A REVIEW: UNDERSTANDING SHEEP BEHAVIOR, A KEY TO MORE EFFICIENT AND PROFITABLE LAMB AND WOOL PRODUCTION[1]

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Summary

A knowledge of sheep behavior can help to improve production efficiency. Flocking instinct and social attachments provide methods to improve the efficiency of managing sheep through bonding to cattle to reduce loss to predation and minimize stress at weaning. Characteristics of sheep movement behavior have contributed to the design of efficient sheep-working facilities and management systems. Cattle, sheep and goats are complementary in transforming the range resource into red meat and fiber. Grazing behavior and diet learning are leading to improved forage utilization and range management. Periodic exposure of rams to ewes increases testes size, fertility and libido. Exposure of ewes, previously isolated from males, to rams during the transitional period between the non-breeding and breeding season can initiate early breeding and fall lambs. Ewe lambs are shy breeders and should be mated separately from mature ewes. Orphan lambs can be fostered to ewes with extra milk utilizing odor transfer techniques resulting in higher and more efficient lamb production. Stress management can improve rate of gain following weaning and in feedlot lambs.

(Key words: Behavior, sheep, production, management)

Introduction

Our increasing awareness of the great importance of behavior in providing more efficient management strategies is establishing the fact that behavior is an important key to more efficient and profitable lamb and wool production. Behavioral characteristics have developed over centuries through natural selection to enhance survival. Frightened sheep run together, forming a solid circle with those on the perimeter facing outward. This presents a more imposing situation for predators than a single animal in retreat. This characteristic simplifies the task of the guarding dog to protect the flock. The following characteristic of sheep provides many opportunities for facilitating the movement and handling of sheep. The lamb-specific odor used by the ewe to identify her lamb provides the basis for efficient techniques for fostering lambs. Knowledge of breeding behavior can be used to obtain earlier, more uniform lamb crops, and to increase lambing rate. Stress management can reduce death loss and improve performance in the feedlot. Grazing and feedlot diet preferences and foraging behavior are greatly influenced by learning and experience. The efficiency of the utilization and management of both feed and forage can be enhanced through behavior management.

Flocking

Sheep, similar to human society, form strong family, social, and racial groups that normally resist integration. This is usually referred to as the flocking instinct and is the key to many behavior characteristics. It is highly developed in some breeds such as the Merino, but is much less pronounced in breeds like the Romney. Winfield and Mullaney (1973) observed that in sheep, strong social groups are formed and maintained even when these separately formed groups are forced into close association. Twelve Merino and twelve Wiltshire horn ewes reared in two separate flocks, forced together one per day and grazed together in a small pasture showed no significant degree of integration after nine days of such treatment. When small groups of sheep have been in close confinement for an extended period of time, such as during feeding trials, they form strong social attachments. When put with a larger group, they stay together as a distinct group within the larger flock for an extended period of time. Twin lambs often stay close to one another in the flock throughout their lives. On the other hand, Hulet (1984) observed that a Hampshire ram reared with horses would not stay with sheep when it was

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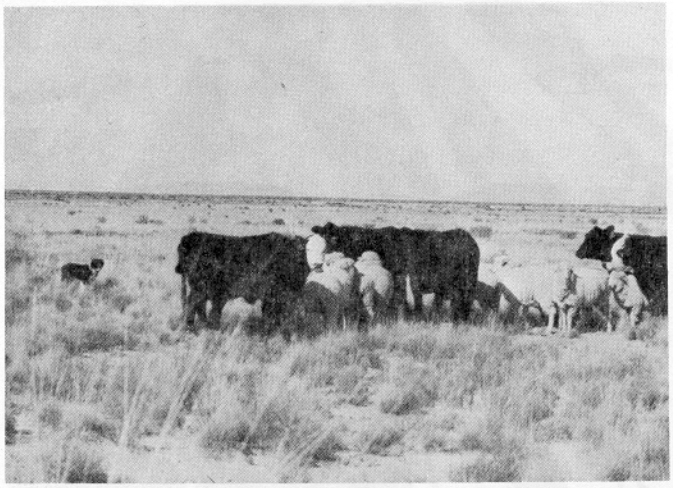

Figure 1. Lambs, bonded to cattle when young, stay close to cattle under open-range management.

possible to be with horses. Six-month-old lambs and yearling steers were observed by Bond et al., (1967) to form cohesive pairs when grazed as pairs in four pastures.

