

2. Flock management

Shepherding of bedouin and fellahin flocks

In large parts of the subtropical semi-arid Awassi breeding area the sheep depend for their sustenance throughout the year solely on natural pasture growth. In the winter and spring they enjoy the new grazing that sprouts up after the rains. When the winter rains have been plentiful, the bedouin do not water their flocks as these obtain sufficient moisture from the young juicy plants. In summer the sheep live on weeds and the stubble, gleanings and fallen grains on the harvested fields of the fellahin. In autumn and early winter they have to content themselves with the meagre herbage found on hillsides or in valleys. This is the time of scarcity of nourishment when the Awassi sheep use up the fat stored in their tails during the months of plenty. In the season of scanty grazing or during violent rain storms fellahin flocks may be given some tiben — straw crushed and torn by primitive threshing methods.

In some parts of the breeding area the Awassi flocks are not stationary but travel with their nomad owners over large distances and customary grounds in search of pasture. Stationary Awassi flocks owned by fellahin are commonly pastured in the neighbourhood of the villages. When the ewes are in milk, they are taken to the tents of the bedouin or the villages of the fellahin in the evening to be milked and rest in the vicinity for the night. During the season when the ewes are dry, they remain in the field at night together with the shepherds and their dogs.

In Syria, flocks belonging to fellahin are usually taken by shepherds to mountain pastures in the spring. They return to the villages for the winter when temperatures at high altitudes are very low and the mountains are covered with snow. In the plains there is ample grazing during the rainy winter season.

The Awassi sheep of the bedouin of Syria are entirely migratory. In winter numerous flocks move deep into the Syrian desert, often as far as the Euphrates, where pasture growth is fairly satisfactory at this time of year. As soon as the steppe and desert flora dries up early in the summer, they return to the western parts of the country where the winter rains are more copious and the pastures provide grazing until well into the dry season. In the hot months of the year bedouin flocks may be found grazing on the stubble and fallow lands of the fellahin. On their annual migrations from west to east and east to west they cover hundreds of kilometres (Hirsch, 1932).

Other bedouin flocks are taken in winter to pastures in the southern parts of Syria, where the vegetation begins to grow in October and November. Later the flocks return to the north, their movements closely following rainfall distribution. From October to July the majority of the sheep of the bedouin are pastured in steppe, semi-desert and desert areas. During this period the main events of the annual cycle occur, that is, lambing, milking, shearing and fattening. With the advent of the summer heat, the vegetation fades and the flocks move on to more promising regions. But in many areas of the Syrian steppe the natural flora of valuable pasture plants has been largely destroyed by overstocking and has given way to coarse and thorny vegetation. During droughts the dearth of fodder causes serious weight loss in the sheep of the bedouin and great numbers of them perish (Gadzhiev, 1968). (See Fig. 2-1.)

In Iraq the difference in the grazing system between fellahin and bedouin flocks is similar to that practised in Syria. The fellahin flocks subsist for more than six months of the year on the rich grazing of the winter wheat, the summer stubble and weeds of the arable land, and fortuitous grazing on



Figure 2-1. Awassi sheep following their shepherd on the Syrian steppe. (Courtesy of Dr D.E. Faulkner, FAO)

common ground or the nearby desert. For the rest of the year the flocks are sent under the care of shepherds into the desert for spring and early summer grazing. The distance traversed by the fellahin flocks in search of pasture depends on the year's rainfall, but in general is relatively small.

The Awassi flocks of the bedouin of Iraq are required to obtain their sustenance by foraging over vast distances. This level of management is prevalent in all areas, in the mountains, plains, marshlands and forests. Yet during November and December supplemental feed is often required for the survival of the sheep until after the rainfall (Kazzal, 1973). In winter and spring the bedouin move with their flocks along the depressions in the desert as the grass becomes available. When the wells dry up they go back to the fringes of the irrigated land and the fallows along the canals and rivers. To the east of the Tigris there is adequate summer grazing for the Awassi flocks along the foothills of the frontier with Iran. In the spring and autumn the desert provides sufficient pasturage and in winter the flocks graze on the edges of the marshes and the river bank. The hill bedouin move up to the mountains or down to the plains as the weather dictates. On their annual migrations the bedouin of the Dulaim tribe may traverse some hundreds of kilometres. The daily distance covered in the desert is about 6-8 km when the grazing is fairly good. While 16 km is considered to be a fair rate of progress when migrating to more distant pastures, if pressed, flocks may be driven for as much as 35 km in 24 hours (Williamson, 1949).

In many parts of the breeding area of the Awassi, flocks comprise sheep as well as goats in varying ratios depending on the climate and topographical conditions of each region. The Awassi sheep, which are rather slow of movement during the summer, are stimulated by the goats to greater activity. (See Fig. 2-2.)

Bedouin or fellahin shepherds know nothing of tents or houses but live entirely in the open together with the flocks under their care. They work 365 days a year, from 13 to 16 hours a day. Their work includes shepherding, watching the sheep at night, the care of sick animals, training bellwethers, shearing, weaning lambs, and tying the ewes up for milking, an activity usually performed by the women. (See Fig. 2-3.)

Before dawn, while the sheep and the dogs are still at rest, the shepherds — who have slept in



Figure 2-2. Bedouin flock of Awassi sheep and Negev goats



Figure 2-3. Bedawi shepherd with full paraphernalia

their clothes on the ground—begin to awaken. Some dry dung or twigs, collected the evening before, are piled up in a small heap and kindled. Each shepherd brings a handful of flour along, one of them mixes it with salt and water, kneads the dough and forms it into flat cakes which are baked in the hot ashes. While the shepherds have their morning meal of bread and onions and a drink of cool water, the sheep slowly get to their feet. When ready to move, the experienced shepherd sounds a sharp cry and the whole flock moves after him, one animal after the other. The shepherd then allows them to pass and, leaning on his staff, counts their number.

While the ground is still wet from the night's dew, the shepherd turns the flock to pastures sparsely covered with dry wilted plants. When the rising sun has dried the dew, the flock moves on to lusher pastures or stubble fields. Progress is slow as the animals move forward while feeding, without much spreading out as Awassi sheep have a close flocking instinct.

When the sun is at its height in the summer, the sheep approach the place of watering. First to rush to the water are the dogs. As soon as they have taken their fill they look for a place in the shade to lie down. As the sheep come up to the water, the shepherd encourages them to drink with suitable cries. After the whole flock has been watered, it may rest for about two hours, ruminating, lying down or standing in a cluster, each sheep with its head below the belly or tail of its neighbour, until the greatest heat of the day has passed. Before moving on, some of the sheep return to the water for another drink. Then the flock goes on to new pastures, feeding with ever greater appetite as the cooler evening approaches. Before sundown the flock is gathered at the night's resting place; the shepherds collect fire material for the preparation of the evening meal and for the following morning. Again fresh bread is baked and eaten with onions or some sour milk or cheese, and the dogs, which serve to guard rather than herd the flocks, get their share.

Awassi flocks of the bedouin and fellahin are commonly accompanied by rams throughout the year. Hence, a ewe in oestrus is served several times. Ewes coming into heat very early in the season may lamb when there is still a shortage of grazing before the rains. In order to prevent this, bedouin owners of large flocks sometimes separate the rams from the ewes before the onset of the breeding season and send them to pasture with the last season's lamb crop. The number of ewes for each ram varies between 25 and 35 in bedouin flocks and between 40 and 50 in those belonging to fellahin.

During the lambing season lambs born in the field and still too weak to follow their dams are carried by the shepherds to the tents or villages where they remain for a few days until strong enough to join the dams at pasture. The suckling period lasts for two to three months, depending on the state of pasture, time of birth, and development of the lamb. After weaning, the lambs are pastured in separate flocks away from the ewes and have to subsist solely on natural grazing.

Neither bedouin nor fellahin castrate male lambs. Only a very few destined to become bellwethers leading the flock may be castrated, either by biting through the spermatic cord or tying a string tightly around the upper part of the scrotum. Such lambs are taken from their dams on the day of birth and fed milk from a small vessel. Their attachment to the shepherd takes place within the first ten days of life, the period of imprinting. Later they are trained to eat grain from the hand of the shepherd. Their training as flock leaders may include the tying of a long cord to the lamb, which is held by the shepherd. The cord is untied as soon as the lamb is accustomed to follow him. The shepherd may also raise his arm and throw a small stone at the lamb, and when it tries to run away, pull it by the cord toward himself. In this way the lamb learns to come to the shepherd whenever he raises his arm.

Milking commences when a sufficiently large number of ewes have suckled their lambs for at least two months. During the first three or four months of the milking season the ewes are milked twice a day, and during the following month only once until they go dry. As the bedouin have no enclosures for milking, the ewes have to be milked in the open. The animals are placed in two rows along a long rope to which they are tied by their heads in opposite pairs.

In some parts of the breeding area Awassi sheep are shorn once a year, in others twice. Shearing is usually done in a rough manner by hand shears or with simple scissors while the sheep are lying on the ground. Wounds caused by the shearers are common. A shearer may shear 20-30 animals a day. Often the wool is sold before shearing, by number and not by weight.

Wherever possible, Awassi sheep are washed once during the summer. After washing the animals are dyed red, green, blue or violet on the back and tail root. Rams are often dyed red all over the body. The reasons given for dyeing vary: distinction between flocks, protection from the intense radiation of the subtropical sun, or aesthetics. Slaughter sheep are dyed on the flanks to make them appear fatter and broader (Hirsch, 1933).

Nutrition of the Awassi dairy flock

In improved Awassi dairy flocks in Israel the Scandinavian (Hansson's) feed-unit system of evaluation of the nutritive value of feedstuffs is used, which considers the value of protein in relation to milk production rather than in relation to energy (therms) or body-fat-producing capacity (starch equivalent) on which other systems are based. The value of digestible protein for fat production in bullocks is considered to be 0.94 of the value of one starch equivalent for this purpose (Kellner, 1971), or 1.0 in the energy evaluation of total digestible nutrients (TDN) (Morrison, 1959), while the relative value of digestible protein for milk production is considerably higher, namely 1.43 (Hansson, 1929). In other words, the energy utilization efficiency of protein for milk production is superior to that for fattening, and to some extent (15-20 percent), this also applies for carbohydrates and fats.

