

---

# Understanding Sheep Production

---

## PREFACE

This paper is one of a series published by Volunteers in Technical Assistance to provide an introduction to specific state-of-the-art technologies of interest to people in developing countries. The papers are intended to be used as guidelines to help people choose technologies that are suitable to their situations. They are not intended to provide construction or implementation details. People are urged to contact VITA or a similar organization for further information and technical assistance if they find that a particular technology seems to meet their needs.

The papers in the series were written, reviewed, and illustrated almost entirely by VITA Volunteer technical experts on a purely voluntary basis. Some 500 volunteers were involved in the production of the first 100 titles issued, contributing approximately 5,000 hours of their time. VITA staff included Patrice Matthews and Suzanne Brooks handling typesetting and layout, and Margaret Crouch as senior editor and project manager. VITA Volunteer Dr. R.R. Ronkin, retired from the National Science Foundation, lent his invaluable perspective, as a volunteer, to the compilation of technical reviews, conversations with contributing writers, editing, and in a variety of other ways.

The author of this paper, VITA Volunteer animal scientist Claudia Ingham, specializes in the care of horses and small stock in Oregon. Loren Sadler is an agricultural engineer who has been a VITA Volunteer for many years. He is retired, and with his wife Joanna runs a small farm in Pennsylvania. VITA Volunteers Bruce Sanborn, a chemical engineer, and Paul Abrahams, a soil scientist, have a special interest in raising sheep.

VITA is a private, nonprofit organization that supports people working on technical problems in developing countries. VITA offers information and assistance aimed at helping individuals and groups to select and implement technologies appropriate to their situations. VITA maintains an international Inquiry Service, a specialized documentation center, and a computerized roster of volunteer technical consultants; manages long-term field projects; and publishes a variety of technical manuals and papers.

# 1. BACKGROUND

The sheep was one of the earliest animal species to be domesticated, with evidence that they were kept and not hunted as early as 10,700 years ago in the gorge of the Greater Zab River in Northern Iraq. Wool has been found in the remains of 20,000-year old villages in Switzerland (Blakely and Bade, 1986). Sheep are in fact well-suited for use by people because they can digest fibrous portions of plants. Bacteria and fungi in the gut of sheep allow them to use feed resources that are of little or no direct value as human food sources. In this way sheep can be raised on marginal lands or make use of crop by-products while producing meat, milk, wool, hides, and manure.

Many breeds of sheep, particularly those that are native to the desert regions of the world, use water very efficiently and can go for several days without drinking. They can graze far from watering holes and place less stress upon soil and vegetation near water. In arid regions or those experiencing desertification, raising sheep would help alleviate erosion and health problems common to areas where animal and human density is too high to be supported by the local resources.

Drawing on the genetic resources of the world's many sheep breeds and using cross-breeding to achieve a desired combination of traits can bring great benefits to people. Whether on small plots in wet tropics or on ranges of many hectares in drier, more varied climates, sheep can be used to alleviate food crises or provide products for trade or barter.

## 2. SHEEP BREEDS AND THEIR USES

Among the hundreds of breeds of sheep, many produce wool that can easily be used by the people who raise them. Moreover, wool is easily stored and transported. Throughout North Africa and Asia sheep are raised for their coarse, durable wool ("carpet wool") that is used to make carpets, tent panels, and other heavy fabrics. This is in sharp contrast to the United States where only 7 percent of the wool consumed is carpet wool (Ensminger and Parker, 1986). The Awassi is a breed commonly found in the Middle East where sheep are raised as dual- or triple-purpose animals providing milk and meat in addition to fiber.

Throughout the world finer grades of wool are used in clothing. The breeds of sheep that grow it are very different from those that grow coarse wool. Fine wool breeds in the Americas trace their ancestry to the Spanish Merino. Sheep of this breed were first taken to the Americas by European explorers. The Debouillet-Merino was developed from European breeding stock and is common in the American West. Many other breeds produce fine wool of high quality while thriving in diverse environmental conditions.