Research indicates that grazing more than one animal species on the same pasture contributes to more uniform and efficient utilization of the forage resource (Cook, 1954; Bennett et al., 1970; Kautz and Van Dyne, 1978; Parker and Pope, 1983), providing a higher economic return (Hamilton and Bath, 1970; Terrill, 1975; Ospina, 1985).However, when this management is practiced, the cattle and sheep seldom graze together and sheep losses to predators have been too high.

We observed that cows normally protect their calves from coyotes as long as the calves stay near their mothers. Would it be possible to socially bond young lambs to heifers to the extent that the lambs would consistently stay with the cattle and would be protected form predation? We have since successfully bonded 45 to 90-day old lambs to heifers by close confinement in groups of seven lambs with six heifers or seven lambs with three heifers for 60 days (Anderson et al., 1987, Figure 1). When turned to pasture, the bond needs to be solidified in small open pastures with one watering place. The lambs may become separated from the cattle while the lambs are young, but normally get back together at the watering trough or while grazing. It is good during this developmental period to put them back together whenever they are observed apart. Lambs that are bonded to cattle get good protection from predation (Hulet et al., 1987). We studied the defense mechanism using a trained Border Collie dog (Anderson et al,, 1988). The bonded sheep always stayed close to the cattle. Whenever the dog chased the bonded sheep, they always ran into the middle of the cattle herd, leaving a perimeter of threatening cows on the outside. When the dog was urged by her handler, she was able to move the herd, but as they moved, the sheep stayed within the protective perimeter of cattle. At no time during many observations did the sheep separate from the cattle. In contrast, unbonded sheep, even when threatened by the dog, ran away from the cattle and thus were vulnerable to attack by the predator. We observed a coyote approach a group of bonded lambs and heifers. One heifer chased the coyote out of the pasture. Mohair goats formed loose bonds with cattle, but they did not stay with them consistently enough to get protection from coyote predation. However, when mohair goats from the same bonding group were also bonded to sheep that had been bonded to cattle, we got good protection (Hulet et al., 1989). In contrast, Spanish goats appear to have a stronger affinity for cattle than for sheep.

It is a problem to integrate several small bonded groups (i.e., seven lambs and three heifers each) into larger groups such as 56 lambs and 28 heifers. When larger groups of these young lambs get together in groups of 15 or 20 or more, they appear to feel comfortable without being near the cattle. However, the bonding of large groups (up to 52 ewes and 20 mohair goats so far) has been achieved by combining the groups slowly over time as the lambs mature (Hulet, unpublished data). Our group of 52 sheep and 21 heifers may temporarily form more than one subgroup in the pasture, but the sheep were almost always near cattle.

Guarding dogs can benefit the sheep enterprise when predation is a problem and other management tools are not adequate (Green et al., 1984). Bonding of the dogs to sheep when they are young (weaning age, six weeks) is the key. The dogs accept the sheep as family and protect them. The sheep also must be tolerant of the close association of the dog or they may scatter, leading to predation and difficulty in locating. It may be wise to hold the sheep and guarding dog or dogs together in a corral for a couple of days when the dogs are first introduced to minimize scattering problems. Although the Navajo Indians have used a variety of mongrel dogs successfully (Black, 1981), it is generally accepted that the guard dog breeds that have been used and selected for many generations for guarding qualities are more consistently satisfactory. Even with these breeds, there are

occasional problem dogs that must be culled. The Akbash guard dogs have been essential to a successful sheep program in large fenced pastures on the Jornada Experimental Range. Often we now have guard dogs with our bonded catttle, sheep and goats. This double-tiered defense system may have great merit where coyote populations are dense.

We have observed a coyote approach a flock of sheep with a guard dog. The dog always kept himself between the coyote and the sheep. Dogs sometimes chase coyotes, and occasionally kill one, but more usually their presence with the sheep simply discourages the coyote.