The nutrition of improved Awassi dairy flocks is composed of pasture and stall feeding. The ratio between these components depends on the availability of pasture in the vicinity of the sheds at different seasons of the year and on the milking standard of the flock. The higher the latter, generally the smaller is the part of pascual feed in the provision of the annual nutritional requirements of ewes, being less than one-third in some flocks.

In the subtropical semi-arid breeding area of the Awassi the natural pasture consists of green grasses and plants and of dry plants, according to the season. These should supply the ewes with about 120 feed units annually, that is, ten in December, 15 in January, 30 in February, 30 in March, and 15 in April. During the remaining months of the year the dry pasturage may provide another 20 feed units in all (Becker, 1958).

Farms with improved Awassi flocks usually include agricultural and horticultural areas which may provide the sheep with additional pasturage at certain periods of the year. Among these are vineyards, citrus and deciduous fruit plantations, and carob and olive groves.

After harvesting grain crops, cotton, green fodder or hay, Awassi sheep are pastured on the fields during the short interval between harvesting and ploughing. For a few days they may also graze on the grain fields when the plants have reached a height of 20-25 cm, without detriment to the future grain crop. The same holds for fields sown with green manure, of which clover, horse beans and fenugreek are the most common. However, fenugreek is unsuited for ewes in milk as it imparts an unpleasant flavour to the milk.

On farms with flocks of improved Awassi sheep, it is also common practice to set aside areas of arable land for annual winter pastures sown with barley, oats, wheat or Italian rye-grass, annual summer pastures of maize or Sudan grass, and also perennial pastures of lucerne, Rhodes grass or paspalum. In addition to these more commonly available types of pasturage, there are various other crops and plant residues that are utilized by Awassi dairy ewes on different farms.

Awassi dairy flocks should have watering facilities at pasture even during the season of fresh plant growth when bedouin flocks are not usually watered. Improved Awassi dairy ewes need much larger quantities of water than unimproved sheep because they consume considerable quantities of concentrates and some hay or straw in addition to the pasture grass, and high-yielding ewes, when in full milk, may excrete 4-5 l of water a day with the milk.

In the composition of feeding rations for Awassi sheep three main factors have to be considered: total feed units, digestible protein and dry matter. The quantities and ratio of these components depend on requirements for maintenance, growth, milk yield, pregnancy, preparation for a new lactation, service of the ram, and wool production. The ration must also supply the necessary minerals and vitamins.

The requirements for maintenance depend on the weight of the sheep. Animals of lighter weight need absolutely less, but relatively more, feed units and digestible protein than those of heavier weight (Loew, Dori & Kali, 1972). (See Table 2-1, based on Kellner & Becker, 1971.)

The daily feeding ration for improved Awassi dairy ewes of an average weight of 60-70 kg should

TABLE 2-1. Daily maintenance including wool growth requirements of Awassi sheep of different live weights

Weight (kg)	Feed units (number)	Digestible protein (g)
35	0.45	40
40	0.49	44
45	0.52	47
50	0.56	50
55	0.59	53
60	0.62	56
65	0.66	59
70	0.69	62
75	0.72	64
80	0.75	67
90	0.79	72
100	0.86	77

TABLE 2-2. Feed unit, digestible protein and dry matter requirements of Awassi ewes in milk

Milk yield/day (kg)	Feed units (number)	Digestible protein (g)	Dry matter (kg)
0.5	1.5	110	1.8
1.0	1.5	150	2.2
1.5	1.9	190	2.6
2.0	2.4	230	2.8
2.5	2.8	270	3.2
3.0	3.2	310	3.5

Source: Loew, 1980

contain 0.7 feed units and 60 g of digestible protein for maintenance. According to recommendations of the Council on Sheep and Goat Nutrition of the Israel Ministry of Agriculture, larger feed-unit amounts should be allotted for the maintenance of Awassi ewes: 0.8 feed units with 70 g of digestible protein for ewes weighing 60-70 kg and 0.9 feed units with 75 g of digestible protein for those weighing 70-80 kg (Loew, 1980). The ration must also include 1.6-1.9 kg of dry matter which is essential for the proper working of the digestive organs and satiation.

No additional nutrients are required for pregnancy during the first three months as the foetus increases very little in weight in this period. But the plane of feeding during the last two months of pregnancy has a marked influence on the birth weight and vigour of the lambs, and more especially of twins. The pregnancy period is also the time when dairy ewes with high milk yields have lost condition in the course of the lactation period; preparation for the following lactation requires restoration of their weight and accumulation of fat in the tail. Therefore, pregnant Awassi ewes are given 0.3 feed units a day in addition to those allowed for maintenance. The daily digestible protein ration in this period is increased by 50 g so that the pregnant ewe receives 110 g of protein for maintenance, pregnancy and steaming up. The pregnant Awassi ewe also has a greater appetite and requires an addition of 11 percent of dry matter in her daily feeding ration. This brings the total weight of dry matter in the ration up to 1.8-2.2 kg. The daily feeding ration of Awassi ewes during the last months of pregnancy comes, then, to 1 feed unit, 110 g of digestible protein, and 1.8-2.2 kg of dry matter. These are minimum requirements for high-yielding Awassi ewes lambing single lambs once a year. Loew proposes a ration of 1.2 feed units with 120 g of digestible protein and 2.0 kg of dry matter for Awassi ewes in the fourth month of pregnancy, and 1.4 feed units with 120 g of digestible protein and 1.8 kg of dry matter during the fifth month. Ewes with twins, and especially ewes lambing three times in the course of two years, require additional nutrients, and only large ones can cope with such increased quantities of feed.

Awassi yearling ewes receive the same amounts of feed units and digestible protein as pregnant adult ewes. However, they require not more than 1.6 kg of dry matter in their daily ration.

Pregnant Awassi yearling ewes require larger amounts of nutrients than pregnant adult ewes, for in addition to their maintenance and pregnancy requirements they also need nourishment for their own growth. But in view of the lower mean birth weights of lambs of yearling ewes, they require only 0.2 feed units and 40 g of digestible protein on account of pregnancy. The total nutrient requirements of pregnant yearlings are therefore 1.2 feed units, 150 g of digestible protein and 1.6 kg of dry matter.

Ewes in milk require additional nutrition in addition to their needs for maintenance, according to the quantity and fat content of the milk they produce. The production of 1 kg of Awassi milk requires 0.6 feed units and 75 g of digestible protein. An Awassi ewe in milk also needs an increased quantity of dry matter in her daily ration, namely 2.0-2.7 kg. A ewe yielding 3 kg of milk a day should therefore obtain at least 2.5 feed units, 285 g of digestible protein and 2.0-2.7 kg of dry matter to cover her maintenance and production needs. Recently, Loew postulated still larger quantities for Awassi ewes in milk (Table 2-2).

For ewes yielding 4 or 5 kg of milk a day, the necessary feed units and protein increase accordingly, but few of them are capable of consuming such large amounts of feed. The majority lose weight, and foremost the weight of the fat tail, when at the height of production.

The growth of the Awassi ewe's fleece of an average weight of 2.75 kg requires not more than 9 feed units annually, a quantity so small that it can be neglected in the daily ration of a well-managed Awassi flock.

Improved Awassi stud and flock rams require, in conformity with their live weight, 1.0-1.2 feed units, 80-90 g of digestible protein, and 2.5 kg of dry matter in their daily ration during the season of anoestrus or reduced sexual activity of the ewes. In the breeding season their daily ration is increased to 1.2-1.8 feed units and 120-200 g of digestible protein, depending on the number of daily services performed. The dry matter content of the ration is reduced to 2.2 kg a day because of the undesirability of too heavy a load on the ram's digestive system during the season of sexual activity.

The part of natural grazing in the total nutritive requirements of ewes in milk or in lamb can only be estimated roughly. Becker (1958) considers that a dry ewe should consume 1.6-1.9 kg of dry matter at pasture, a pregnant ewe 1.8-2.1 kg, and a ewe in milk 2.1-2.5 kg. In reality, however, pregnant ewes or ewes in milk generally will not consume more than open and dry ewes, that is, about 12-14 kg of pasture plants. If the natural or sown pasture is of a high quality and the ewes can graze to satiation, they should obtain 1.0-1.2 feed units from a day's grazing. But poorer pastures may supply only one-half or one-fourth of this amount. The balance between the estimated consumption of the ewes at pasture and the actual nutritive needs of dry and open, in milk or pregnant Awassi ewes has to be provided by the stall-fed ration.

The necessary quantities of minerals and trace elements are contained in the concentrate mixture. In addition, the sheep have free access to salt licks in every pen.

On days of heavy rainfall when the animals do not go out to pasture or in the absence of grazing for other reasons, the dairy flock has to be entirely stall-fed. Becker gives examples of rations for the stall-feeding of improved Awassi sheep (Tables 2-3 to 2-7).