The Karakul, originally from what is now the Southeastern Soviet Republics and Iran, is raised for its pelt. Young animals (lambs) are generally slaughtered at a few weeks of age when the hide is soft and pliable. Many fat-tailed sheep thrive in desert regions of Africa and Asia. Although belonging to the same species as the breeds mentioned previously, they have a broad base to the tail that allows them to store

more fat than other breeds. This energy store allows the animals to survive harsh conditions; they can go for long periods of time without replenishing their body water.

Breeds commonly used in meat production are cross-bred to take advantage of a variety of genetic traits. The Suffolk is popular in the United States because it is a tall, large-framed breed. Its size provides the kind of lean carcass desired by consumers. This would not be the ideal meat breed in a country where the fat content of the carcass is of great value. Even where the market demands large, lean carcasses, Suffolks are cross-bred for other traits. They are not known for their mothering ability and so may be cross-bred to ensure that lamb survival rates are as high as possible. Range flocks often use a cross-bred Dorset ram (adult male) because they have sturdier legs and will be able to breed more ewes (females) in a lifetime.

The Hampshire is another popular meat breed in the United States that also yields a coarse to medium wool. Its dual purpose and adaptability to wet climates are assets where such traits are desirable. It is generally raised in farm flocks and not on range.

The Finnsheep has found popularity in some breeding programs, including those in Third-World countries. Though not a very hardy sheep due to its extremely fine bones it is prolific; ewes have 3-4 lambs at a time and are good mothers. These positive reproductive characteristics have made it popular in cross-breeding projects. Such positive traits must be considered with regard to the production system and resources available. If these sheep were to be raised in an area where inadequate feed was available for lactating ewes, then the death loss due to inadequate milk supply would not warrant the investment in the Finn ewes.

Throughout the Third World there are many breeds of sheep appropriate to the needs of family or commercial producers. It is estimated that there are 300 million sheep in Third-World countries (Smith, 1985); this is 30 percent of the world's sheep population. Drawing on this vast resource it is possible to choose breeds best suited to the environmental conditions of an area as well as the product needs of the people raising the animals. Cross-breeding is one of the most effective tools we have for improving or altering sheep products. Its application must take into account many variables including available resources and any diseases endemic (naturally occurring) to an area. The prudent use of cross-breeding can allow the shepherd to combine the traits most desirable to a specific production system.

### **3. RESOURCES FOR SHEEP PRODUCTION**

#### **Fencing of Pasture and Range**

The area intended for raising sheep should be evaluated before the first animal is purchased. One might decide to buy one pregnant ewe, in which case a small pen would be sufficient if feed is to be brought to the animal. A flock requires a large pasture or range.

If the sheep are to be confined, not herded by a shepherd, fencing must be adequate to keep the animals within an area. Less labor is required for daily herding with a fenced range or pasture. The one-time costs of materials and labor to construct the fencing are significant. The costs of repairs and availability of fencing material in the future (over many years) should also be considered.

Fences can be built from a variety of materials. Wherever possible, local material should be used as this will make the fence more affordable and any fence repair can be done easily because supplies are readily available. Wood panel fencing is ideal for sheep although it is usually the most costly type of fencing. Barbed wire and rolled wire are commonly used. In a pasture where lambs will be kept, the strands or boards will need to be close together so that the lambs do not escape. Mesh fencing is commonly used for young lamb pasture. The mesh should be small enough that the lambs do not push their heads through and get stuck. A mesh of 15 cm is generally better than a larger size mesh (Ensminger and Parker, 1986).

The lowest strand or board in the fence should be no more than 10 cm from the ground, to ensure that sheep neither push the wire up and escape, nor--worse--become entangled and injured. A fence 120 cm in height is usually tall enough to maintain a flock. The height depends on the breed to be raised. Large aggressive rams may need to be kept behind a more sturdy fence, perhaps of wooden plank.

Securely planted posts and well-built gates are essential to good fencing. The width of openings will depend on how many animals are to be herded through them and what, if any, machinery will need to pass through gates.