Movement

Leadership is dependent on social attachments. In wild sheep, the oldest ewe is usually the leader. In farm and range flocks, the older more aggressive ewes tend to be the leaders. If one can control the leaders, one can control the flocks. An electronic device has been developed for commercial use in recent years to control the movement of animals without fences (Fay et al., 1988).[4] It has been tested successfully on dogs and goats but should also work on sheep. An insulated 14-guage wire is buried or laid on the ground around the perimeter of the area to be grazed. A shock device on a collar worn by the leader animals is electronically activated. As the animals approach the buried wire, they receive a warning tone followed by a series of mild shocks until the animal moves away from the wire boundary. When a collared animal retreats, the electric shock ceases. In follower species, the rest of the animals characteristically follow and stay with the leaders.

Sheep tend to follow any sheep or even a goat that leads. Therefore, some sheep ranches train orphan lambs or goats to lead. The other sheep will then easily follow, saving valuable time and effort in movements through cutting chutes, loading chutes, shearing sheds and lambing sheds. See-through panels, permitting the sheep to see other sheep ahead of them can greatly facilitate the movement of sheep.

Corrals designed to capitalize on environmental factors and social behavior make cutting and moving of sheep much easier and more efficient. Grandin (1983) has studied this important management area. Sheep dislike moving into the sun or through areas with vertical or horizontal streaks of light and shadow. An efficient cutting facility will provide for the movement of sheep away from the sun. It will provide a funnel-shaped gathering corral which leads to two parallel crush alleys four feet wide with a see-through partition between the parallel alleys. The far end of the crush alleys tapers down to a cutting chute sufficiently narrow so that the sheep cannot turn around. Sheep frequently will back up in a chute. Movement through the chute is often greatly improved by installing spring operated metal anti-backup valves (Figure 2). Hay placed in strategic locations often can get sheep to move into unfamiliar areas.

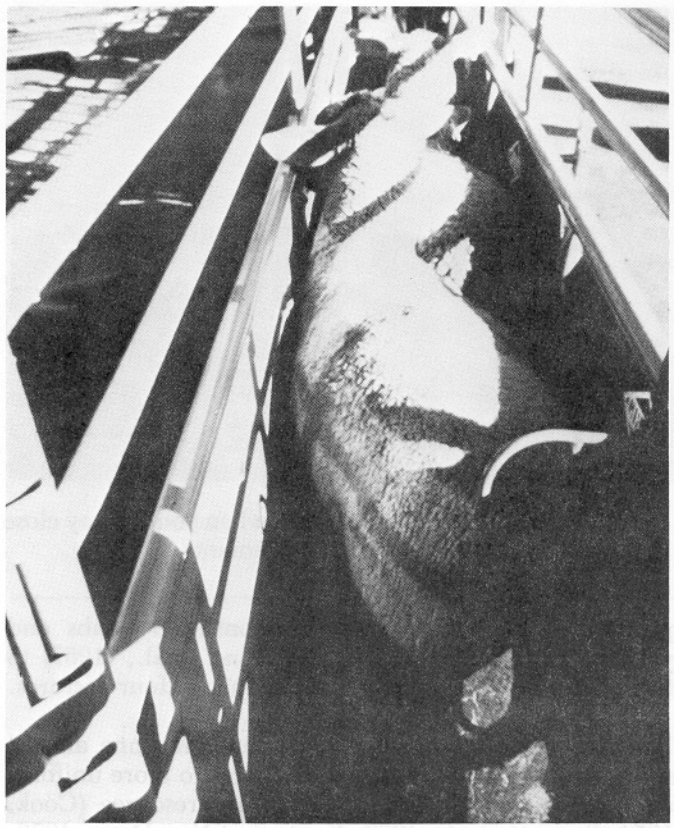

Figure 2. One-direction flow valve to prevent sheep backup in chute. (Photo courtesy Gibson manufacturing Co., Inc., Brook, IN).

A knowledge of sheep behavior can save valuable time in finding lost sheep on mountain ranges. Sheep tend to like high places and will usually seek the highest point in the area to bed down or camp on. Lost sheep can usually be found most quickly by checking the highest points in the area where they became lost.

[4] The Invisible Fence Co., Wayne, PA.