TABLE 2-3. Dry ewes, open or in early stages of pregnancy (0.7 feed unit, 60 g digestible protein, 1.6-1.9 kg dry matter)

Feed	Kg
Vetch hay	0.75
Barley straw	0.70
(a) Legume hay	0.75
(b) Cereal grass hay	2.20
Maize silage	2.00
Legume hay	1.00
(c) Barley straw	0.50
Cereal or other grass hay	1.20
(d) Maize husks	1.00
Screenings	1.00
Cereal grass hay	0.50
(e) Barley straw	0.50
Oat-and-legume silage	2.00
Screenings	0.50
(f) Barley straw	1.00

Source: Becker, 1958

TABLE 2-4. Dry ewes in later stages of pregnancy (1.0 feed unit, 110 g digestible protein, 1.8-2.2 kg dry matter)

Feed	Kg
Vetch-and-oat hay	1.00
(a) Screenings	1.00
Barley straw	0.25
Vetch-and-oat hay	1.25
(b) Maize silage	2.00
Barley straw	0.50
Clover hay	0.75
(c) Screenings	1.00
Barley straw	0.50
Clover hay	1.00
(d) Citrus peel	2.00
Barley straw	0.75
Green clover	3.00
(e) Screenings	1.00
Barley or legume straw	0.80
(f) Vetch-and-oat hay	1.50
Maize husks	1.00
Clover hay	1.25
(g) Chopped wintersome	2.00
Barley straw	0.50
Clover hay	0.50
(h) Screenings	1.00
Green oats	2.00
Barley straw	0.50
Cereal or other grass hay	1.50
(i) Cereal grass-and-legume silage	2.00
Screenings	0.50

Source: Becker, 1958

TABLE 2-5. Yearling ewes, open (1.0 feed unit, 110 g digestible protein (DP), 1.6 kg dry matter)

Feed	Kg
Vetch-and-oat hay	1.00
(a) Screenings	0.50
Concentrates (10% DP)	0.30
Clover hay	1.00
(b) Silage	1.50
Concentrates (10% DP)	0.35

Source: Becker, 1958

TABLE 2-6. Yearling ewes, in lamb (1.2 feed units, 150 g digestible protein (DP), 1.6 kg dry matter)

Feed	Kg
Vetch-and-oat hay	1.00
(a) Screenings	0.25
Concentrates (10% DP)	0.60
Clover hay	1.00
(b) Silage	1.50
Concentrates (10% DP)	0.50

Source: Becker, 1958

TABLE 2-7 Ewes yielding up to 1 kg milk (1.3 feed units, 135g digestible protein (DP), 2.0-2.7 kg dry matter)

Feed	Kg
Vetch-and-oat hay	1.00
(a) Screenings	1.00
Concentrates (10% DP)	0.20
Straw or maize husks	0.50
Clover hay	1.00
(b) Chopped wintersome	2.50
Concentrates (10% DP)	0.30
Straw or maize husks	0.75
Clover hay	1.00
(c) Citrus peel	2.50
Concentrates (10% DP)	0.20
Straw or maize husks	1.00
Vetch-and-oat hay	1.00
(d) Maize silage	2.50
Concentrates (10% DP)	0.30
Straw or maize husks	0.50
Cereal or other grass hay	1.50
(e) Green clover	3.00
Concentrates (10% DP)	0.30
Straw or maize husks	0.75

Source: Becker, 1958

These examples of feeding rations for Awassi ewes yielding up to 1 kg of milk a day are also recommended for ewes with daily yields of 1.0-1.5 kg, with the difference that in this case the concentrate component in the rations is increased by 0.1 kg a head and the concentrate mixture contains 15 percent instead of 10 percent digestible protein (Tables 2-8 to 2-10). Ewes that yield 5 kg of milk a day cannot cope with more feed units and dry matter than those yielding 4 kg. It is, however, possible to raise the digestible protein content in the concentrate mixture up to 20 percent.

In general, the feedstuffs given in the rations may be exchanged for others according to availability. For example, dry clover may be replaced by vetch-and-oat hay, and green clover by green cereal grasses along with an increase in the digestible protein content of the concentrate mixture. Straw and maize husks are also interchangeable. Again, 'wintersome' (*Sorghum vulgare* Pers. var. *caffrorum*, a grass of South African origin), citrus peel or green cereal grasses may be substituted for silage, and hay for screenings. The ration for rams off the breeding season is given in Table 2-11. If the rams are pastured, no additional feed is required during the off-season.

At the height of the breeding season, 0.5 kg of concentrates may be added to the rations given in Table 2-12. In consequence, the rams will consume less hay. If the rams are pastured during the breeding season, they should receive 0.7-1.0 kg of concentrates containing 15 percent digestible protein, in addition to grazing.

In improved Awassi dairy flocks, lambs already weaned at the age of 60 days because their dams were mated again shortly after lambing should have free access to high-quality hay and crushed barley or a concentrate mixture containing 18 percent total and 16.5 percent digestible protein until they reach a weight of 25 kg. Then the total protein content of the concentrate ration may be reduced to 14 percent and the digestible protein content to 11.5 percent. This mixture is also recommended for lambs weaned at three or four months. If pasturage is available not farther away from the barn than 1 km, female lambs may be pastured after weaning. They will consume about half a feed unit at pasture and on return to the barn for the night should obtain their additional needs from concentrates. After being mated at the age of eight to ten months, their ration during the first three months of pregnancy need not exceed that of unmated lambs; during the last two months of pregnancy it should be increased by the addition of half a feed unit including 50 g of digestible protein a day in order to meet the requirements of the growing foetus and to prepare the young ewe for lactation (Loew, Dori & Kali, 1972).

From the time of weaning to the age of ten months female Awassi lambs require 1 feed unit, 130 g of digestible protein and 0.9-1.2 kg of dry matter a day, and male lambs 1.2 feed units, 150 g of digestible protein and 1.1-1.3 kg of dry matter. The rations given in Table 2-13 for the stall-feeding of female Awassi lambs during this period are recommended (Becker, 1958).

On many dairy farms larger rations than these are given to stall-fed female lambs from three to eight months of age, namely 1.25 feed units, including 750 g of concentrates, 500 g of hay and 2.0 kg of green fodder a day. On this ration lambs weighing 30-35 kg at the age of three months attain a weight of 50-55 kg at eight months and are fit for breeding at nine months.

For the stall-feeding of male Awassi lambs raised for breeding, the same rations are recommended with the addition of 0.2 kg of concentrates a day. Male Awassi rams for stud breeding

TABLE 2-8. **Ewes yielding 1.5-2.0 kg milk** (1.6 feed units, 210 g digestible protein (DP), 2.2-2.7 kg dry matter)

Feed	Kg
(a) Vetch-and-oat hay	1.50
Concentrates (10% DP)	0.40
Screenings	1.25
(b) Vetch-and-oat hay	1.20
Silage	2.50
Concentrates (10% DP)	0.70
(c) Cereal grass hay	1.50
Green clover	3.00
Concentrates (12.5% DP)	0.80
(d) Vetch-and-oat hay	1.75
Concentrates (10% DP)	0.85
(e) Clover	1.00
Silage	2.50
Concentrates (15% DP)	0.50
Straw or maize husks	0.75

TABLE 2-9. **Ewes yielding 2.25-3.0 kg milk** (2.0 feed units, 285 g digestible protein (DP), 2.2-2.7 kg dry matter)

Feed	Kg
(a) Vetch-and-oat hay	1.75
Concentrates (12.5% DP)	1.25
(b) Clover hay	1.50
Green oats	2.00
Concentrates (12.5% DP)	1.20
(c) Vetch-and-oat hay	1.75
Green clover	3.00
Concentrates (10% DP)	1.00
(d) Vetch-and-oat hay	1.25
Silage	2.50
Concentrates (15% DP)	1.00
(e) Clover hay	1.50
Citrus peel	2.00
Concentrates (15% DP)	1.00

TABLE 2-10. Ewes yielding 3.25-4.25 kg milk (2.6 feed units, 385 g digestible protein (DP), 3.0-3.3 kg dry matter)

Feed	Kg
(a) Vetch-and-oat hay	2.00
Green clover	5.00
Concentrates (10% DP)	1.25
(b) Lucerne or clover hay	2.00
Silage	2.00
Concentrates (13% DP)	1.40

Source: Becker, 1958

TABLE 2-11. Stud and flock rams, off the breeding season (1.0 feed unit, 80 g digestible protein (DP), 2.5 kg dry matter)

Feed	Kg
(a) Hay	1.0
Green maize	3.0
Straw	1.5
(b) Barley	0.5
Green clover	4.0
Straw	1.5
(c) Hay	1.0
Silage	3.0
Straw	1.0
(d) Green oats	10.0
Straw	1.5
(e) Screenings	1.0
Green clover	4.0
Straw	1.5
(f) Hay	3.0

Source: Becker, 1958

TABLE 2-12. Stud and flock rams during the breeding season (1.5 feed units, 160 g digestible protein (DP), 2.2 kg dry matter)

Feed	Kg
(a) Concentrates (15% DP)	0.5
Hay	1.5
Green maize	4.0
(b) Concentrates (15% DP)	0.5
Green cowpea	4.0
Green maize	4.0
Hay	0.7
(c) Green lucerne	3.0
Crushed barley	0.7
Hay	1.2

Source: Becker, 1958

TABLE 2-13. Female Awassi lambs from weaning to 10 months of age (1.0 feed unit, 130 g digestible protein (DP), 0.9-1.2 kg dry matter)

Feed	Kg
(a) Concentrates (10% DP)	0.60
Green clover	1.00
Vetch-and-oat hay	0.60
(b) Concentrates (10% DP)	0.60
Silage	0.75
Lucerne or clover hay	0.60
(c) Concentrates (10% DP)	0.60
Green lucerne or clover	3.00
Vetch-and-oat hay	0.25

Source: Becker, 1958

TABLE 2-14. Male Awassi slaughter lambs during the 3rd month of age (1.2 feed units, 150 g digestible protein (DP), 1.1-1.3 kg dry matter)

Feed	Kg
(a) Crushed barley or maize	0.30
Concentrates (10% DP)	0.30
Hay	0.75
(b) Crushed barley or maize	0.30
Green clover	3.00
Hay	0.25

Source: Becker, 1958

receive a ration of 1.5 feed units a day composed of good hay, green fodder and 1.0 kg of concentrates from the age of five months on, making them fit for service at seven to eight months of age.

For male lambs destined for slaughter, Becker proposes the rations given in Table 2-14 during the third month when the lambs still obtain one or two daily residue sucklings of short duration.

The feeding ration of stall-fed slaughter lambs at this age may include 0.5 kg of silage along with a reduction in the quantity of hay or clover. Should green oats be fed in the place of clover, the digestible protein content of the ration should be increased by the substitution of a suitable concentrate mixture for barley or maize.

After weaning, male slaughter lambs should receive 350-500 g of hay a day and an unlimited quantity of concentrates containing 11.5 percent digestible protein. From the age of four to five months the digestible protein content of the concentrate mixture may be reduced to 8.5 percent. The mixture should include 8-10 million IU of Vitamin A a tonne (Loew, Dori & Kali, 1972).

