Scientists at the TAES Guayule Research Site are cooperating with researchers in the agricultural experiment stations of Arizona, California, and New Mexico and the USDA/ARS in evaluating guayule selections for regional adaptability and rubber production. Studies in conjunction with scientists in the TAES Department of Biochemistry and Biophysics are focusing on the effects of selected bioregulators on guayule rubber synthesis. Cooperating researchers with the Texas Engineering Experiment Station's Food Protein R&D Center have developed a solvent extraction method for guayule processing. Firestone has also established a pilot processing plant at Akron, Ohio.

Summary

Guayule, a semidesert shrub native to the Trans Pecos of southwest Texas and Mexico, produces natural rubber. Significant supplies of guayule rubber were produced in the early 1900's, and more recently during World War II. Political and economic situations worldwide have caused a renewed interest in guayule as an alternative source of natural rubber. The development of a domestic rubber source would alleviate the dependence on foreign supplies and provide an alternative crop for farmers in the Southwest. Past experience has indicated that technologically, guayule can be cultivated for the production of natural rubber. Current research is committed to improving existing production, harvesting, and processing technologies to develop an economicaly viable guayule production system in the United States.

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Coyotes, Guard Dogs, and Electric Fences

C.V. Hulet, W.L. Shupe, and V.W. Howard, Jr.

Editor's Note: The reader may wish to refer to the following articles for further information on coyote predation and control.

"Toward a More Effective Coyote Lure" by Jerry H. Scrivner, Walter E. Howard, Roy Teranishi, and Daniel B. Fagre, *Rangelands* 7(2), April 1985.

"Cost and Other Effects of Predation on an Angora Goat Ranch" by Jerry H. Scrivner, Dale A. Wade, Guy E. Connolly, and L. Charles Howard Jr. *Rangelands* 7(2), April 1985.

"The 1080 Livestock Protection Collar for Predator Control" by Jerry Scrivner and Dale A. Wade, *Rangelands* 8(3), June 1986.

In 1983 sheep were introduced on the Jornada Experimental Range (JER) in southwest New Mexico to determine if cattle and sheep grazing would lead to more efficient utilization of the range. It was rumored that there were many coyotes in the area and predation was expected to be a serious problem. A year after the sheep were introduced, the Fishery and Wildlife Sciences Department at New Mexico State University (NMSU) in cooperation with USDA estimated from scent-post visitations and helicopter gunning that coyote density was 1 per 2.7 square miles (Kumm 1985).

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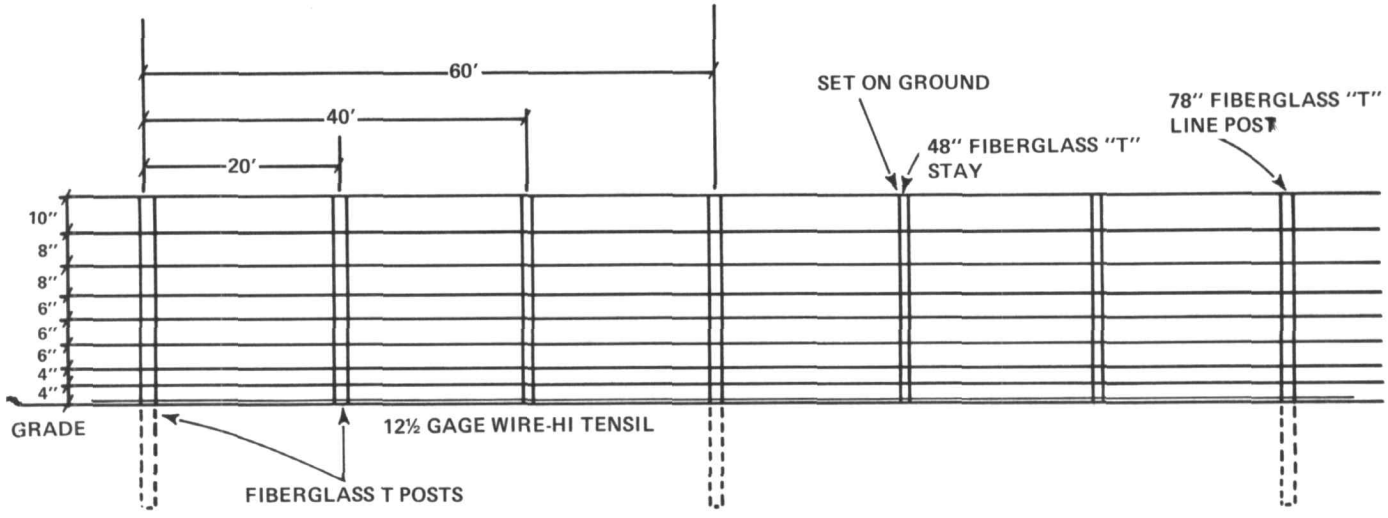
Loss of Sheep in an Unprotected Flock

