of the individual cells – the morphology – is evaluated using a phase contrast microscope, as some defects are undetectable with a regular light microscope. Any defects should be noted on the BSE form. Above 50% normal morphology is satisfactory and above 80% normal morphology is exceptional. The presence and volume of white blood cells (WBC), if found on the microscope, will be noted as it may indicate disease. This may warrant an ELISA blood test or semen PCR test for *Brucella ovis* (*B. ovis*), or other treatment and breeding soundness retest.

Lamb Resource Center



The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.

➤ The overall results and other considerations

The overall breeding soundness rating for a ram is based upon the parameters measured above. The ram will be rated as:

- E = Excellent
- S = Satisfactory
- Q = Questionable
- U = Unsatisfactory

The libido or sexual drive of the ram is not part of the BSE; therefore, it is essential to observe the sexual activity of each ram. A mature ram rated as excellent should be able to service 75 to 100 ewes in a 17-day breeding cycle under most range and semi-confinement conditions. Similarly, one rated as satisfactory should be able to breed 50 – 75 ewes in that time period (Kimberling et al., 2007). Depending on what makes a ram rate as questionable, or unsatisfactory, along with its age and prior history, will effect whether the ram warrants a retest in 30, 45, or 60 days, if at all.

Other testing may be incorporated at the same time as a breeding soundness examination but is not limited to:

- Blood testing for *B. ovis* (the most common cause of epididymitis in mature rams)
- Codon testing (scrapie or spider lamb)
- Ovine progressive pneumonia (OPP)

Most states require a *B. ovis* negative test within the past 30 days or that a ram be from a *B. ovis* free certified flock for any change in ownership. Buyers should always require this, as well as all rams over six months of age and owned by the seller, be tested and *B. ovis* negative – and get this in writing!



A modified calf table may be used to comfortably and safely hold the ram during an electro-ejaculation procedure.

Why do breeding soundness examinations?

Incorporating ram BSEs as part of production management can increase profits by \$20 to \$27 per ewe. A study in south central Wyoming was conducted in the late 1980s using a range flock of 2,800 ewes divided equally into two groups.

Group 1 was exposed to rams having a BSE of satisfactory or better. Group 2 was exposed to non-tested rams selected by traditional ranch selection criteria. At weaning, the Group 1 ewes produced an average of 17 more pounds of weaned lamb per ewe than those in Group 2 (Colorado State University, 1983-1993). Assuming a low market price of \$120/cwt and a high market price of \$160/cwt, this equates to a \$20 to 27 increase in revenue per ewe. This increased revenue was realized with a cost of \$0.60 per ewe for the BSE. The assumptions being the cost of the BSE is \$18 per ram and the exposure rate is 30 ewes per one ram.

Healthy rams with excellent semen can service more ewes in a given year and produce more lambs. In one case, a western U.S. range flock of 1,410 ewes utilizing BSE tested rams with satisfactory or better semen was able to run one ram per 85 ewes. Only 50 (3.55%) ewes turned up not pregnant. More impressively, 1,050 (74.47%) of the ewes had twins, while only 310 (21.99%) had singles and a total of 90% of the lambs were born in the first 18 days of lambing (Kimberling et al., 1999-2008). A shorter lambing season decreases labor costs and provides the producer with better feeding and marketing options with a more uniform lamb crop.

Increasing the number of ewes served per ram in an operation can have a significant impact on lowering costs per lamb produced. Assuming a 150% lamb crop and \$400 annual ram costs, using one ram per 30 ewes translates into a ram cost of \$8.89 per lamb produced. Increasing the number of ewes per ram to 50 head would lower the ram cost to \$5.33 per lamb produced. A ratio of one ram per 85 ewes would lower the ram cost to \$3.15 per lamb.

BSEs are inexpensive insurance

Producers often think if ewes are getting pregnant, they do not have a problem or need to semen test rams. If rams are not tested, they will not know if there is a problem. A BSE will:

- Identify less productive rams so they can be culled, therefore improving overall flock reproductive efficiency.
- Set the stage for a more uniform lamb crop by producing more lambs in a shorter period of time.
- Maximize ram breeding potential (higher ewe-to-ram ratio), thus allowing for fewer rams to keep, manage and replace.



The ram breeding soundness examination provides much needed information, allowing producers the ability to make better management decisions.

- Decrease the number of open ewes. In single ram operations, a BSE can save the producer from the disaster of no lamb crop.