A day's work with a large, high-yielding dairy flock

The information given in this section was recorded once a month, beginning with the commencement of the main lambing season in October, in a highly improved Awassi dairy flock of about 1 000 adult and yearling ewes and rams belonging to a communal settlement in the Plain of Esdraelon ('Emeq Yizre'el) in northern Israel. The economy of this flock is based on the supply of milk to a central dairy and of fat lambs and culled ewes for slaughter, in addition to the sale of male and female breeding stock in Israel and abroad. The grazing at the disposal of the flock includes 10 ha of arable land sown with different pasture plants according to season and approximately 100 ha of natural hill pastures and cultivated fields after harvesting. In view of the aim of maximum milk yields and early maturity of the flock, and owing to the scarcity of grazing land and the high costs of irrigation water, green fodder, silage and hay, a considerable part of the feed consists of concentrates.

October. In October, work in the shed starts at 05.00 h. During this month the shed is prepared for the coming winter season. The lambing season also begins and by the end of October about 20 percent of the ewes have lambed.

At the time of morning milking one of the sheepmen attends to the lambs born during the night. He disinfects their navels with iodine, cleans the udder and thighs of the ewes, sees to it that the lambs are owned and suckled, and marks their ears with the numbers of their dams. He also performs the daily cleaning and disinfection of the lamb sheds and pens.

Female lambs born late during the last lambing season are bred with or without hormone treatment as soon as they attain a weight of 50 kg.

The ewes fresh in milk obtain 1 kg of pelleted concentrates at milking and 500 g of good hay. During the night when they stay with their lambs they have free access to concentrates, but generally they do not consume more than a total of 2 kg of concentrates a day. The ewes that are to lamb in November receive 750 g of pelleted concentrates with 14 percent protein a day in addition to grazing; those that are to lamb in December receive 500 g of the same mixture.

During October the flock is pastured in two groups. One includes dry ewes soon to lamb and the few that lambed late in the last lambing season and that still give more than 200 g of milk a day, and the other one of dry ewes and last season's lambs. The grazing consists of dried up natural hill pasture



Figure 2.4. Before parturition of the second twin

which should provide the animals with sufficient roughage. For about an hour a day they are also pastured on vidan (sorghum x Sudan grass) and toward the end of the month on rye-grass sown for winter grazing. As long as the sown grass is still short, only the ewes soon to lamb or in milk are pastured on it; as it grows longer, the dry ewes and lambs follow. If the grazing is insufficient, maize silage is added to the daily ration.

The sheep return to the shed at about 17.00 h, before darkness sets in. The sheepman responsible for this work enters the day's new data in the flock diary and the birth and service registers. At 18.00 h the work in the shed comes to an end.

November. Work in the shed begins at 05.00 h. First the young lambs that stayed with their dams during the night are separated from them and the milk still left over in the udders of the ewes is milked. The ewes fresh in milk receive 2 kg of high-quality maize silage and 500 g of hay; those shortly due to lamb are given only silage. In addition to this ration, both groups are pastured together on rye-grass from 09.00 to 15.00 h. They are accompanied by the rams at pasture. On their return to the shed the ewes in milk are milked again and then join their lambs for residue suckling, remaining with them throughout the night. The ewes in milk have free access to a concentrate mixture at night, while those that are shortly due to lamb are limited to a concentrate ration of 800 g. The rams receive 1 kg of concentrates in the evening. In the course of November the percentage of ewes with lambs at foot rises from about 20 to 50.

The second group, consisting of yearling and pregnant ewes due to lamb later in the season, has already left the shed at 06.00 h to be pastured on harvested cotton fields. Most of the yearlings that have been served in August, September and October, either without or following hormone treatment, are in lamb. However, since a very few may not yet be pregnant and may still come into heat, a selected ram accompanies this flock so that the sire of the few future late-born lambs is known with certainty. This flock returns from pasture only at 17.00 h when the ewes in lamb receive 700 g of concentrates a head and the yearlings 750 g.

After the onset of rain, the flock is no longer sent to pasture but remains in the shed where the animals are fed legume straw, 2 kg of maize silage and 700 g of concentrates a head; the ewes in milk are also given hay. The rams receive hay, silage and 1 kg of concentrates.

The work in the shed ends at 18.00 h, but a responsible sheepman may remain in the shed for another few hours to look after the ewes that lambed during the day and those due to lamb during the night.

December. Work in the shed begins at 04.00 h. First to be milked are the ewes with lambs less than one month old which are suckled for 12 hours each night until they weigh about 12 kg. The ewes with older lambs, which are suckled for eight hours a day, are next to be milked. This leaves enough time for the lambs to remain with their dams for four hours after milking in the morning before the ewes leave for pasture. Then follows the milking of the ewes suckling their lambs for four hours, two hours or one hour a day, and finally of the ewes with lambs less than eight days old which remain with their dams in the stalls all the time but are incapable of coping with the whole quantity of milk these produce. Milking of the flock in the rotary parlour is completed at 07.00 h.

At the milking the ewes are given 1 kg of pelleted concentrates a head irrespective of their yields. During the first two months of lactation they also have free access to pelleted concentrates in self-feeders after evening milking, but they make little use of this and on average do not eat more than a total of 2 kg of concentrates a day. The ewes with lambs less than eight days old receive unlimited quantities of concentrates and vetch hay in their separate box stalls, but again they do not consume more than 2 kg of concentrates.

The dry, yearling and last season's late-born females obtain their day's ration of 750 g of pelleted concentrates, containing 14 percent digestible protein, before leaving for the pasture grounds. The ewes in lamb receive 700 g and the stud rams 1 kg of concentrates. Lambs older than two months are given the same concentrate mixture in self-feeders in addition to 200-300 g of hay and 300 g of straw a day. Lambs less than two months old receive a concentrate mixture containing 18 percent digestible protein *ad libitum*, and also an unlimited quantity of good hay.

Before going out to pasture, the ewes in milk that lambed early in the lambing season are joined by a teaser ram furnished with an apron. Those found to be in oestrus are served by one of the stud rams in accordance with the mating plan. They are not tried again in the afternoon after return from pasture, but if still in heat next morning they are served once more. Ewes in milk that do not come into heat naturally within two months after lambing are given hormone treatment as the flock-master aims at three lambings in two years.

At 10.00 h the flock is taken by the shepherds in two or three separate groups to the pastures, which are situated near the shed, while the lambs remain at home. The rams, save one, join the group of pregnant ewes at pasture. The small percentage (about 5 percent) of adult ewes that remained barren in the previous breeding season and the yearling ewes are pastured together with a single stud ram by which those ewes coming into heat naturally or after hormone treatment are served. The shepherd makes a note of the ear numbers of such ewes for later entrance in the service register of the flock.

The pastures consist partly of wild grasses and plants and partly of sown rye-grass and oats. After the flock has left the shed, the sheepmen distribute the feed for the ewes returning from pasture in the afternoon and are then free to rest for four hours.

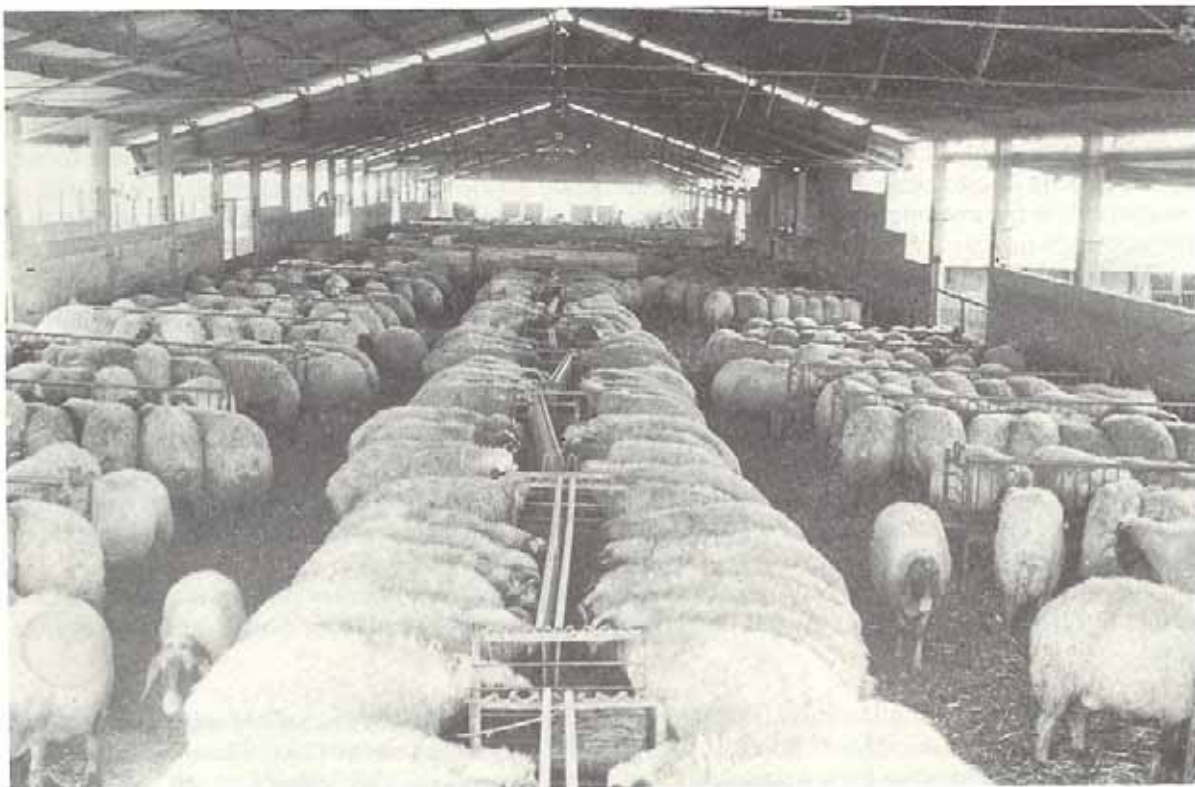


Figure 2-5. Shed feeding of Awassi ewes in winter

January. In January work in the shed begins at 04.00 h. Toward the end of the month the lambing season of the 13- to 16-month-old yearling ewes commences. In general flock management in January, there is one marked difference from December. In January (as well as in February and March) ewes are not bred, although many of them that are in milk may still come into heat. This measure is taken to prevent lambings in June, July and August, the hottest months of the year, for lambs born in the heat of summer develop more slowly than those born in cooler months. Also, the high ambient day temperatures depress the milk yields of the ewes when they should be at their highest. During the hot summer months the sheepmen also wish to avoid the additional work involved in the care of new-born lambs and in freshening ewes.