Fencing is not always necessary for sheep production. In the Western United States many flocks are maintained on open range and are never confined until put in pens at a finishing feedlot or packing house. Nomadic peoples herd sheep throughout Northern Africa and Asia without fencing. Sheep herded this way have a strong flocking instinct, which makes a migratory existence practical for the herder. Their tendency to stay near other sheep, particularly when confronted by danger or at night, increases the survival rate of animals where predators or harsh climate are daily challenges.

Nomadic shepherding requires knowledgeable herders and great adaptability on the part of the sheep and their keepers. Although 44 percent of the world's sheep are kept in this fashion (Smith, 1985) it is not likely that a new sheep program would include such an extensive production system. A possible exception would be where groups of nomads already herding camels, cattle, or goats wish to add sheep to their herds. This might be done where cattle are inappropriate due to drought conditions or where a new market exists for the sheep or their wool or milk.

### **Quality of the Feed Resource**

The quality of forage and seasonality of plant growth should be determined when selecting the pasture or range on which the sheep will be kept. The species of plants, rainfall variation, and soil type will all affect the nutritional composition of the pasture. Although one species may reach its peak in protein content in the spring, others may be just starting to grow then. Most vegetation is of highest digestibility just prior to flowering or the beginning of reproduction. All these factors must be considered in order to maximize production from a pasture resource.

Although chemical analysis is the most accurate way to assess nutrient composition of plants, experienced animal scientists and herders can make assessments by inspection. Accurate assessments require familiarity with the grasses, legumes, or brush. A grass that is green and lush-looking may nevertheless not be digestible by

sheep for a variety of reasons. Some plants produce toxins and are not palatable to sheep. In some cases the water content may be so high that little nutritional value is realized.

Determining how many sheep can be fed on a given amount of pasture also depends on the breed of sheep and the reproductive cycle of the flock. In areas where plant growth is constant throughout the year and where day length varies little, sheep mate throughout the year as well. It is up to the manager to decide when lambs should be born to best match the resources available. Where there is a market incentive to produce lambs "off season" the cost of supplemental feed may be warranted. In some locales supplemental feeding will always be necessary. This may include vitamins and minerals or energy and protein supplements depending upon the flock's requirements.

Knowing the quality of the feed resource, the herd's requirements and the timing of availability will go a long way toward meeting the goals of the producer. The willingness of the sheep to eat particular feeds is not always predictable. Although not known to be fussy eaters, sheep do have preferences. They will eat weeds and brush but they prefer grasses and legumes. Such factors need to be included, whenever possible, when assessing the carrying capacity of the land and the impact of the sheep on vegetation.

### **Life-Cycle Nutritional Requirements**

Ewes and rams require the least energy, protein, vitamins, and minerals per unit of body weight. For the ewes, these requirements, amounting to 2.5 to 3 kg equivalent in dry forage per day for each animal, increase during breeding and during pregnancy and lactation. Young lambs have high nutritional requirements, particularly of protein, for growth.

Most managers recommend that the nutritional level of ewes be increased just before breeding. This can be done in several ways. Ewes may be placed on superior pasture two to three weeks before introducing rams to the herd. In many places ewes are grazed on crop stubble so that they may make use of the residue. Where available, grain can be fed to condition the ewes. The last method is the least desirable. First, it is likely the most costly alternative; second, it is difficult to gauge how much grain each ewe will consume and ewes are likely to become too fat. The aim of flushing, as the period of conditioning is known, is to increase the ovulation rate of the ewes. Although the mechanisms are not fully understood, this is a generally accepted practice. In order for flushing to be successful it must be done 10 to 20 days prior to introducing rams. If it is begun any sooner the advantage of increased ovulation rate is not realized. Excessively fat ewes produce fewer lambs, in fact. Rams should also be conditioned, by feeding an energy and protein supplement approximately one month prior to breeding.

Gestation in sheep takes 144 to 155 days. During the first two-thirds of this period, the requirements of ewes do not increase significantly. They must have adequate feed and water but this requirement is only slightly above that of maintenance. During the last third of the period of gestation, when most of the growth occurs in the fetuses, the ewes require 1 1/2 times the feed of maintenance. It is important that grain or a crop by-product be fed at this time if the pasture resource is not adequate. The number of lambs the ewe is carrying and climatic stress will also effect the nutritional needs of the ewe.