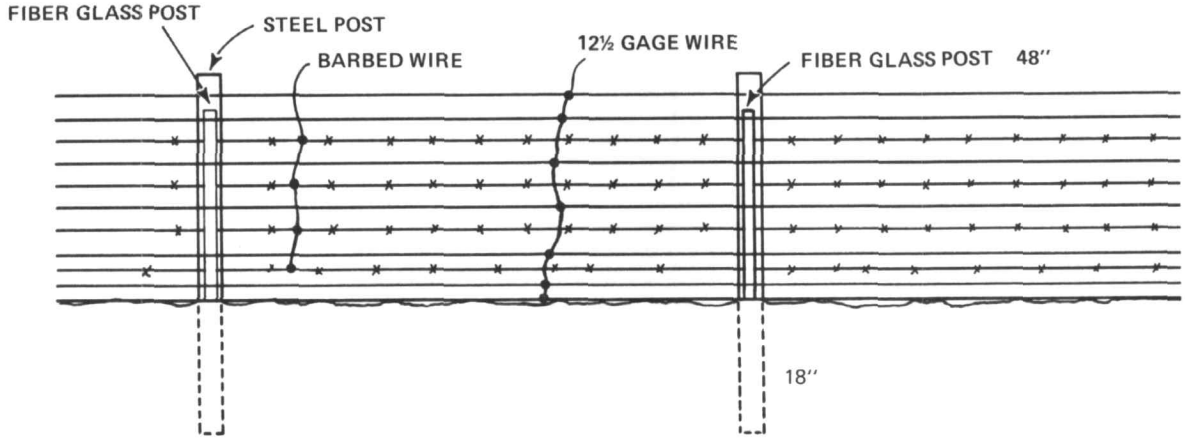
In early February 1983, 144 aged, Rambouillet-type range ewes were placed in a fenced area to study the effects of nutritional environment on ovulation and to evaluate predation. A smaller representative sample of 54 ewes from the same source were maintained in drylot on alfalfa hay. This article presents an assessment of the predation problem. subsequent predator management practices which were instituted, and changes which occurred in the incidence of predation on large, expansive, brush-covered, fenced pastures.

Two noncharged high-tensile smooth wires were added to the lower part of an existing 4-strand barbed wire cattle fence to contain the sheep in 2 major areas on the range. One area (East Area) included 2 pastures (4,463 and 2,537 acres). The second area (West Area), 5 miles from the first area, also had



TYPICAL NEW FENCE SECTION

NO SCALE



TYPICAL MODIFIED FENCE SECTION

NO SCALE

Specifications for new and modified electric anti-predator fence.

2 pastures (5,512 and 3,172 acres). The predominant vegetation in both areas was dense mesquite and tarbush, but part of the West Area was more open with mesa dropseed and desert forbs.

The large size of the pastures and the brushy vegetation made it extremely difficult to find and gather sheep for counting, weighing, and other activities. To aid in locating the sheep, 6 head were fitted with radio transmitter collars. The collars, an all terrain vehicle (ATV), and a stock herding dog facilitated gathering the sheep. We counted the sheep at least twice a week. It was virtually impossible to locate all of the dead sheep. However, we developed a practical approach to account for losses. We observed 3 important causes of loss: (1) woolly paperflower poisoning, (2) coyote predation, and (3) escaping from the pasture. Poisoning from paperflower was a cumulative condition, and the sheep characteristically had massive discharges of thick green mucus and labored breathing for several days before death. Poisoned sheep were noted and presumed dead from poisoning when they became missing. If sheep were unaccounted for, the ground around the perimeter fence, gates, and cattle guards was checked for tracks. If tracks were discovered, an estimate was made of the loss, and a search was made for the missing sheep. Usually the sheep were found and returned. However, in 2 instances sheep observed outside the pasture were not recovered. The straying losses all occurred at the

beginning of the study before fence deficiencies were fixed. Losses from woolly paperflower poisoning occurred in January, February, and March during the early vegetative growth of this forb. As the plant matured toxicity declined. Few losses occurred during April and virtually none from May through the remainder of summer and fall.