Ewes in milk that were served in December continue to be tested by a teaser ram every morning, not, however, to be bred if not in lamb but in order not to be dried up prematurely after three months of lactation in preparation for the following lactation, as in the case of the ewes that lambed before the end of the year and are again pregnant.

The flock is pastured in three separate groups from 10.00 to 16.00 h. One consists of adult ewes in milk, the second of ewes due to lamb within two months, and the third of ewes in the first three months of pregnancy, yearlings in lamb, and stud rams. The pastures consist of natural grazing in the hills and areas sown with pasture grasses. The afternoon milking begins at 14.00 h. The ewes are turned in in batches and return to the pasture grounds as soon as they are milked; only the last batch coming in at 16.00 h remains in the shed. The rations of concentrates are similar to those given in the previous month. Work in the shed ends at 18.00 h.

February. Work in the shed begins at 04.00 h. Owing to its large size, the flock is again pastured in three separate groups, two of which comprise ewes in milk and the third ewes and yearlings due to lamb and rams. The pastures consist of natural hill grazing and fields sown with pasture grasses. As the days grow longer and day temperatures are somewhat higher, the whole flock returns from grazing not at 16.00 h, as in December and January, but at 17.00 h.

In addition to pasture, ewes in milk receive 400 g of hay, 400 g of straw and concentrate rations according to the quantities of milk they produce. Only ewes in the first two months of lactation have free access to concentrates at night. The dry ewes and yearlings are given 600 g of concentrates in the morning and 400 g of straw at night. The lambs are not yet pastured in February, but remain in the shed and receive 400-500 g of hay and an unlimited quantity of concentrates with 14 percent protein.

During February the ewes in milk are no longer tested by a teaser ram. At the end of the month the male lambs born in October and November are sold for breeding or slaughter.

March. As during the last three months, work in the shed begins at 04.00 h and afternoon milking at 14.00 h. But as the days grow longer, the sheep return from pasture after 17.00 h and the day's work in the shed ends at 18.30 h.

The flock continues to be pastured in three separate groups, two of ewes in milk and one composed of adult and yearling ewes still to lamb, stud rams, female lambs, and male lambs selected for the replacement of culled rams. In the morning the flock leaves the shed as soon as the dew has been dried by the rising sun at about 10.00 h. Before coming back to the shed for afternoon milking the sheep are rather sluggish, grazing more eagerly on their return to pasture and especially in the late afternoon. The pastures are now less juicy than in winter. They provide the lambs and ewes with sufficient nourishment for maintenance. At milking times the ewes are given additional concentrate rations for milk production or pregnancy, the rations corresponding to yields. At night they receive straw. On return from grazing, male and female lambs have free access to concentrates in order to fit them for early breeding. The lambing of yearlings and of those adult ewes that lamb late in the season owing to two lambings the year before continues. Ewes that lambed early in the lambing season and that are due to lamb again in April or May are dried up. Male lambs born in October or November are sold in this month at a live weight of 50-60 kg according to market demand.

April. As the warmer weather during April dries the dew of the night sooner than in March, the sheep have already gone to pasture at 05.00 h. Again the flock is divided into three groups, two of which consist of ewes in milk. Some of the ewes have already been milked by 05.00 h; those that have not yet been milked return in batches to the milking parlour after an hour or so of grazing. This is possible because some of the pastures are situated near the shed. Generally the flock grazes on the hills in the morning as there the dew dries earlier than on the plains. As the day advances the sheep are moved to the juicy green sown pastures.

From 14.00 h on the ewes return in batches to the shed for milking, as in the morning. The last group — consisting of the dry adult and yearling ewes still due to lamb, the stud rams and the lambs — returns between 18.30 and 19.00 h. The day's work in the shed ends at 19.00 h.

The lambing of those adult ewes that did not lamb earlier in the season and of those that had already lambed in October or November but had again become pregnant continues in April, as does the lambing of yearling ewes.

Preparations are made for the shearing of the flock, which takes place at the end of April if the weather does not suddenly turn cold and rainy. The dry and pregnant ewes are shorn first, then the rams, and finally the ewes in milk. The lambs are shorn three weeks later. The sheep to be shorn remain in the shed and are fed on hay while waiting their turn. Once shorn, they leave for the pasture grounds.

Shearing begins at 04.00 h and ends at 12.00 h and is done by the sheepmen themselves who are assisted by additional workers on the days of shearing. Three shearers work with three shearing machines while four workers prepare the sheep, placing them on hydraulic tables which lift them to a convenient height. Each shearer finishes approximately ten sheep an hour, or 80 in an eight-hour working day. The shearing of an adult flock of nearly 1 000 sheep therefore takes three to four days.

The wool is put into bags to be dispatched collectively by the Sheep Breeders' Association for export to the United Kingdom.

May. The flock leaves the shed for pasture at 04.00 h in two groups, a larger one consisting of ewes in milk and a smaller one comprising dry ewes, lambs and the remaining ewes in milk. The rams are left in their shed as the mating season commences at the beginning of the month. Before going out, the

adult and yearling ewes are tested by a teaser ram for oestrus. Two-year-old females that failed to lamb as yearlings receive a hormone treatment. As each of the stud rams in the flock serves three females a day, the hormone treatment is restricted to a corresponding number.

The dew of the night is no longer a hindrance to early morning grazing as the plants of the natural pasture begin to go to seed and dry up and the dew makes them tastier to the sheep. In addition to the natural hill pastures, the flock is also taken for a few hours to the sown rye-grass and fodder beet in succession. During the early hours of grazing the ewes are returned to the shed in groups for milking and concentrate feeding and return to pasture as soon as they are milked. Between 09.00 and 10.00 h the whole flock returns to the shed for watering and rest. Milking begins again at 13.00 h. At 16.00 h the flocks are once more taken to graze on the natural hill pastures until 19.00 h, just before darkness, when they are returned to the shed for the night.

The concentrate feeding of rams, ewes, yearlings and lambs continues on the same levels as before. Small lambs, born in April or May, join their dams at 19.00 h on the latters' return from pasture, until they are separated from them at 04.00 h. At 06.00 h the ewes are milked in order to relieve their udders of the milk remaining from the night's suckling with which the lambs could not cope, and the renewed production during the two hours since their separation from the lambs. They then return to pasture. After the noon milking, which is completed at about 15.30 h, the small lambs are again suckled for half an hour and then separated from their dams which join them after their return from grazing at 19.00 h. Work at the shed ends at 17.00 h, except for the shepherds who return from the pasture two hours later, distribute the sheep into their compartments in the shed and admit the young lambs to their dams for the night.

Toward the end of May the female lambs and the males retained for breeding are shorn.

June. There are no lambings in June. Ewes whose daily milk yields have fallen to 750 g or less are now milked only once a day, at midday. They are dried up as soon as their yield drops to below 200 g a day.

All other activities are similar to those of May, save that at pasture vidan is now available in addition to fodder beet.

July. A large number of ewes are dry by July. About one-fourth of them are again in lamb. Those that lambed in February, March or April and are not again pregnant and do not come into heat naturally because of their high milk yields receive hormone treatment in order to induce oestrus and a second lambing in the same year.

The flock is pastured in two groups. One group comprises dry ewes, ewes that are milked only once a day, yearlings and female lambs, and the other group consists of ewes in milk. Lambs born in February are also sent to pasture in July, joining those born since October. The flocks graze on sown pasture for one hour a day and on dry natural pastures for the rest of the time. The lambs receive an additional ration of 700 g of concentrates a day in the shed. Lambs born after February continue to remain in the shed where they obtain their standard rations.

August. In August work at the shed begins at 04.00 h. Nearly two-thirds of the flock are dry or are milked only once a day. The rest, consisting of ewes that lambed late in the season or for the second time in addition to the yearlings ewes, are milked twice a day. The dry ewes and those that are milked only in the afternoon leave for pasture at 04.00 h. Those ewes that are milked twice a day follow as soon as their morning milking is completed. The flock is pastured in two groups, the first comprising the ewes which are to lamb in October and the second those due to lamb at a later date. The pasture consists of sown vidan and fodder beet and of dried up natural pasture plants. The ewes that are due to lamb in October receive an additional concentrate ration of 500 g a day containing 14 percent digestible protein to prepare them for freshening and to provide sufficient nourishment for the growth of the foetuses into strong and vigorous lambs.

Before leaving for pasture the ewes are tested for oestrus by a teaser ram and those found to be in heat are bred in accordance with the mating plan. The stud rams remain in the shed. Female lambs that have attained a weight of not less than 50 kg are now also bred so that they may lamb as yearlings. If they do not come into heat naturally, they are given a hormone treatment.

The afternoon milking begins at 13.00 h. In view of the high midday temperatures in August, the flock is returned to pasture only at 16.30 h and taken back to the shed for the night at 20.00 h.

September. In September, as in August, work at the shed begins at 04.00 h. The hours of midday milking, grazing and return from pasture for the night are also the same as in August. A large part of the flock is now dry; only yearlings and the adult ewes that lambed for the first or second time late in the season are still in milk.

Again the flock is pastured in two groups, one comprising the ewes that are to lamb in a month or two and the few still in milk, and the other group the ewes that are due to lamb later and the female lambs born during the last lambing season. The grazing consists of vican and dry natural pasture; fodder-beet grazing is coming to an end. Annual rye-grass is now sown for winter grazing.

The concentrate ration of the ewes due to lamb in October is increased to 750 g a day, while ewes that are to lamb in November receive 500 g in addition to grazing. The rams do not go to pasture but are fed in the shed.

The testing of the ewes for oestrus and the breeding of lambs that have reached a weight of 50 kg continues. Those that do not come into heat naturally receive hormone treatment.