Grazing and Diet Learning

Many studies have clearly established that cattle, sheep and goats have different dietary habits. Cattle prefer grass, sheep prefer forbs (weedy plants) and goats prefer browse (shrubs and trees). These diet preferences lead to a more complete utilization of the forage resource and, therefore, more efficient production. We call this complementarity. The greater the variety of plants, the greater the complementarity with more animal species. Sheep and goats, in most situations, improve the range for cattle. In New Zealand, cattle production would not be economically possible without the use of sheep to control gorse (*Ulex europaeus*) and other shrubs that can quickly over-run the hill country pastures.

Sheep generally travel farther while grazing than do cattle. However, bonded sheep stay with the cattle. Can their reduced travel lead to less energy expenditure through physical exertion, thus more efficient production? Sheep characteristically graze early in the morning and late in the evening (Dudzinski and Arnold, 1979). This is especially true during warm weather. This characteristic can lead to more efficient performance and should be facilitated with proper management.

A new and exciting area of research is diet modification. Learning early in life may play an important role in the development of dietary habits and foraging skills of domestic ruminants. Livestock select a diet from a wide range of potential food. Some are nutritious while others are of poor quality or poisonous. Animals learn what to eat through trial and error, based on favorable or unfavorable consequences, or by observation of other individuals. Some evidence suggests, as the mother's milk supply declines and nutritional needs of lamb increase, that the lamb learns about foods most efficiently. After weaning and during the first year of life, willingness to accept novel foods declines steadily (Provenze and Balph, 1987, 1988). Some speculate, based on physiological studies, that taste experiences as a fetus may influence formation of adult taste preferences in livestock (Bradley and Mistratta, 1973). However, it is more likely that nursing lambs are influenced by flavors that come through the milk (Bassette et al., 1986).

Young livestock learn about foods through social models (Key and Maclver, 1980) and through trial and error (Provenza and Balph, 1987). The best social models are mothers and familiar peers. Lambs four to eight weeks of age, exposed to foods with their mother, consumed about twice as much of those foods after weaning as did lambs exposed with another adult ewe, and lambs exposed with an adult ewe consumed about twice as much as lambs exposed alone (Thorhallsdottir et al., 1987).

Apparently, these taste experiences are imprinted on the lamb early in life. A study indicated that only four to eight days of experience with a new food (barley-protein mineral pellet) at an impressionable age in the presence of the mother was required to have a lasting effect on the animal's lifetime food preferences (Ortega-Reyes et al., 1987, 1988). This suggests that the rancher could expose young lambs with their mothers to foods they will encounter in the feedlot. Lambs exposed to whole barley for eight days, at six to seven weeks of age with their mothers, accepted barley more readily during the first three weeks in drylot and reached slaughter condition one to two weeks sooner than lambs with no exposure to barley (Ortega-Reyes et al., 1987, 1988). This should reduce the cost of preconditioning for more efficient feedlot performance. Lambs raised on alfalfa hay have difficulty adapting to pasture forage. Lambs reared on hay, then moved to pasture, grazed 20% longer and consumed 40% less forage than lambs reared on pasture. This difference persisted for at least three months (Arnold and Maller, 1977).

Certain weeds are serious range and horticultural problems. Sheep are recognized as weed eaters. However, there are weeds and shrubs that they do not eat well. However, when they have been conditioned at a young age to eat these undesirable plants, their efficiency in utilizing and controlling these plants can be greatly enhanced. Ewes and lambs put on range infested with leafy spurge initially ate very little of the spurge, but there was a steady increase in consumption from one to three weeks of age at which time it comprised 40-50% of their diet. Other lambs were conditioned to eat leafy spurge in drylot and became leafy spurge eating machines (Landgraf et al., 1984). Other sheep were conditioned as lambs to eat a highly unpalatable subspecies of sage brush. *Artemisia tridentata* subsp. *tridentata* (Narjisse, 1981). These experienced sheep ate much more sagebursh than inexperienced sheep and goats under high forage availability in June (26 vs - vs 0%) and August (7 vs 1 vs 0%) and under low forage availablily, in June (57 vs - vs 7%), August (30 vs 5 vs 0%), and November (19 vs 6 vs 1%).