These attributes add to the bottom line in the production scheme. Producers who have adopted BSEs, and utilize the information, look at the testing as an inexpensive insurance policy. The ram breeding soundness examination provides much needed information, allowing producers the ability to make better management decisions.

What are you paying to keep a ram for just one year?

Ram Cost/Year	
Purchase Price:	\$1,000 per Ram*
Salvage (Cull) Value:	\$170
Depreciation (4 years)	\$207.50
Interest (6%)**	\$35.10
Death Loss (5%)	\$29.25
Feed & Maintenance	\$120.00
Cost/Year	\$391.85

Annual ram costs of around \$400 are common when fully accounting for investment value, depreciation, feed and maintenance.

* Average sale price at 2015 Wyoming Ram Sale

** Based on \$585 average investment value in rams on a per head basis in any given year

Author & reviewers

Authors: Geri Parsons, Optimal Livestock Services, Fort Collins, Colorado, and Cleon Kimberling, D.V.M., Optimal Livestock Services and Colorado State University Professor Emeritus, Fort Collins, Colorado

Contributors: Jay Parsons, University of Nebraska – Lincoln, Lincoln, Nebraska; Bill DeMoss, Mountain Vet Supply, Fort Collins, Colorado, and the awesome sheep producers we work with.

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>

Literature cited

Guidelines for Ovine Breeding Soundness Examination, Society for Theriogenology.

Kimberling C.V., & Parsons G.A. (1999-2008) Breeding Soundness Evaluation Records, Cooperative Extension Service and Department of Clinical Sciences, Colorado State University, Fort Collins, CO.

Kimberling C.V., & Parsons G.A. (2007) Breeding Soundness Evaluation and Surgical Sterilization of the Ram, Current Therapy in Large Animal Theriogenology 2. Elsevier, St. Louis, MO.

Sheep Integrated Resource Management Records. (1983-1993) Cooperative Extension Service and Department of Clinical Sciences, Colorado State University, Fort Collins, CO.

SID Sheep Production Handbook. (2002). Edition, Vol.7 American Sheep Industry Association, Inc. Denver, CO.



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change



Increasing Your Lamb Crop Series

Manage for Seasonal Changes in Reproduction

Introduction

Annual lambing rate is determined by the proportion of the flock that lambs, and the number of lambs born per ewe lambing. Annual lambing rate is also affected by the frequency of lambing. In temperate regions, the seasonal nature of reproduction in sheep limits the frequency of lambing to once per year; however, three lambings in two years is often obtained in more tropical latitudes.