Diseases, parasites, poisoning and hygiene in Awassi flocks

There is a marked difference in the incidence of several ovine diseases and parasites between unimproved Awassi flocks maintained on natural grazing and improved dairy flocks which obtain the major part of their nutritional requirements from high-plane stall-feeding and only a relatively small share from natural or artificial pastures. Thus, mastitis, ketosis, hypocalcaemia, virulent foot-rot, vaginal and uterine prolapse and lamb dysentery occur more frequently in improved Awassi dairy sheep than in unimproved flocks. The latter are more prone to tetanus, anthrax, sheep pox, brucellosis and scab as a consequence of their contact with carrier flocks or other sources of infection in pastures.

Some infectious diseases, such as foot-abscess, arthritis, infectious pneumonia, botulism, listerella and salmonella infections, necrotic hepatitis and malignant oedema, are generally rare or absent in Awassi sheep. But several non-infectious diseases are fairly widespread, some of them in improved dairy sheep and others in unimproved stationary or migratory flocks maintained solely on pasturage.

Diseases due to photosensitivity of the exposed mucous membrane of the mouth, nostrils, ears and eyelids do not occur in Awassi sheep owing to the pigmentation of the head.

The following infectious and non-infectious diseases are of rather common occurrence in Awassi sheep throughout their range.

Adenomatosis. Histologically pneumonia occurs in two different forms in Awassi sheep, one chronic and progressive (Maedi-Visna, Montana disease) and the other adenomatous (jaagsiekte). Both are caused by the same virus, which in a climate suitable to its development and in animals under stress, is transferred from sick to healthy sheep by the air. The susceptibility of sheep to the infection varies. In affected Awassi flocks it rarely exceeds an incidence of 5 percent, but one improved dairy flock had to be disbanded because of heavy financial losses due to adenomatosis.

The disease mainly strikes sheep three to five years of age or older, but may also occur in younger animals, although rarely in those under one year. The interval between infection and the appearance of the first symptoms lasts from six to eight months. Usually the disease is first observed when the sheep have to walk long distances to and from pasture, to ascend hills or are driven at a fast pace. Adenomatous animals show difficulty in breathing and discharge from the nostrils and lag behind at the end of the flock. In spite of a normal appetite, they continuously lose condition until the fatal outcome two to three months after the outward appearance of the first symptoms.

Post-mortem examination shows a cancerous enlargement of the lungs which are sometimes three times their normal weight. Large parts are hard and of a greyish-white colour, occasionally accompanied by secondary congestion and abscesses caused by microbes or lung-worms. The cancerous character of the disease is indicated by metastases in the lymph system connected with the lungs and in some instances also in the heart, liver, spleen and kidneys, in voluntary muscles, on the peritoneum in the abdominal cavity and in the pelvic basin.

There is no efficient remedy, and affected sheep should be slaughtered at once to prevent infecting other sheep and to preserve the value of the carcass. Close confinement and the overcrowding of sheep in small compartments aids the spread of infection.

Anthrax. Anthrax is an infectious disease caused by *Bacillus anthracis*, to which sheep are highly susceptible. In several parts of their range Awassi sheep are infected on natural pasture. The greatest source of the disease is the carcass of an animal that has died of anthrax. When its blood is exposed to the air, large numbers of spores are formed from the bacilli. The spores, which are very resistant to heat and dryness and retain their vitality for years, may either be swallowed or inhaled or gain access

to the body through scratches or wounds. On entering the bloodstream, the bacilli, freed from the spores, multiply rapidly and discharge their toxins. Infected sheep may drop down suddenly and die in convulsions, displaying a blood-stained discharge from the nostrils, mouth and anus. Occasionally death is preceded by grinding of the teeth, rapid breathing and pounding of the heart. In the early stages penicillin and oxytetracycline (terramycin) have proved effective in combatting the infection. Prophylactic measures consist of the burning or deep burial of the carcasses of animals that have fallen prey to the disease and the annual vaccination of Awassi flocks in which anthrax occurred during the previous decade.

Bluetongue. Bluetongue is a non-contagious disease of sheep and, to a lesser degree, of cattle. It is caused by a virus transmitted by biting gnats of the genus *Culicoides*, which are active at night. The virus occurs in different strains, some of which are more virulent than others. Sheep two to four years old are more vulnerable than younger and older ones, and in rams the disease usually appears in a particularly severe form. Suckling lambs may obtain temporary or permanent immunity from the antibodies in the milk of their dams.

In Awassi sheep bluetongue is rare; its symptoms are commonly light and seldom fatal. It is a seasonal disease that occurs only in summer when the insect host is active. It is more widespread in low-lying, swampy areas than on hills or high plateaus. The symptoms include a rise in body temperature of up to 41°C, loss of appetite, rapid loss of weight, a reddened mucous membrane of the mouth which later turns blue (cyanosis), frothing of the saliva, formation of lip and tongue ulcers, discharge from the eyes and nostrils, the appearance of a red band at the top of the hoofs (coronitis), and a loss of wool. Breathing becomes difficult and congestion of the lungs and intestines may follow. Sick animals stop walking and lie down most of the time. In light cases recovery follows in a short time, but in severe instances death may occur in six to seven days after the first symptoms, or recovery may be very slow.

There is no specific cure, but antibiotics are used in order to prevent additional infection. Sheep that have recovered from bluetongue are often attacked by scabies and worms. Flocks threatened by bluetongue are vaccinated. Immunity commences eight to ten days after vaccination, reaches its height after one month, and lasts for about nine months. In regions where the disease is prevalent in summer, vaccination is repeated every year before the onset of the breeding season. Ewes should not be vaccinated during the early stages of pregnancy as they may give birth to still-born or defective, dummy lambs (hydranencephalus). Flocks in which bluetongue has already struck a few animals should be vaccinated to protect those that are still healthy. Barns should be sprayed with a 0.5 percent solution of a phenol compound.

Brucellosis. Brucellosis has repeatedly been observed in Awassi flocks. It is caused by a strain of bacillus bang (*Brucella ovis*), which differs from those attacking cattle, goats and pigs. Many flocks have been found to be infected with *Brucella melitensis* Biotype 1 (Kamal, 1981). When a number of abortions and retained afterbirths, combined with lowered milk production, occur in a flock without apparent cause in feed or management, brucellosis should be suspected. After one or two abortions infected ewes usually become immune and carry out their lambs, although remaining carriers. The placenta and genital discharge and their milk may contain large numbers of the organisms.

Often *B. ovis* infection is transmitted by rams in which the bacillus causes epididymitis, orchitis and impaired fertility. It may be spread during the mating season when a clean ram serves a ewe previously served by an infected ram which has shed *B. ovis* bacteria with semen.

Sheep may be immunized by vaccination with one of the vaccines prepared from *B. abortus* Strain 19 or *B. ovis* or *B. melitensis*. The live vaccine Rev. 1 is used for lambs from July to December and for ewes from April to June when most of them are not in lamb. It confers immunity for at least four years, which is the major part of a ewe's productive life. Rams are not vaccinated with the live vaccine Rev. 1 (Kamal, 1981). Streptomycin and chlortetracycline used together have proved effective in promoting a bacteriologic cure for brucellosis (MVM, 1973). Once a few animals in a flock have been infected by spreader sheep introduced from outside or on common pastures, the disease can sometimes be eradicated only by destruction of the entire flock or, at least, by culling the reactors traced by a blood or milk test.

Contagious agalactia. Agalactia occurs throughout the breeding area of the Awassi and is prevalent in Awassi flocks of the fellahin and bedouin. Improved dairy flocks are known to have been infected by goats, animals in which agalactia occurs in a particularly severe form. It is an infectious disease, characterized by the sudden, rather painless cessation of the milk flow and degeneration of the udder

tissue. Temporary side-effects, such as swollen leg joints and eye troubles, occur in about 10 percent of affected sheep. In rams agalactia is characterized by inflammation of the joints.

The causative agent, *Mycoplasma agalactiae*, is intermediate between a microbe and a virus. It resembles a virus in its filtering capacity and a microbe in its capability of multiplying in a culture medium without the presence of live cells. Infection occurs by way of the alimentary canal.

Typically, in an infected flock a number of ewes show a marked decline in milk yields and the milk changes in consistency and content. Firstly, it is more viscous than normal Awassi milk; in a few days it turns to a watery and flocky fluid. This is followed by a hardening of the udder tissue and a cessation of milk production. Usually both halves of the udder are affected at the same time. The appetite of agalactic sheep remains normal. The disease is rarely fatal in adult ewes, but may cause serious damage through loss of milk. Infected lambs may die or be retarded in their growth.

If accompanied by conjunctivitis and inflamed leg joints, agalactia is readily distinguishable from mastitis. Otherwise laboratory examination of the milk is necessary for diagnosis. Sheep that have recovered from the disease may remain carriers for a considerable time, spreading the organism with their milk, urine and droppings. Infected flocks can be immunized by vaccination. The daily intramuscular injection of tylosin, instituted early, has been reported to be beneficial.

In an improved Awassi dairy flock of 450 ewes, 150 animals were severely attacked by agalactia, in addition to others in which the disease passed in a light form. Fifteen percent of the infected ewes also had swollen joints. This symptom was particularly harsh in lambs and yearlings, which also suffered from severe eye troubles, some of them being struck by blindness. Aureomycin application to the eyes successfully cured these yearlings. The infected ewes continued to be milked irrespective of whether or not their udders contained any milk. In doing so, 60 percent of the infected ewes in milk recovered their production, although on a considerably reduced scale; the rest went dry for the year. Sheep that could not go to pasture owing to inflammation of the leg joints were kept in the barn for a few weeks until they recovered. In the following years the flock remained free of agalactia (Becker, 1958).

Contagious ecthyma. Contagious ecthyma, also called pustular or labial dermatitis or scabby mouth, is an infectious disease of sheep and goats, occasionally also of man, caused by a highly epitheliotropic virus which produces hard, wart-like scabs about the lips, nostrils and udder, sometimes also around the coronet of the legs, between the toes and on the naked side of the fat tail. Lesions also appear inside the mouth.

The disease is transmitted through feed and water as well as by direct contact between animals, spreading speedily throughout a flock. Once a flock has been infected, new outbreaks may occur in young lambs every year or two, or the disease may flare up two to three years after a previous outbreak. Awassi dairy flocks are rarely attacked, but in flocks of the fellahin and bedouin which come into contact with other flocks in pasture, the disease is common. In the breeding area of the Awassi it appears in the winter and spring but very seldom in the summer.