Lambs require little care, but up to 20 percent of newborn lambs may die if no attention at all is given. Disinfect the umbilical cords of newborns in iodine solution to prevent infection. One good method of preventing losses of new lambs is to put the mother and the lambs in a small pen (1.5 m square) for two days after birth, and frequently verify that the lambs are nursing. If they are noisy and have cold mouths they are not nursing and will die. The teats of the mother may need to be checked to make sure they are not clogged and the lamb may need to have its mouth placed upon the teat until it learns to suck. The manager should ensure that all of a ewe's teats are being used. If lambs nurse and, starting at two months, are kept free of worms, they will likely survive.

Lambs raised for meat may be fed 1 kg of grain (maize) daily for the last two months, then slaughtered at about 50 kg live weight.

Detailed tables of the nutrient requirements of sheep for maintenance, early and late pregnancy, and lactation in ewes as well as for early and late weaned lambs and finishing (being fattened for slaughter) lambs are available from the National Research Council in Washington, D.C. Although these figures have been determined through extensive research, they should not be applied blindly to any situation. The sheep involved in these trials were in superb health, free of parasites, and maintained in a thermoneutral environment. A thermoneutral environment is one in which the animal neither gains nor loses heat from or to its surroundings.

Sheep raised in the tropics or sub-tropics will undoubtedly have a greater heat load than those in temperate zones; this difference will influence their feed intake and thus the extent to which the needs for growth, reproduction, or other body functions are met. Climatic stress and health status will also influence the animal's ability to eat and to utilize its feed. This cannot be exactly determined in terms of grams of feed, but should be considered when determining feed requirements and desired levels of production from the flock.

### **Terrain**

Physical features of pasture or range can be as important as the plants and fencing. Such important features include rocks, slope of hillsides, drainage, and elevation.

Sheep can harvest feed in areas of somewhat rough terrain where most animals cannot be successfully raised. Pasture that is extremely hilly or has many large rocks will reduce the animals' ability to graze. The sheep will tend to bunch up in the flatter, less rocky areas and may overgraze these more accessible areas. The animals' feet may become bruised from the rough terrain, making it more difficult to move around and graze. Lamé animals are usually the thinnest and least productive individuals in a herd. Another serious problem is the accumulation of feces and urine. Excessively wet soil encourages foot rot (caused by a soil bacterium and a fungus) and survival of parasites.

Extreme slopes can obscure sunlight, thus retarding plant growth. Shade plants may thrive in such an area and in such a situation it would be worthwhile to determine if sheep will eat these plants before planning the number of sheep to be kept there. Supplemental feeding is an option where forage or crop by-products are available and affordable. The cost of bringing the feed to the animals must be included in planning.

Ensminger and Parker (1986) state that for every 305 meters gain in elevation, vegetative development is delayed 10-15 days. Although this figure refers to rangeland in the Western United States, there is also an elevation effect at or near the equator. High elevations, such as Mt. Kenya and Kilimanjaro in Africa and Kotopaxi in South America, are examples. Vegetation in the foothills and slopes of these peaks is surely influenced by altitude.

Variation in growing season due to altitude and the type of terrain are important in determining the feed resource available for sheep production. By taking these factors into account--as well as the biological factors of the plants--one can determine the number of animals that can be kept per hectare, known as the stocking capacity.

### **Herding and Handling the Flock**

Sheep that have been on range are most likely to gather into a group when approached by people. If frightened or chased by a predator they will become scattered and more difficult to herd into a corral. In many countries, dogs are often used to assist in herding of sheep. These are well-trained animals that know how to move sheep slowly and at the command of the shepherd. Untrained dogs should never be around sheep because they will chase them like prey. Dogs are natural hunters and therefore enemies of sheep, so great care must be taken if one plans to use sheep dogs for herding.

Farm flocks of sheep may not be as accustomed to being herded. The more sheep are herded and handled, the calmer they will be and less likely to be injured. As with sheep on range, they should be approached slowly and moved into a small corral for handling.