Depraved Appetite

Completely pelleted diets can be a problem if fed for extended periods of time. This is not usually observed in market lambs, but sheep maintained on completely pelleted diets will, in time, develop depraved appetite, which includes chewing and damaging any wooden

structures with protruding edges, and eating wool off from other sheep. Phosphorus supplementation appears to reduce the problems slightly, but does not prevent it. The cause has been attributed to the fine grind and rapid consumption of the pellet and boredom. Feeding a coarse roughage, such as straw or coarse hay, along with the pellet, more space and a diversified environment will effectively prevent the problem. However, once the problem or habit is developed, it is difficult to stop (Hulet, 1984).

Breeding

Domestic sheep, in general, breed during a somewhat restricted season, mainly during late summer, autumn and early winter in temperate zones. Some breeds such as the Dorset, Rambouillet and Polypay have extended breeding seasons in constrast to breeds such as the suffolk, Southdown and Border Leicester. In the tropics and subtropics, sexual activity continues throughout the year (Hafez, 1953).

The seasonal nature of reproduction in sheep limits the times available to management for producing lamb for market, resulting in peaks and valleys in the supply and market price of lamb. It also limits the use of certain commercial and byproduct feeds to times when lambs can be produced, which may not coincide with the most economical utilization of the feed.

Scientists are now using genetic selection to overcome this problem. This is a slow process and will require a number of years of selection. However, some immediate benefit can be derived by using behavior. Exposing rams to ewes in advance of the breeding season stimulates testes development and sex drive, and improves semen quality in rams (Illius et al., 1976). When these fertile rams are introduced into a flock (which has been isolated from rams for a few weeks) during the transitional period between anestrus and the breeding season, it leads to ovulation, followed by estrus and ovulation in advance of the normal breeding season (Martin and Scaramuzzi, 1983). This early breeding response is maximized when rams are introduced in the morning (Martin et al., 1985). Manipulation of breeding behavior, especially in long-breeding-season sheep, can produce fall lambs.

We breed Polypay and Rambouillet ewes in New Mexico during May and June, and have 50 to 70% of them lamb in the fall. All the ewes are exposed again in September and October so the balance of the ewes lamb in the spring. This provides a good supply of market lambs throughout most of the year. Lambs and yearling ewes do not breed well out of season, and ovulation and twinnings rate are lower in fall-lambing ewes (about 150% vs. 175% averaged over breeds).

A knowledge of mating behavior in rams can improve production efficiency. A small percentage of rams have either greatly reduced libido (sex drive) or will not breed at all (Hulet, 1964). Other rams are aggressive and dominant, and in multi-sire mating flocks, will prevent or greatly reduce mating by subordinate rams. Therefore, it is important to make sure when rams are put into breeding that they have adequate libido and mating ability. It has been proposed that inhibition might be an effect of monosexual group rearing (Hulet et al., 1964; Mattner et al., 1971). Sexual inhibition was prevented by rearing ram lambs in isolation so that they had no physical contact with any other animal of either sex (Zenchak, J.J. et al., 1974). Keeping a few ewes with ram lambs during rearing may reduce sexual inhibition in rams. In multi-sire breeding flocks, it is important to use a minimum of three rams of uniform age in pastures large enough so that the dominant ram cannot prevent the other rams from breeding (Hulet, 1966).

Fertility in yearling ewes and especially ewe lambs, is reduced when they are mated in large flocks with mature ewes (Keane, 1976). This is because ewe lambs and yearling ewes are shy and do not routinely seek out the ram, no do they stand well for mating. In contrast, mature ewes aggressively seek out the ram and often monopolize his time and interest to the partial exclusion of the younger ewes. Therefore, fertility in young ewes is nearly always improved by breeding them in separate groups. Because of the shyness of young ewes, Ercanbrack (personal communication) has observed that experienced yearling rams can improve the conception rate in young ewes when compared with inexperienced ram lambs.