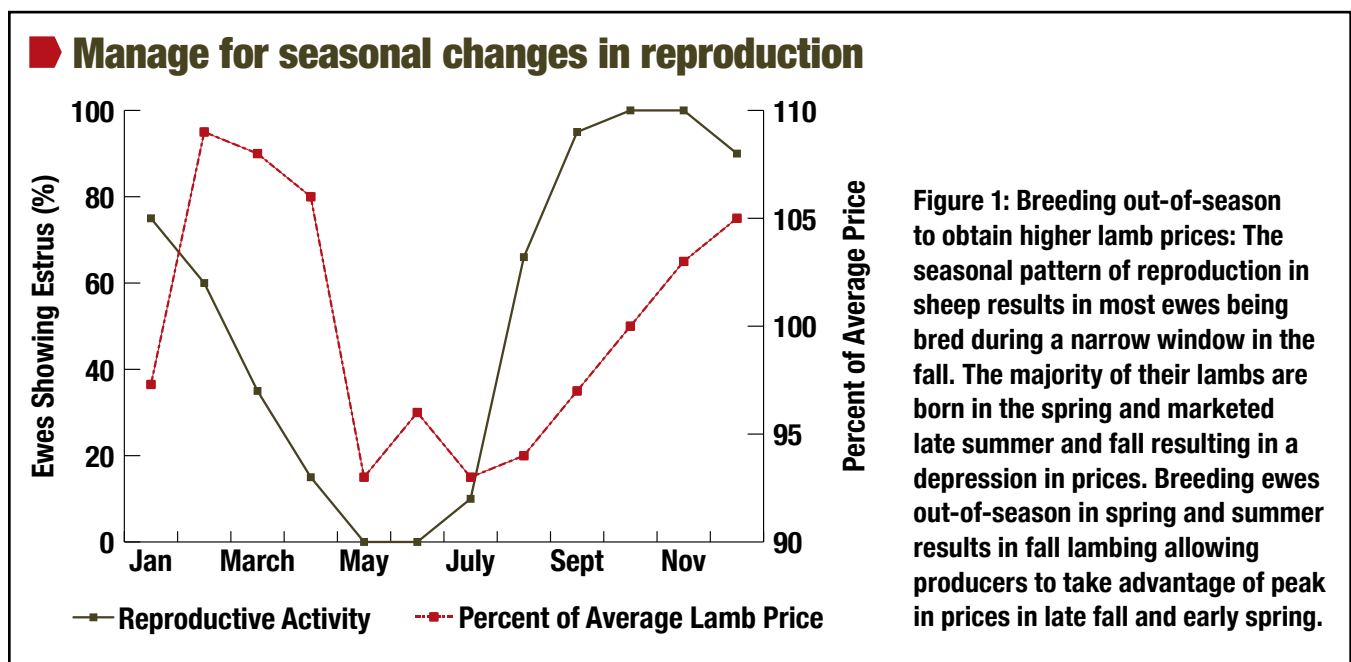
Seasonal reproduction

Temperate breeds of sheep are considered to be seasonally polyestrous with ewes having regular reproductive/estrous cycles during the fall months, after which, reproductive activity decreases, and eventually ceases in late spring and summer months in most of the flock (Figure 1). Seasonal changes in reproduction can be observed by changes in the proportion of females showing sexual receptivity (estrus/heat), but also involves an associated decline in the proportion of females ovulating and the ovulation rate (the number of eggs released each estrous cycle). The ram also shows seasonal changes in reproduction including, lower quantity and quality of semen and reduced sexual aggressiveness.

Overcoming seasonality by getting a proportion of ewes to **breed out-of-season** will not only **increase** the average number of lambs weaned per ewe, per year, but can also **positively impact marketing** of lambs.

Seasonality of reproduction in sheep is governed by and cued to photoperiod/day length. Decreasing photoperiod, or short days as occurs in fall and early winter months, are stimulatory and results in increase secretion of hormones that stimulate the reproductive system. Conversely, increasing day length, as occurs in spring and summer, results in the suppression of reproduction.

Seasonality of reproduction in sheep results in significant variation in the quantity of lamb reaching the market, which often influences price (Figure 1). Therefore, overcoming seasonality by getting a proportion of ewes to breed out-of-season will not only increase the average number of lambs weaned per ewe, per year, but can also positively impact marketing of lambs.





Overcoming seasonality by getting a proportion of ewes to breed out-of-season will not only increase the average number of lambs weaned per ewe, per year, but can also positively impact marketing of lambs.

Approaches to breeding ewes during the non-breeding season

1. **Selecting the right breeds and ewes:** The length of the breeding season varies among breeds of sheep. Most breeds of sheep that originated in the tropics, and those with Merino ancestry, have longer breeding seasons which allows for higher lambing rates to be achieved from spring-summer breeding.
2. **Photoperiod manipulation:** Exposure to an artificial stimulatory sequence of day length changes can be used to successfully breed ewes out-of-season. Specifically, exposing females to 15 to 16 hours of light during late winter/early spring for 45 to 60 days, followed by exposure to 30 to 25 days of a short day photoperiod consisting of 8 to 9 hours of light and 15 to 16 hours of darkness, will induce fertile estrus in ewes. While photoperiod manipulation can be quite effective, it requires an enclosed barn with electricity, three months of photoperiod manipulation and it does not result in synchronized estrus.
3. **Melatonin treatment:** Melatonin is a hormone that is released by sheep when they are exposed to darkness. Sheep are exposed to a longer duration of melatonin secretion during the short days in fall and winter. This long duration of melatonin secretion triggers the release of other hormones that eventually result in the resumption of regular reproductive cycles and mating. Therefore, treatment of sheep with melatonin for as little as 35 days in late spring after they have been exposed to natural or artificial long day photoperiod induces fertile mating in the summer. The use of melatonin removes the need for holding ewes in barns. However, commercial melatonin implants have not been approved for use in sheep by the Food and Drug Administration (FDA) and can only be used in the United States under the supervision of a veterinarian.
4. **Ram effect:** The anestrous period in ewes could be broken by abrupt introduction of novel rams. Pheromones, and to a lesser extent physical and visual perception, stimulates the release of hormones from the ewe that result in two peaks in estrus activity 17 and 24 days after the introduction of rams.

Lamb Resource Center



The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.