A herd should be put into a corral for routine care, such as foot baths, vaccinations, or shearing, or prior to transport for sale. Frightened sheep will run at fences and may try to jump out of corrals. Panic will result in injuries and makes the animals more difficult to handle in the future.

Some herders recognize individuals by horns, wool on the face, size, or coloring. Ear tags or paint brands on the wool can also be used. Ear tags are the most reliable method if properly punched in the animal's ear. Paint washes out of the wool or brands become distorted as the wool grows. Where wool is a marketable product, paint brands should easily wash out so as not to reduce the value of the wool.

Chutes are useful to confine individuals. They should be wide enough for one sheep at a time to walk through but not turn around and walk out the way it entered. When the chute is full of sheep they will not be able to move because they are held in place by the animals in front of and behind them. This is an ideal time to check the health of individuals.

### **Routine Health Checks**

One should have a system for examining an animal before moving on to the next one. Keeping records of individual health is very useful in assessing performance. Persistent problems will be identified if records are kept from month to month.

The eyes and ears of the sheep should be examined. Runny eyes may indicate infection. Some species of flies will lay their eggs in the eyes; hatched larvae then cause swelling, hemorrhage, and possibly blindness. Eyes should be cleaned and ointments applied if necessary. Most sheep have some nasal discharge but thick or discolored discharge may indicate disease. Irregular breathing accompanied by nasal discharge or coughing are signs of pneumonia.

It is good practice to examine the sheep's hooves. This requires turning the animal on its back outside the chute. Grasp the sheep's jaw firmly in one hand. (Never hold the sheep by its wool as this will cause bruising.) Turning the animal's head to face its rump and push its hindquarters to the side, then flip the sheep onto its tail. The animal is relatively immobile in this position, with its weight on its lower vertebrae. At this time trim the hooves and check for foot rot.

While a ewe is on her back, check the teats for injuries or infection. Likewise examine rams' testicles for any abnormalities. Treat any wounds with antiseptic ointment. For more serious infections antibiotic injections may be necessary. Individuals requiring special care should be separated from the main flock as they leave the chute or holding pen. They are then kept in a small pasture so they can be more easily treated.

Finally, examine the dock (area around the anus and vagina). Diarrhea is common in recently weaned lambs that are adjusting to a new diet. Diarrhea in older animals may be an indicator of poor nutrition or internal parasites. Where feces have accumulated in the wool around the dock, flies are likely to lay their eggs and cause damage to the animal. In wet climates or where flies are a problem the wool is often cut away from the dock to prevent infection.

### **Other Health Considerations**

Although sheep diseases are numerous, losses from disease are usually moderate to low. Maintaining the health of a herd or a single animal involves the same basic principles. A visual assessment of individuals, as described in the previous section, will allow the animal manager to find problems and take action before the animal's health and productivity suffer.

A thorough survey of even the major diseases is beyond the scope of this short paper. Some health problems require a veterinarian for diagnosis and treatment. Veterinary services are very costly, especially related to the economic return from a single sheep. For this reason and because such services are not always readily available, it is worthwhile for the manager to be acquainted with common diseases and know how to prevent them or give simple treatment. Common or noteworthy diseases are listed below:

Anthrax is a very serious disease because the bacteria that cause it multiply very rapidly in the body and death usually occurs in a few hours. The disease is highly contagious and is deadly to humans also. It is passed in contaminated water and animal products, such as wool (hence the term "wool sorter's disease") and hides. The disease is widespread in the tropics, where the bacteria have many reservoirs and multiply rapidly. In these areas vaccination is recommended (Robertson, 1976).

Brucellosis is a bacterial infection that causes abortion. It is highly contagious from animal to animal and to humans. It is passed in milk and other body fluids. Animal handlers may be infected by airborne transmission of infectious agents at lambing

(birth of lambs). Some countries have brucellosis policies that require the slaughter of all infected animals because of the seriousness of the disease in humans.

Enterotoxemia, or overeating disease, is common where sheep are fed grains. Signs include sudden loss of appetite, staggering, convulsions, and death. Treatment consists of using antitoxins under specialist supervision. Vaccines are available to prevent the disease.