Lambing Behavior

Impending parturition in the ewe can often be detected in her posture (lowered head, pawing, sniffing the ground, and repeatedly lying down and standing up and restlessness). Lambing ewes tend to seek a degree of seclusion. Some ewes have a premature onset of maternal behavior showing an intense interest in newborn lambs of other ewes. This can lead to lamb-stealing, which can be a serious problem in registered flocks. It is not uncommon to see a ewe with a set of twins a day or two old giving birth to another set of twins. This creates a survival problem requiring some fostering or orphan rearing. The shepherd should make sure that every ewe with lambs has definitely given birth. Careful observation and a reasonable degree of dispersion are required to prevent pedigree errors and management problems. Gonyou and

Stookey (1983 and 1985) have found that lambing cubicles (enclosures 1.8 x 1.2m with 1m high walls and .6m wide access openings) distributed in large group-lambing pens, especially in areas away from working areas of the herdsmen, attracted parturient ewes resulting in fewer lambs separated from their dams (5.4 vs 9.6%) and less stealing of lambs (3.1 vs 5.2%). Once the lambs are born, survival can be enhanced, especially in multiple births, if the ewe and her lambs are confined in a 4′ x 5′ lambing pen for three days. This provides opportunity for close observation, and enhances a strong maternal/offspring bond so fewer lambs are mismothered.

The most economical way to raise lambs is on their dams. However, some ewes have more lambs than they can supply adequate milk for, and other ewes have more milk than the lambs can use. Efficient management requires putting the lambs where there is adequate milk. This requires a procedure to graft or foster lambs with an inadequate supply of milk to a ewe with surplus milk. Procedures for doing this were outlined by Hulet et al., (1979). Lamb-specific odor is used by the ewe to distinquish their own lambs from other lambs. Lamb fostering techniqes in general are designed to transfer sufficient odor to induce the ewe to claim and mother the orphan lamb. These techniques include slime grafting (transferring placenta fluids or birth slime to the orphan lamb), wet grafting (after newborn lamb is mostly dry, both "own" lamb and "extra" lamb are immersed in salt water and both lambs are thoroughly and systematically rubbed together), skin grafting (skin of ewe's dead lamb is put on the orphan; head, legs, and tail are smeared with blood and body fluids from the dead lamb), and cloth stockinettes (a stockinette is first placed on the ewe's own lamb as soon after birth as convenient. After about 24 hours, it is taken off the natural lamb and put on the orphan lamb [Price et al., 1984; Martin et al., 1987]).

Grafting and fostering is more successful when attempted as soon after parturition of the ewe as possible. This sensitive period varies greatly among ewes. The sensitive period can be extended with tranquilizers or with high doses of estrogen (Poindron et al., 1980). Some restraint of the ewe is often required for a highly successful fostering program (Alexander and Bradley, 1985)

Social Bond Disruption and Stress

Stress, psychological and social factors influence the relative ease and efficiency of handling and working sheep, and can have profound effects on production efficiency. Weaning is an extreme example of the disruption of close social relationships. When lambs are early-weaned, they characteristically exhibit a stasis of growth. Nutritionists have tried without success to formulate diets which would eliminate this reduction in rate of growth. It is probable that the stress associated with removing the lamb from its mother, a strange new environment and frequently, a new type of feed account for the marked reduction in gain for a period of time following weaning. Lambs should be adapted to the feed they will be given at weaning starting at least a week before weaning, and the ewes should be moved away from the lamb and not the lambs away from the ewes. This permits the lambs to stay in familiar surroundings on a familiar feed which should reduce stress and improve post-weaning performance.

Disruption of social or companionship groups even later in life can be psychologically disturbing and can negatively affect performance for a period of time. If disruption of social groups occurs at breeding time, ovulation and fertility could be adversely affected, as has been observed in the human menstrual cycle. This may explain why some small farm flocks with one owner-operator have superior lamb production performance compared to large flocks where the sheep are sorted by various criteria into many small, single-sire breeding pens disrupting many close asociations.

Sheep may also be stressed by inexperienced and abusive handlers. The consequence of the caretaker's attitude and behavior on livestock performance was demonstrated in a study evaluating operator attitude on milk production in dairy cattle. Production was better in cattle attended by a kindly, gentle person than one who disliked cattle (Seabrook, 1972).

Conclusions

Many important facts pertinent to the relationship of behavior and lamb production have been discussed. Sheep are clearly social animals. Stress, psychological and social influences affect the ease of handling and working sheep, and can have profound effects on lamb production efficiency.

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