Improving lambing rates of ewes bred out-of-season

The following management practices can be used to improve lambing rates of ewes bred out-of-season:

- 1. Use the right genetics:** Hair sheep breeds – Dorsets, Polypay and Finish Landrace – are among breeds that have high reproductive rates from spring-summer breeding. Additionally, improvements in the proportion of ewes that conceive out-of-season can be made through selection. For example, the proportion of cross-bred Dorset ewes lambing from a May breeding season increased from 50 to 60% to over 85% due to selection over five generations. Therefore, using an appropriate breed combination and continuous selection can increase the lambing rate from out-of-season breeding.
- 2. Wean lambs and improve the nutritional status of the ewes:** The proportion of ewes lambing to spring breeding is almost twice as high in dry as in lactating ewes (Table 1). Ewes with body condition scores of 2.7 or higher have higher lambing rates from out-of-season breeding than do ewes with lower body condition scores. To improve lambing rates, lambs should be weaned at least one month prior to introduction of rams, and ewes could be supplemented with grain (1 to 2 lbs./day) to allow them to regain body condition.

Table 1. Reproductive performance is better in dry than in lactating ewes bred out-of-season.

Variable	Lactation Status	
	Weaned	Lactating
Estrus	95	73
Pregnancy rate (%)	75	27
Percent lambing (%)	81	45

Lactating ewes lambed 2 to 3 months earlier, while dry ewes were weaned at least 2 months prior to breeding. All ewes were pretreated with progesterone controlled intravaginal drug releasing devices (CIDRs) for 5 days prior to introduction of rams.

- 3. Isolate ewes from rams:** Ewes can become habituated to rams that are in close contact with them and so will not show the ram effect unless the rams are removed for a period of time or new/novel rams are introduced. To maximize the ram effect, separate rams from ewes for approximately one month prior to breeding so ewes cannot smell them.
- 4. Have a good age distribution of ewes:** In general, the lambing rate of ewe lambs and yearlings bred out-of-season is lower and more variable than that observed in mature ewes in part due to lower expression of estrus.

- 5. Conduct breeding soundness examination on rams prior to use:** Reproductively superior rams will not only breed more ewes, but also have higher first service conception rates, lower early embryonic death rates, and improved lambing rates. To identify superior rams, breeding soundness examinations should be performed and observation of libido, intromission, and social behavior should be done prior to use. Only rams with good sperm concentration, motility, and morphology should be used.
- 6. Use rams with high sexual activity:** The sexual activity of the ram, as assessed by the number of mounts and ejaculations, influences the percentage of ewes ovulating in response to ram effect. Sexual activity increases with age, therefore, using older rams will improve fertility. Additionally, photoperiod/melatonin treatments of rams increase their sexual activity. For example, exposing rams to a long day photoperiod (16 hours of light) during late winter, followed by treatment with melatonin or melatonin treatment beginning late spring and early summer, enhances sexual activity and increases the ram effect.
- 7. Use a high ram to ewe ratio:** The proportion of ewes ovulating, and subsequently lambing, following ram introduction during the non-breeding season is increased with a greater ram to ewe ratio. This is in part due to the lower semen quality and sexual activity of rams during the non-breeding season and synchronized nature of the induced estrus. In general ram:ewe ratios of more than 1:18, or 6 rams per 100 ewes, is recommended.
- 8. Pre-treat ewes with controlled intravaginal drug releasing devices (CIDRs):** When ewes are treated with progesterone (the hormone contained in CIDRs) for 5 to 7 days prior to ram introduction synchronized estrus and ovulation occur in greater than 70% of the ewes between 2 to 4 days after CIDR removal. Lambing rates are at least 60% higher than that observed in ewes introduced to rams only over a 30 day breeding period (Table 2).

Table 2. Reproductive performance of ewes bred out-of-season is improved by pre-treatment with CIDRs.

Variable	Treatment	
	Control	CIDR
Percent lambing (%)	41 to 45	63 to 83
Prolificacy (%)	150	150 to 160
Lambing rate (%)	60 to 68	95 to 125

Summary of results from studies in which ewes were introduced to rams alone (Control) or pretreated with progesterone (CIDR) for 5 days prior to introduction of rams.

Conclusion

Implementing practices to manage seasonal reproduction requires a small investment and some change in management practices. However, lambing rates that are equal to or greater than the current national average can be achieved from out-of-season breeding. Lambs derived from ewes bred out-of-season demand higher prices and will provide consistency in the quality and quantity of lamb in the market place (Figure 1). Moreover, when used as a component of an accelerated lambing program, out-of-season breeding will result in significantly higher annual lambing rates which will improve the productivity and profitability of your sheep operation.