Foot-and-mouth is a viral disease spread by direct contact between infected animals, which contaminate their surroundings and spread the disease. Mouth lesions, mastitis, muscle degeneration, and eventually foot lesions are symptoms. Vaccinations are available but offer immunity for only four to six months. Where control measures are enforced, animals are quarantined and infected animals slaughtered if a disease-free zone is to be established. This disease has been studied extensively in cattle because they are most often infected and are transported between countries in larger numbers than sheep.

Foot rot is a common problem that can be prevented by proper management. Sheep kept on wet pasture or dirty bedding develop foul-smelling decay between the wall and sole of the hoof. Well-drained soil and clean bedding will help prevent this disease. Vaccinations are available but are costly and may not be available throughout the world.

Lamb dysentery or scours is seen in the lamb as a loose stool and fever during the first few days after birth. Having too many sheep in a small area favors the bacteria that cause the disease. Death can come quickly. Prevention involves good sanitation and keeping the living quarters dry. Treatment with antibiotics is only partially effective.

Ewes with mastitis (infected, swollen udder) may have injured mammarys or may have been suckled by a lamb that spread the disease. Good sanitation and isolation will prevent spread. If a ewe has a persistent problem she should be culled (removed from the flock and sold or slaughtered).

Pneumonia is a lung disease of sheep throughout the world. It is caused by any of several different bacteria. Animals living in damp conditions, particularly where ventilation is inadequate, are most susceptible. Proper sanitation and ventilation will help prevent it. Some pneumonias clear up as the weather changes; some will cause the animal to stop eating and may cause death. The disease can be treated with antibiotics.

Pregnancy disease occurs in ewes during the last two weeks of pregnancy. The ewe trembles when exercised, shows weakness, and may collapse. If the ewe aborts her lamb(s) the symptoms will disappear unless the disease has been neglected too long. Prevention consists of an adequate diet of grain during the last few weeks of pregnancy. Treatment consists of feeding high-energy foods such as molasses.

Sheep pox or sore mouth is a viral disease commonly seen in lambs. It causes lesions and then scabbing around the mouth and on the teats of ewes. Humans are infected when handling infected animals. The disease usually runs its course with no long-term ill effect unless lambs are unable to suckle for a long period and become emaciated. Live vaccines are available for use if the problem is serious in a flock. Generally vaccine use is not warranted.

Sore mouth is often confused with blue tongue, which also causes lesions but is not transmitted directly from sheep to sheep. Infected animals will not eat, have swollen tongues, become stiff, and develop secondary infections, commonly pneumonia. Muscle tissue is also affected. Animals should be vaccinated once per year and kept on well-drained ground to avoid transmission by blood-sucking insects (Robertson, 1976).

Tetanus is a bacterial disease that attacks the central nervous system of all infected animals causing paralysis and death. It enters the body through wounds and is commonly found in the soil. Vaccination, good management and sanitation are the best preventive measures.

Tetanus and other diseases, including black quarter, big head in rams, and pulpy kidney disease, are caused by bacteria that belong to the Clostridium genus. Clostridia are found in soil and feces and so exposure to these diseases is common. The infection often enters through a wound or, in the case of pulpy kidney disease, the bacteria are ingested. By keeping the animals' housing clean and preventing injuries by not crowding, these diseases can be prevented. Sudden changes in diet will precipitate some clostridial infections and so any change should be made gradually. If the sheep are to be put on rich pasture where their intake cannot be controlled, they should be allowed on it for only a few hours each day until their digestive systems adjust to the dietary change.

Sheep owners should be aware of the diseases that are common in their own areas. Such internal parasites as liver flukes, lungworms, and intestinal worms are problems throughout the world. Where animals are in a continuously wet climate they are likely to be infected throughout the year and in some cases develop an immunity to certain parasites. In seasonally wet climates the parasite burden is worst after the onset of rains, when the animals become infected. Although a program of regular de-worming can sometimes be replaced by frequent rotation of pasture land, the threat of stomach worms usually requires that a sound de-worming program be in place when sheep raising is started. If a program is established it should be maintained because the animals will lose any immunity to infection if not exposed to the parasite. Good management can prevent many kinds of infection so a combination of preventive and control measures should be used.