We found no evidence of predation during the first 44 days of the study, perhaps due to the unfamiliarity of the local coyotes with sheep as potential prey. No sheep had been kept in this area for over 50 years.

The first evidence of predation occurred in late March, 1983. Once predator-wounded sheep were observed, sudden and otherwise unaccountable disappearances of sheep increased markedly. The rate of predator verified or unaccounted for loss accelerated during April and early May in the East Area. Most coyote-inflicted wounds in nonfatally attacked sheep were to the upper part of the right hind leg. Ten ewes survived coyote attacks and were gathered with other sheep at times of counting or weighing. Eight of these sheep recovered. It is presumed that the sudden disappearances of sheep was due to predation if no earlier symptoms of illness or poisoning occurred and no escape from the pasture had been observed. The sheep were then moved to pastures in the West Area in an attempt to reduce predation. The loss dropped substantially and remained low through mid-October. However, 6 ewes were lost in 28 days (Oct. 13 to Nov. 10). Following this loss the sheep were moved frequently between areas in an attempt to reduce predation. During the next 92 days 32 ewes were either missing, maimed, or killed by coyotes. This completed a one calendar-year assessment of predator losses. Sixty-three ewes (44%) of the original 144 sheep managed on the range were estimated to have been killed by coyotes during the 12-month period of the study. Only 1 ewe out of 54 (2%) maintained in the drylot control group on alfalfa hay died during the same period.

Predation Associated with Different Electric Fence and Guardian Dog Management Strategies

The next step was to evaluate various predation control technqiues. An anti-predator electric fence was constructed around the East Area. Existing cattle fences in good condition were modified as shown on the lower half of Figure 1 in an effort to reduce cost. This area was split into 5 pastures varying from 600 to 2,000 acres in size. The pasture cross fences were not predator proofed. An attempt was made to remove coyotes from within the perimeter fence. During a 6-week period, 13 coyotes were either shot or trapped within the fenced area, yielding an estimated density of more than 1 coyote per square mile. Some coyotes apparently penetrated the electric fence not only during the coyote removal phase, but periodically thereafter. Knipe (1985) states that 4″ spacings are necessary up to 16″ from the surface of the ground to consistently prevent coyote penetration of the fence. Our fence had 4″ spacings only up to 12″ followed by 6″ spacings. This may have allowed some coyote access.

One hundred forty-four young Rambouillet type ewes 1 to 3 years of age were kept in close confinement with a spayed 2-year-old Great Pyrenees (Pyrenees) guard dog in a 0.1-acre enclosure in the East Area beginning on May 3, 1984 (Flock A). This (socialization) was done so that the sheep would learn to tolerate the close association of the dog and not scatter. After 6 days the sheep were divided into 2 groups

Princess with Rambouillet sheep on the Jornada Experimental range. Socialization of sheep to dog and cohabitation is critical to the protection of sheep from coyote predation.

of 72 ewes each and placed in adjoining pastures. The guard dog was placed with 1 group of sheep. However, the sheep were still only mildly tolerant of the presence of the dog. The dog wandered about within the electric fenced area spending more time with both groups of sheep. However, after a while she started leaving the enclosure (over the gate) and going to the ranch headquarters. Subsequent disciplining and refraining from feeding her at the ranch reduced, but did not eliminate, the problem.

Seventeen sheep were badly wounded by coyotes or disappeared during the 175-day period. A periodic effort was made to trap or call and shoot coyotes within the enclosure when this could be done with minimum hazard to the guard dogs. Two male and two female coyotes with blood on their heads were shot within the East Area.