Author & reviewers

Author: Marlon Knights, Ph.D., West Virginia University Division of Animal & Nutritional Sciences, Morgantown, West Virginia

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>

Literature cited

- Knights, M., Baptiste, Q.S., & Lewis, P. E. (2002). Reproductive Performance of anestrus ewes treated with used-CIDR devices and estrogen. Joint Annual Meeting of the ADSA/ASAS Quebec City, Canada, July, 21-25, 2002. *J. Anim. Sci.*, 80: (Suppl. 1): 297.
- Knights, M., Maze, T. D., Bridges, P. J., Lewis, P. E., & Inskeep, E. K. (2001). Short-term treatment with a controlled internal drug releasing (CIDR) device and FSH to induce fertile estrus and increase prolificacy in anestrus ewes. *Theriogenology*, 55:1181-1191.
- Knights, M., Baptiste, Q. S., & Lewis, P. E. (2002). Ability of ram introduction to induce an increase in LH secretion, estrus and ovulation in fall-born ewe lambs during anestrus. *Anim. Reprod. Sci.*, 69 (3-4):199-209.
- Knights, M., Baptiste, Q. S., Dixon, A.B., Pate, J.L., Marsh, D., Inskeep, E.K., & Lewis, P. E. (2003). Effect of Dosage of Follicle Stimulating Hormone (FSH), Vehicle and Time of Injection on Ovulation Rate and Prolificacy in Anestrus Ewes. *Small Ruminant Research*, 50:1-9.
- Knights, M., Singh-Knights, D., Bourne, G.A., Inskeep, E.K., & Lewis, P.E. (2004) Use of the ram effect to induce out of season breeding. Workshop on productivity and profitability of ovine enterprises. 7th World Sheep and Wool Congress, July 17-14th Quebec, Canada. July 20, 2004, pp 355-377
- D'Souza, K.N.D., Rastle-Simpson, S.L., Redhead, A.K., Baptiste, Q., Smith, B. & Knights, M. (2014). Gonadotropin stimulation using P.G. 600® on reproductive success of non-lactating anestrus ewes. *Anim. Reprod. Sci.*, 148: 115-120.
- Knights, M., Redhead, A.K., D'Souza, K.N.D., S.L., & Baptiste, Q. (2015). Effect of stimulation with a gonadotropin mixture on reproductive outcome in nulliparous ewes bred during seasonal anestrus and early breeding season. *Anim. Reprod. Sci.*, 159: 198-204.



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change



Increasing Your Lamb Crop Series

Accelerated Lambing Cycles

Introduction

Accelerated lamb production is a proven system that provides a consistent, year-round supply of lamb while increasing ewe productivity and production efficiency of the lamb production enterprise. This system of production has evolved from efforts in both Northern Europe (1,2) and America (3,4,5) that have sought to overcome the seasonal constraint in lamb production occurring with traditional, annual lambing systems. These systems differ in birth interval but are defined by the birth interval of an individual ewe of less than 12 months, with the majority of systems striving for ewes to lamb every 7 to 10 months. Therefore, ewes on these systems give birth at different periods from year to year thereby creating a year-round supply of lamb. This also creates an even cash flow for the farm, which is not possible with traditional, annual production, and allows for opportunities to borrow capital for expansion efforts.

Lambs sold throughout the year

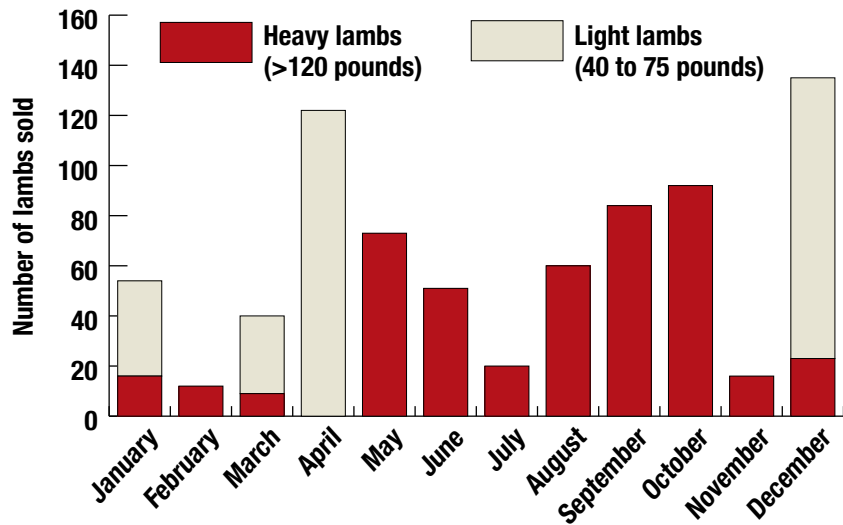


Figure 1. Example of lambs sold throughout the year from a 300 ewe accelerated farm. Lambs can be sold to fit many market endpoints depending on opportunity with this production system. Lambs can also be sold at a uniform size providing a consistent flow to market every month of the year.