Infection with such external parasites as ticks, fleas, maggots, mites, and lice should be treated as recommended for the geographic area by a veterinarian or animal-care specialist.

Some diseases, many of which are not mentioned here, are controlled by laws that require owners to vaccinate or otherwise treat their livestock. This is particularly true where animals are to be transported between regions of a country or across international boundaries. Certificates proving vaccination, or negative blood-test results for various diseases, are included in the law enforcement procedure.

Veterinarians or regional livestock officers of an extension service are good sources of information on local disease problems and recommended management techniques. The Handbook on Animal Diseases in the Tropics provides good reference material. It outlines transmission, symptoms, prevention, control, and treatment.

## 4. SCALE OF THE OPERATION

The scale of the production system will always place certain restrictions on what can be achieved from raising sheep. If one raises a large number of sheep the cost of labor, feed, veterinary care, and marketing will be high. Whether or not the cost will be higher per unit of product, as compared with a family flock of just a couple of sheep, depends on the quality of management and factors of the marketplace. A wise choice of resources and attention to the details of daily management are keys to success no matter how large or small the endeavor.

A family may choose to raise one or two sheep. Many village cooperative projects have been established that allow individuals to lease a ram for a few weeks to breed ewes. In this way the cost of buying and then maintaining the ram is not the burden of one family. Cooperative marketing is also helpful where wool is collected from several families and sold at once to a processor.

In any size operation lambs may be slaughtered for meat, and milk may be used for family consumption. Timing of breeding can allow for a year-round supply of these products. Care must be taken not to deprive lambs of necessary nutrients if milk is to be used for human consumption.

Large commercial sheep operations are based on an assumed market. It would not be profitable to raise lambs or regularly shear wool if there were not a way of transporting and selling those products. The costs of shipping live animals to a slaughter house and the effect of this transport on the sheep should be considered. If meat or milk is to be shipped, refrigeration or other preservation methods must be readily available. Coordinating the production time and the demands of the market, whether it be in a regional or international market, is a complicated, but quite possible, task.

Marketing meat and wool is an especially challenging endeavor because there are many countries that already have a large share of the market. New Zealand and Australia are two such countries. A wise approach might be to introduce a slightly different product than is currently available to importing nations. In this way one can take advantage of a new niche in the market. A thorough knowledge of import restrictions is mandatory because many nations have experienced serious disease problems from imported animal products.

Despite the complexity and cost of producing sheep it is possible to benefit from their products. A thorough knowledge of the sheep's requirements for growth and disease prevention will aid every manager in realizing the potential from these versatile animals. Indeed, with any livestock program that is new in the area, a highly experienced person should plan to be in residence for an extended period. Applying basic concepts to specific climatic and cultural conditions requires adaptability and foresight on the part of the animal manager.

## REFERENCES

The following addresses are in the United States unless otherwise shown.

Blakely, J., and Bade, David H. *The Science of Animal Husbandry*, 4th ed. New York: Prentice-Hall, 1986.

Cole, H.H., and Garrett, W.N. (eds.). *Animal Agriculture: The Biology, Husbandry and Use of Domestic Animals*. San Francisco: W.H. Freeman and Co., 1980.

Ensminger, M.E., and Parker, R.O. (eds.). *Sheep & Goat Science*. Danville, Illinois: Interstate Printers and Publishers, 1986.

National Research Council. *Nutrient Requirements of Sheep*. Washington, D.C.: National Academy Press, 1985.

Robertson, A.R. (ed.) *Handbook on Animal Diseases in the Tropics*. Abingdon, U.K.: Burgess & Son, 1976.

Smith, A.J. (ed.) *Beef Cattle Production in Developing Countries*. Avonmouth, U.K.: Western Printing Services, 1976.

Smith, A.J. (ed.) *Milk Production in Developing Countries*. Trowbridge, U.K.: Redwood Burn, Ltd., 1985.

Webster, C.C. and Wilson, P.N. *Agriculture in the Tropics*. New York: Longmans, 1980.