The virus contained in scab particles fallen to the ground is resistant to dryness and may penetrate the skin of sheep through small abrasions caused by thorns or rough grasses. The incubation period varies between two and eight days when small vesicles make their appearance. The scab reaches its maximum development in eight to ten days and is shed after about another week when the underlying skin has healed.

In adult sheep the disease usually passes in a light form, but lambs are very sensitive. If a large area of the lips and muzzle is involved, feeding becomes difficult and young lambs may cease sucking and feeding. Feed should be nourishing and easy to pick up so that the lambs do not die from starvation. Dams that have passed the disease may be allowed to suckle their offspring, but those that have not yet acquired immunity should be milked and the lambs bottle-fed since the udders may become infected by the scab of the lambs, commencing as a black scab on the teats and extending over the skin of the udder. Sheepmen should not touch scabs with hands that have abrasions or small wounds as these may become infected. In humans the disease passes within three weeks and provides immunity.

The lesions of contagious ecthyma may be washed with a solution of 2 percent potassium permanganate, 10 percent lysol, and 5 percent copper sulphate or 1-2 percent argentum, followed by the application of iodine, Chloromycetin tincture or a boric acid, salicylic acid or sulphanilamide ointment to the dry scabs. In endangered flocks or areas, prophylactic vaccination with a living virus should be practised once a year or at outbreaks. Animals of all ages may be vaccinated, ewes at the last stages of pregnancy. In many flocks only the lambs are vaccinated on the assumption that older sheep have already acquired immunity. In areas free of the disease or in improved dairy flocks that do not

come into contact with diseased sheep or infected pastures, there is no need for vaccination as it may actually introduce the disease to a hitherto clean flock.

Dysentery in Awassi lambs. Diarrhoea in lambs occurs in different forms, that is, normal diarrhoea in the new-born, bacterial dysentery during the first weeks of life, and coccidiosis in lambs three to four weeks of age and older.

Diarrhoea is normal in lambs on the first day of life owing to the laxative effect of colostrum on the meconium. Sometimes the meconium sticks the broad tail to the anus so that excrement cannot be discharged and, if not cleaned in time, the lamb will die a painful death.

Meconium discharge may be followed — usually after an interval of a few days but rarely after the first week — by bacterial dysentery or scours of a yellow, grey, greenish or white colour that may be tinged with blood. This is a highly fatal disease caused by enteropathogenic strains of *Escherichia coli*, occasionally also by the toxins of *Clostridium perfringens* Types B and C, which are usually introduced into the intestines of lambs with the milk from contaminated teats and udders. In an infected flock a yearly increasing number of lambs may fall victim to the disease. Sick lambs are weak, depressed, show a rise in temperature and no inclination to suck. The disease takes its course in from a few hours to three to four days, varying with the strength of the lamb and the severity of the attack. Post-mortem examination shows small ulcers crowded into comparatively large ulcerated areas on the inside of the bowels and also an enlarged liver.

Prevention of lamb dysentery consists of rigorous stall hygiene, clean feed, water and troughs, dry and clean bedding, and the cleaning of the udder and teats of the ewes before milking and suckling. The bacteria causing dysentery require moisture for their propagation and are killed by dryness.

The lamb creates antibodies to bacterial dysentery in its body, but its immunization system begins to work only a few days after birth. Until then the lamb depends on the antibodies contained in the colostrum. But these can enter the bloodstream of the lamb only during the first day; thereafter the intestines are no longer permeable to the antibodies which leave the intestines with the excrement. If the quantity of colostrum sucked on the first day is sufficient, the antibodies will help the lamb to withstand infection for several days until it can defend itself with its own antibodies. If the lamb is insufficiently provided with antibodies by the colostrum, the disease gains an upper hand. The same holds true if the lamb is incapable of sufficiently developing its own system of antibodies owing to a low birth weight, weakness, poor nourishment, cold, or unhygienic conditions. Disowned or orphaned lambs are particularly susceptible to scours. They should be fed bottled colostrum milked from their dams or from other ewes, which has been frozen as a reserve for this purpose.

Vaccination of the ewes with a vaccine prepared from the dysentery bacillus at mating time and one week before lambing provides a sufficient quantity of antitoxin in the colostrum to protect the lamb during the period of susceptibility. Injection of the lamb with a potent antitoxin serum soon after birth has also been recommended in certain circumstances, immunity lasting for three to four weeks. The remedies for scours are based mainly on antibiotics. However, the bacteria responsible for an outbreak may acquire immunity to the antibiotic used in a relatively short time, necessitating the use of another type.

From the age of one month the lamb is usually immune to bacterial dysentery, but may henceforth be attacked by coccidiosis which produces scours differing in colour and smell from those of lambs suffering from bacterial diarrhoea.

Coccidiosis is a parasitic disease, caused in animals and birds by protozoa which destroy the cells of the intestinal lining of their hosts. Each class of animal harbours a specific type of coccidia. In sheep one or several species of *Eimeria* may be responsible for an outbreak of coccidiosis. Awassi dairy lambs, often crowded together in small enclosures for long periods, are more prone to the infection than are unimproved sheep kept in the open. Lambs in poor condition owing to worm infestation are particularly susceptible. Infection with the oöcysts of the coccidia occurs by way of the mouth. In the stomach and duodenum sporozoites are liberated from the oöcysts by the digestive juices and enter the epithelial cells of the mucous membrane where they multiply, invading and destroying additional cells. After a time this acute stage ceases; new oöcysts are formed and expelled with the faeces, ready to infest another host. The coccidia abound in wet, dirty conditions and are resistant to freezing and ordinary disinfectants, being viable outside the body for up to two years, but are readily destroyed by direct sunlight and complete drying.

The symptoms displayed by lambs suffering from coccidiosis are a stiff gait, partial paralysis of the hindquarters, nervousness and accelerated breathing. Scouring is brown or black, blood-stained and bad-smelling. The lamb weakens and may eventually die from exhaustion. Those that survive the

acute stage of the disease remain unthrifty and coccidia carriers for months. Treatment consists mainly of good nursing and relief of the symptoms. Sulphonamide drugs, such as sulphaguanidine, sulphamerazine, sulphamethazine or sulphaquinoxaline, are employed for treatment, 2 g of sulpha-guanidine being recommended for young lambs once a day for four to six days. Favourable results have also been obtained from nitrofurazone. The principal means of prevention are the avoidance of overcrowding, worm infestation, insufficient or low-quality feed, and wet, dirty bedding.

Enterotoxaemia. Infectious enterotoxaemia, also called pulpy kidney disease, is caused by the organism *Clostridium perfringens* Type D (*Bacillus Clostridium Welchii D*). It is rare in unimproved Awassi flocks maintained mainly on grazing, but frequent in improved dairy flocks where it particularly strikes young stock in the pink of condition.

The disease is due to a very powerful toxin produced in the intestines by the bacillus and absorbed into the bloodstream, causing either sudden death or death after a few hours of acute sickness. Sheep in which enterotoxaemia assumes a more chronic form, with listlessness and foetid diarrhoea as the only symptoms of the disease, may recover. A predisposing condition for the proliferation of the bacillus present in the intestines seems to be a digestive disturbance connected with a change in the feed. The disease strikes male and female sheep of all ages, being particularly frequent in single lambs — but rare in twin lambs — and in adult sheep in poor condition.

The post-mortem examination carried out a few hours after death indicates an acute toxaemia. The intestines are distended with gas and the kidneys are dark red or grey in colour and soft or pulpy owing to large quantities of blood retained in the kidney vessels. The liver is also congested and the heart sac full of fluid.

Antitoxin serum, prepared in horses by the injection of the toxin of *C. perfringens* Type D, confers almost immediate protection for a short period. Given intravenously in a large dose, it also has some curative effect at an early stage of the disease. Lambs in improved Awassi dairy flocks are regularly vaccinated against enterotoxaemia with an inactivated formalized and potassium alum-precipitated culture of the microbe. This confers immunity from ten days after the vaccination on. The vaccination is performed on lambs three to four weeks of age or older, along with that against tetanus. Ewes are vaccinated during a late stage of pregnancy to confer immunity to their lambs during the first few weeks of life. Rams are vaccinated once a year. Unimproved flocks are vaccinated only at an outbreak of the disease.

Enzootic virus abortion. Enzootic abortion occurs fairly widely in Awassi dairy flocks and is responsible for the loss of up to 5 percent of lambs, which may be either aborted, still-born, premature and dying soon after being expelled, or may rot in the womb. Typically, abortion occurs at a late stage of pregnancy. Of twins, one may be born alive and the other one dead. Some lambs are normal to outward appearance, but die during the first month.

The causal virus, which is transmitted by the afterbirth of infected ewes, belongs to the psittacosis-lymphogranuloma group (*Miyagawanella ovis* = *Chlamydia psittaci*). It infects mature sheep, yearlings and young lambs, causing them to abort one or two years later. Once a ewe has aborted or lambled prematurely owing to the enzootic virus, she will remain immune and not abort a second time.

The disease can be controlled by proper sanitation, the culling of infected animals in flocks in which the disease has been diagnosed, and the vaccination of unexposed females from six months on prior to their first mating. A single vaccination gives lasting protection (Fraser & Stamp, 1961). Tetracycline compounds have been used in the control of enzootic abortion (MVM, 1973). Secondary bacterial infection is prevented by the administration of sulphonamide drugs and antibiotics.

Foot-and-mouth disease. Foot-and-mouth disease, caused by a rhinovirus that exists in seven distinct strains, occurs from time to time in every part of the range of the Awassi. Generally the disease passes in a light form, but in one outbreak in bedouin flocks about 40 percent of the lambs died, while there was no mortality among mature animals. If flocks are attacked before the onset of the breeding season, many ewes may fail to get in lamb in the early oestrous periods but may become pregnant later. In flocks struck during the lactation period there is usually a moderate fall in milk yield and some ewes may develop congestion of the udder, refuse to eat for a number of days or have difficulty in standing on their legs.