Marketing flexibility and year-round supply

Accelerated systems allow more opportunistic marketing possibilities, which is advantageous in reducing risk. As markets fluctuate within and between years, accelerated production units are able to adapt and change target markets quickly as this system allows diverse marketing options. Lambs can be sold as market-ready, light lambs for the non-traditional market (35 to 80 pound lambs), as heavier, older lambs for the traditional market (>125 pound lambs), or for weights in between, depending on market conditions (Figure 1). Perhaps the greatest selling point for accelerated production is that the creation of a consistent, year-round supply allows a producer to build markets that would not be possible for traditional, annual, seasonal production systems. These markets pay premiums for this consistent, year-round supply of young, lean quality product.

Perhaps the greatest selling point for **accelerated production** is that the creation of a consistent, year-round supply **allows a producer to build markets** that would not be possible for traditional, annual, seasonal production systems. These markets **pay premiums** for this consistent, year-round supply of young, lean quality product.

Types of accelerated systems

Several types of accelerated systems exist with the two most common known as the “8-month” system (three lambings per ewe in two years, ref. 2,3) and the “STAR®” system (five lambings in three years, ref. 5). Important system differences include birth interval, time to re-breeding, and system flexibility.

Table 1. Comparison of two popular accelerated lamb production systems.

	STAR®	8-month
Minimum birth interval	7.2 months	7-9 months
Lactation length	42-72 days	~42-100 days
Breeding period	<30 days	<51 days
Time to re-breeding	72 days	~120/60 ¹ days
Lambing periods/year	5	3/6 ¹
Breeding periods/year	5	3/6 ¹
Maximum births/ewe/year	1.67	1.5

¹ Lambing periods can be doubled to six if two 8-month systems are used within an operation and offset by 2 months. This would also reduce the time to re-breeding to as little as 60 days if non-pregnant ewes are identified early and placed in the next breeding period of the opposing schedule.

► The 8-month system excels in providing:

- more time for recovery following lactation,
- long pre-weaning periods,
- potentially larger lamb weaning weights, and
- a less rigid schedule.

► The STAR® allows for:

- faster re-breeding opportunities and
- greater overall flock productivity.

Other variations include two overlapping 8-month systems in which the systems are offset by two months. This allows for six lambing periods within a year with the advantages of shorter re-breeding periods and even greater consistency in lamb supply. This overlapping system also allows heightened labor efficiencies as employees can be trained for more specialized tasks.

Lamb Resource Center



The Lamb Resource Center is your one-stop shop for industry resources and information. Visit www.LambResourceCenter.com to learn more.

► Genetics resources for accelerated production

Sheep with extended breeding seasons are required for accelerated production (short to no anestrus period). These breeds that are less seasonal include many breeds common in North America (Figure 2). There is likely variation within breeds, as well as it is common to find some ewes and rams within even highly seasonal breeds that are capable of breeding out-of-season. Sheep breeds that are less seasonal include those that have evolved closer to the equator and those specifically selected for out-of-season breeding in higher latitudes. There is also evidence suggesting that crossbreeding (heterosis) improves out-of-season reproduction just as it does other reproductive traits (4). Therefore, producers interested in accelerated production are encouraged to maximize the use of crossbreeding to improve both out-of-season breeding and lambing rate.

Figure 2. Sheep breeds commonly available in the US that are more capable of conceiving year-round:

- Rambouillet
- Merino
- Horned and Polled Dorset
- Finnsheep
- Romanov
- Katahdin
- Dorper
- Hair sheep of west African descent
- Ile de France
- Polypay

► Nutrition

In general, the nutritional requirements of accelerated production are higher as animals are in a more productive state a greater proportion of the time. The precise nutritional requirements of sheep in accelerated systems are not clearly defined, however, there is evidence (6,7) indicating that the plane of energy nutrition of both rams and ewes is more important for fertility during the less optimal breeding season (February through July in the northern hemisphere) than during the optimal breeding season. The extent, timing, and duration of improved plane of nutrition are not established, but producers are advised to improve energy intake of the ewe during late lactation and during the period just prior to breeding as is commonly done in pre-breeding flushing protocols to improve ovulation rate during the normal breeding season. During the less optimal, spring breeding season, improved energy intake may boost conception rates in ewes and improve libido in rams.