On July 19, 1984, another study (flock A remained in the same location) was begun in the East Area. Fifty-three head of aged Rambouillet-type ewes (Flock B) were divided into 3 approximately equal groups and placed in 3 adjoining pastures. These sheep were on a nutritional supplement study and were weighed at monthly intervals. The weighing record was used as inventory to detect predation. Losses declined sharply in Flock A but were exceptionally heavy (105% annualized rate) in Flock B. Flock A was socialized and tolerant of the presence of the dog, whereas Flock B would not allow the dog to come near. The guard dog spent most of her time with the 2 socialized groups (flock A).

On October 25, 1984 a 3-year-old Akbash female guard dog which had previously been used for guarding sheep on the range was placed in the East Area with the Pyrenees. The dogs selected separate groups of sheep in different pastures and were seldom found together. However, there were 5 groups of sheep in 5 separate pastures and only 2 guard dogs so it was not possible to have a dog with each group. However, with the addition of one more guard dog there was some reduction in the annualized loss rate when compared to the rate loss with one guard dog.

On January 21, 1985 the 3-year-old female Akbash and an 8-month-old Akbash male were moved with 121 surviving sheep of Flock A to the West Area where a new anti-predator electric fence (4,000 acres) had been completed. By this time

Flock A had become very tolerant of the close association of the guard dogs. The Pyrenees and a second Akbash male guard dog were put with the surviving Flock B sheep maintained in 3 seperate pastures in the East Area.

Although only 8 months old, the Akbash male in the East Area was very mature in behavior. He sought out and remained with a group of sheep separate from the group the Pyrenees dog was with. In spite of the addition of another dog, losses continued to increase in the East Area until an extremely high rate (249% annualized) occurred during May, June, and July 1985. The losses occurred in only 1 of the 3 pastures at any one time, suggesting that coyotes were preying heavily on the group of sheep unattended by a dog.

By contrast, the single group of sheep moved to the West Area with 2 guard dogs experienced no predation loss for at least a 133-day period and only 1% loss over the total 233-day period. The only obvious difference in management was that there were 2 dogs with 1 consolidated flock of ewes in the West Area and 2 dogs with 3 sub-flocks of ewes in the East Area. Both areas appeared to be equally accessible to and subjected to predator coyotes. The West Area flock was well guarded, whereas it was physically impossible for 2 dogs to be with 3 widely separated sub-flocks of sheep at the same time in the East Area.

The loss in the West Area flock was similar to the loss rate in the drylot control group the year before (2%) which was not subject to predation. This contrasts with the loss of 29 of 53 ewes (74%) in the 3 groups of aged ewes maintained in the East Area during approximately the same period of time. These ewes did not become accustomed to the guard dogs and would run away whenever they would approach.

This study suggests 2 principles for successful protection of sheep by guard dogs: (1) Sheep must be well socialized and highly tolerant of the dogs so that they stay with the dogs and do not scatter (this was previously noted by McGraw and Blakesley 1982), and (2) at least 1 dog must cohabit with each group of sheep and leave them only for relatively brief, noncritical periods. Other studies (Green, et al. 1984, Green and Woodruff 1985) stress the importance of early socialization of dogs with sheep while they are young puppies (6–10 weeks of age).

One may tend to discount, in view of these results, the importance of electric fencing in predator control. However, we believe that the electric fence can complement guard dog performance. A properly installed and maintained electric fence will establish a well-defined perimeter to confine both guard dogs and sheep to specific territory. The guard dog often patrols and scent marks the fence line. The electric fence, the presence of the dog, his scent, sight and sound all serve as deterrents to penetration by coyotes. However, due to the low carrying capacity of these arid ranges (about 25 acres/sheep) it may not be economical for a commercial producer to construct electric fences on this type of range, since the cost of fencing material was about $64 per ewe. Adding this to the cost of labor and fence maintenance, and the relatively poor performance of the fence under the existing conditions, the best current alternative in our view would be a stable supply of proven guard dogs with highly dog-socialized sheep with good flocking instinct. Although our dogs performed well in a 1,500-acre pasture in the West Area, the experience of other observers suggests that guard dog performance is best in small pastures of 1,000 acres or less. Two or even 5 dogs per range flock would cost only a small fraction of the cost of constructing and maintaining an electric fence (Green et al. 1984). Further research is needed to establish the optimum number of dogs to protect flocks of various sizes under different types of range (rough or smooth terrain, brush or open rangeland, sparse or heavy vegetation, large or small pastures).

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