A challenge in the nutritional management of accelerated ewes is balancing the need to decrease energy intake just prior to and after weaning to minimize incidence of mastitis with the need to replenish energy reserves to improve out-of-season fertility. Producers with accelerated flocks typically decrease both energy

Continued on next page

and protein intake for 3 to 5 days pre-weaning and then begin to increase energy intake 3 days post-weaning improving it to a flushing level of energy intake by 2 weeks post-weaning.

Table 2. Proposed energy requirements of sheep in accelerated systems based on National Research Council (NRC) requirements for ewes raising, carrying and rearing twins (8), but altered to allow for greater energy intake during late lactation.

Period	Annual system*	Accelerated system*
2 weeks prior to breeding	1.4	1.4
Day 0-40 post conception (PC)	1.2	1.2
Day 40-115 PC	1.1	1.1
Day 115 to term	2.0	2.0
Day 0-30 of lactation	2.2	2.2
Day 30-60 of lactation	1.9	2.2

* Energy intake is expressed relative to maintenance energy requirements of non-pregnant adult ewes.

Reproductive management

Reproductive technologies such as intravaginal controlled internal drug releasing devices (CIDRs) that provide a sustained source of progesterone supplementation to ewes, may be used to synchronize breeding and improve conception rates during the spring breeding season. CIDRs have been demonstrated to be effective in improving breeding synchronization, but their ability to improve conception rates above that observed using vasectomized “teaser” rams is less certain (9,10). The use of teaser rams to enhance reproductive management of sheep is commonly known as the “ram effect” (11). This form of bio-stimulation of reproduction is especially effective in improving conception in ewes on the “edge” of the normal breeding season, but is not as effective in improving conception in sheep that may be in the depth of the non-breeding season.

The use of artificial light to enhance sheep reproduction is an effective means of improving both ram and ewe fertility. Lighting protocols can greatly improve out-of-season fertility and ovulation rate in accelerated systems (12). Some of these protocols require conditions that are not feasible on many farms, including the use of a barn that must be kept dark along with proportionally more feeding of stored feed. Both of these conditions increase the cost of production and must be considered when evaluating the economics of improved productivity of these systems.

Infrastructure

In cold climates, an indoor lambing facility is needed for accelerated production as at least one of the lambing periods will take place in winter. (Figure 3) Although not an absolute



Figure 3. An insulated, indoor birth facility with a center aisle feeding system. This barn has sufficient attic insulation to stay above freezing during the vast majority of winter in southern Michigan with animal heat alone. Side wall curtain ventilation allows for air intake and exhaust. Balancing humidity and warmth requires management finesse in such a system.

requirement, insulated birth facilities heated by supplemental heat or by capture of animal heat, allow for improved operator and animal comfort during winter birth periods. The size of these facilities can be smaller than for traditional, annual lambing programs using indoor facilities for a single birth period as less than 60% of the ewe flock typically gives birth in a given period.

Efficient feeding systems are critical for any sheep production system, whether it be a grazing program, one using machine harvested feeds, or a combination of both. This especially applies to accelerated production due to the greater nutritional needs of the sheep. Grazing programs can easily meet the nutritional needs of highly productive sheep for at least part of the production cycle but must be carefully managed to meet the higher requirements of the pre-breeding period, late pregnancy and lactation that collectively constitutes about half of the cycle. This may require greater investment in subdivision fencing and other grazing infrastructure. In most accelerated systems, investments in efficient forage feeding programs are also needed to reduce feeding labor and to meet the relatively higher nutritional needs of the flock. Larger operations commonly employ a total mixed ration feeding program to reduce labor and cost of feed, and to more effectively meet animal requirements during late pregnancy and lactation.

Barriers and challenges

The chief barrier to accelerated success is poor and variable out-of-season breeding success. Producers may struggle to achieve consistent breeding success during the spring. Particular emphasis must be placed on:

- Ram fertility and libido: screen with breeding soundness exams and monitor mating activity.
- Nutrition: ensure an adequate plane of nutrition prior to and during the breeding season.
- Genetics: source genetics with the capacity to breed out-of-season.

► Pros and cons of accelerated production

Pro	Con
Year-round supply: create new and build existing markets	Precise management: nutrition, reproduction, health
Consistent cash flow	Requires a winter lambing period
Reduced market risk	Requires high-quality forage
Greater net income (per ewe, lamb, enterprise)	Requires steady labor
Even distribution of labor	

► Choosing accelerated lambing

- Accelerated production systems are well suited for higher value, more productive land.
- Aseasonal genetics are key: light control protocols reduce risk.
- Accelerated production requires high-quality forages.
- Accelerated production requires a greater initial investment (indoor lambing facility, feeding, infrastructure); however, the higher productivity may create lower fixed cost per lamb produced when depreciated over time.
- Accelerated production evens labor over the year, but is a steady requirement.
- Accelerated production is a profitable option if the current annual program can attain greater than 1.3 lambs marketed per ewe.

► Author & reviewers

Author: Richard Ehrhardt, Ph.D., Michigan State University, East Lansing, Michigan

Reviewers: Reid Redden, Ph.D., Texas A&M AgriLife Extension, San Angelo, Texas; Dan Morrical, Ph.D., Iowa State University, Ames, Iowa; Susan Schoenian, M.S., University of Maryland Extension, Keedysville, Maryland; and Rodney Kott, Ph.D., Former Montana State University Extension Sheep Specialist, Fredericksburg, Texas

► Literature cited

1. Goot, H. & Majjala, K. (1977). Reproductive performance at first lambing and in twice-yearly lambing in a flock of Finnish Landrace sheep in Finland. *Animal Production*, 25: 319-329.
2. Speedy, A., & FitzSimons J. (1977). The reproductive performance of Finnish Landrace x Dorset Horn and Border Leicester x Scottish Blackface ewes mated three times in 2 years. *Animal Production*, 24: 189-196.
3. Notter, D., & Copenhaver, J. (1980). Performance of Finnish Landrace crossbred ewes under accelerated lambing. I. Fertility, prolificacy and ewe productivity. *J. Anim. Sci.*, 51:1033.
4. Fahmy, M. (1990). The accumulative effect of Finnsheep breeding in crossbreeding schemes: ewe productivity under an accelerated lambing system. *Can. J. Anim. Sci.*, 70:967-971.
5. Lewis, R., Notterm D., Hogue, D., & Magee, B. (1996). Ewe fertility in the STAR accelerated lambing system. *J. Anim. Sci.*, 74: 1511-22.
6. Hotzel, M., Walkden-Brown, S., Fisher, J., & Martin, G. (2003). Determinants of the annual pattern of reproduction in mature male Merino and Suffolk sheep: responses to a nutritional stimulus in the breeding and non-breeding seasons. *Reproduction, Fertility and Development*, 15:1-9.
7. Menassol, J-B., Collet, A., Chesneau, D., Malpoux, B., & Scaramuzzi, R. (2012). The interaction between photoperiod and nutrition and its effects on seasonal rhythms of reproduction in the ewe. *Biology of Reproduction*, 86:52:1-12.
8. National Research Council. (2007). *Nutrient requirements of small ruminants*. Washington, DC. National Academy Press.
9. Knights, M., Maze, T., Bridges, P., Lewis, P., & Inskeep, E. (2001). Short-term treatment with a controlled internal drug releasing (CIDR) device and FSH to induce fertile estrus and increase prolificacy in anestrus ewes. *Theriogenology*, 55:1181-91.
10. Knights, M., Baptiste, Q., & Lewis, P. (2002). Ability of ram introduction to induce LH secretion, estrus and ovulation in fall-born ewe lambs during anestrus. *Animal Reproductive Science*, 69:199-209.
11. Ungerferd, R., Forsberg, M., & Rubianes E. (2004). Overview of the response of anestrus ewes to the ram effect. *Reproduction, Fertility and Development*, 16 479-490.
12. Cameron, J., Malpoux, B., & Castonguay, F. (2010). Accelerated lambing achieved by a photoperiod regimen consisting of alternating 4-month sequences of long and short days applied year-round. *J. Anim. Sci.*, 88:3280-90.

► More information

U.S. Lamb Resource Center

<http://lambresourcecenter.com/production-resources/productivity/>

National Sheep Improvement Program

<http://www.nsip.org>

U.S. Sheep Industry Roadmap

<http://lambresourcecenter.com/reports-studies/roadmap/>



AMERICAN SHEEP INDUSTRY ASSOCIATION
YOUR INDUSTRY ADVOCATE SINCE 1865

LET'S GROW

thru change