If an outbreak of foot-and-mouth disease occurs in the vicinity of a flock, it can be successfully vaccinated against the relevant strain. In some improved Awassi dairy flocks it is common practice to vaccinate all animals of more than three months of age against the various types of the disease each

winter. If foot-and-mouth disease strikes a flock that has not been immunized, simultaneous infection of the entire flock with the saliva of a sick sheep is recommended so that the disease may pass in the shortest possible time. Daily intramuscular injections of antibiotics assist in a speedy recovery. The sheep should be kept on dry ground or litter to avoid a secondary infection of the claws with contagious foot-rot.

In a number of Awassi flocks lameness (paraplegia), muscular rigidity or paralysis due to lymphatic congestion of the brain has been observed four to six weeks after vaccination with an inactivated African Type 1 strain of foot-and-mouth disease. In typical instances, 10-15 percent of the animals in a flock were affected with a mortality rate of 0.5-1.0 percent.

Hypocalcaemia. Hypocalcaemia, also called parturient paresis or milk fever, occurs from time to time in improved Awassi dairy flocks at or shortly after lambing, more rarely before. This distinguishes hypocalcaemia from pregnancy toxemia which always strikes before lambing. In unimproved flocks, where the disease sometimes occurs in outbreaks, it may also affect dry ewes, yearlings and rams after a sudden change in grazing conditions.

The earliest signs of hypocalcaemia are a weakness in the hindlegs and loss of appetite. Later the animal goes down and rests on its chest and belly, and finally on its side in a state of coma until it dies in a day or two.

The examination of the blood of hypocalcaemic ewes shows a level of 6-7 mg of calcium in 100 cc of serum instead of a minimum of 9 mg in healthy sheep. This calcium deficiency also distinguishes hypocalcaemia from pregnancy toxemia in which the blood is deficient in glycogen. The calcium deficiency may be caused by grazing on lush green pastures deficient in calcium or by intestinal congestion that prevents the absorption of Vitamin D, essential for the production of the parathyroid hormone that regulates the calcium concentration in the blood.

An intravenous injection of calcium borogluconate leads to a speedy recovery from the disease. If the injection is made subcutaneously, recovery is slower. Only in rare instances is a second injection required. In high-yielding ewes inflation of the udder, as practised in cows, is also effective.

Mastitis. Mastitis, also called bluebag or garget, is the most destructive infectious disease in Awassi dairy flocks. It is caused chiefly by two organisms, *Staphylococcus aureus* and *Pasteurella mastidis* (*haemolytica*). Occasionally other staphylococci, streptococci, *Escherichia coli* and *Corynebacterium pyogenes* are involved, some causing only congestion and others the speedy development of gangrene. Infection enters through the teats and slight wounds on the udder and breaks out suddenly. It may be facilitated by many factors, such as chilling or injury by the teeth of suckling lambs, sharp stones or thistles, manure sticking to the entrance of the teat canal, milking without previously cleaning the udder, prolonged milking, changes in the vacuum pressure of the milking machine, or roughness of the rubber facing of the cups. It is commoner in wet winter weather than in dry summer.

The infection is accompanied by a hot and painful swelling of the affected half of the udder, lameness on its side, a rise in temperature to 40.5-42.0°C, and refusal to eat and suckle. The udder becomes congested, red and hard, and secretion from the teat is thin, watery and blood-stained or thick, creamy, lumpy, of a yellowish colour and foul odour. After about six hours the udder may become gangrenous, the gangrene beginning at the teat and spreading to the base of the udder which turns blue, then on to the belly and the other half of the udder. At this stage the disease may be fatal owing to blood poisoning by the microbes and gangrenous parts of the udder. The acute stage of the disease usually lasts 24 hours and rarely more than 48 hours; in fatal cases death occurs within three days from the onset of the disease.

Affected ewes should be separated from the flock as a precautionary measure. Treatment is of little avail in saving the affected half of the udder. Extension of the infection to the other half may be prevented by injection of 3 million units or 1 cc Procaine penicillin G in oil, which is effective against *Staphylococcus aureus*, together with 5 g dihydrostreptomycin, effective against *P. mastidis*. Aureomycin and antibiotics of the tetracycline group may also be used. The antibiotics may be injected either into the rump muscle or into the udder close to the gangrenous part, or syringed into the udder by way of the teat canal. The oral administration of sulphamerazine and sulphamethazine has also been recommended. Abscesses should be syringed out with a weak antiseptic solution. Hot fomentations, ointments and massaging of the udder with fat mixed with some turpentine should help to alleviate congestion, while the pus should be gently stripped from the teat.

Prevention of mastitis consists of hygienic measures, washing of udders with a 1 percent hypochloride solution before milking, and disinfection and treatment of small scratches and wounds of the udder.

If gangrene has destroyed the tissues of one-half of the udder, the ewe is usually culled. Many sheepmen slaughter the ewe the moment the udder is attacked to prevent the spoiling of the meat by the toxins of subsequent gangrene. Valuable Awassi breeding animals with one udder half intact after an attack of mastitis may, however, be retained, for they may still produce more than 200 kg of milk per lactation, a quantity sufficient to raise a lamb and cover the feeding expenses of the ewe.

In a trial with 40 Awassi and 229 East Friesian-Awassi cross-bred ewes kept under the same conditions, Jatsch and Sagi (1979) found that ewes with hard tissue lumps in their udders, following a previous staphylococcus infection, yielded 188 g more milk a day on average than those with healthy udders. The authors suggest that the larger yield from ewes with lumpy udders may either be owing to the rarer culling of high yielders after an attack of mastitis or to the greater susceptibility of superior dairy ewes to udder infections.

Ophthalmia. Ophthalmia or pink eye, caused by the organism *Rickettsia conjunctivae*, is a common infectious disease in Awassi sheep. It occurs more frequently during the hot months of the year, sometimes taking the form of an epidemic, rather than in winter. However, in at least one improved Awassi dairy flock, ophthalmia was particularly troublesome in winter owing to a predisposing cause, namely, the feeding of clover straw containing a large amount of dusty particles which penetrated into the eyes of the sheep. Other factors favouring outbreaks of the infection are dust on the roads over which the sheep travel on their way to pasture, fine chaff or straw, small seeds, flies and mosquitoes, glaring sun and strong winds. However, the disease may also appear in the absence of any pre-disposing condition. Close contact between infected and healthy sheep in the barn or at pasture favours the rapid spread of ophthalmia throughout a flock.

The incubation period of ophthalmia lasts three to five days. Early symptoms are inflammation of, and a watery discharge from, one or both eyes. The discharge may subsequently change to pus and the animal may partly or completely close the affected eye. Mild cases may recover in a fortnight, but in more serious cases the cornea is covered with a whitish film, with a temporary loss of eyesight. In such instances recovery may take many weeks. If an ulcer develops on the cornea, blindness may be permanent without possibility of a cure. On recovery the animal is immune to ophthalmia for a period lasting up to one year, but may remain a carrier infecting healthy sheep with the secretion from its eyes when conditions for a new outbreak are favourable. In a dried state the organism remains infective for not more than two days.

Sheep suffering from ophthalmia should be isolated from healthy ones, although this cannot completely prevent their infection, for flies may transfer the disease or pastures may be infected with the secretion from the eyes of sick sheep. In a shady, dustless place the disease often passes without complication. Washing of the infected eyes either with a boric acid, zinc sulphate or copper sulphate solution three or four times a day, and the application of an ointment containing penicillin, aureo-mycin, sulphathiazole or mercuric oxide will assist in curing more severe outbreaks of ophthalmia.

Paratuberculosis. Paratuberculosis and tuberculosis are two entirely different diseases. Tuberculosis is very rare in sheep, while paratuberculosis, which is caused by *Mycobacterium paratuberculosis*, is fairly widespread in Awassi flocks maintained on a high plane of nutrition and management. It is an intestinal disease not transferable to humans. Healthy flocks are usually infected by the introduction of outwardly healthy animals from an infected flock, the manure of infected animals and its ingestion being the primary source of infection. The latter occurs at a young age, but the disease develops slowly and its first symptoms commonly appear only after the first lambing at lambing and suckling time (from December to June), the majority being in sheep from three to five years old.

Paratuberculous sheep lose condition for weeks and months, with alternating diarrhoea and constipation, until there results a total loss of strength. However, their appetite, body temperature, breathing and pulse rate appear normal until the end.

Sheep suspect of the disease should be isolated and if the microcomplement fraction test of the faeces and blood shows the presence of paratuberculosis, they should be culled at once. However, not all carriers can be detected by laboratory examination, for the microbes are not always present in the intestinal contents, and such seemingly healthy sheep are liable to spread the disease after all detected carriers have been removed.

In the 1950s a dead culture vaccine providing permanent immunity was developed in Iceland where paratuberculosis was introduced from Germany with imported sheep. The vaccination of newborn lambs has proved a success in infected Awassi flocks so that the disease has now become rare. Immunization of female lambs is practised at the earliest age, not later than at two months, while male lambs are vaccinated only if destined for breeding.

Pregnancy toxaemia. Pregnancy toxaemia or twin-lamb disease occurs sporadically in nearly every improved Awassi dairy flock. It is a nutritional disease in ewes carrying twin lambs and appears within the two weeks before lambing when the foetuses grow at a high rate. It often follows a feed supply, more especially a carbohydrate intake, that is inadequate for the needs of the ewe and her two lambs, or a change in feed or weather at the critical time. Since twinning has become increasingly frequent in improved Awassi dairy flocks, pregnancy toxaemia occurs much more often in these than in unimproved flocks. The disease is associated with a marked lowering of the glycogen level of the body, resulting in a disturbed metabolism and auto-intoxication.

Early symptoms are loss of appetite, a staggering gait and semi-consciousness. As the disease progresses, severe ketosis and acidosis may develop (MVM, 1979). Finally, the ewe can no longer stand on her legs and dies within a few days. If the disease appears shortly before lambing, the ewe quickly recovers after parturition or removal of the young by Caesarean section. At an early phase of pregnancy toxaemia, it is possible to assist the ewe in overcoming the disease by an intravenous injection of a glucose solution or drenching her twice a day with calcium and sodium lactate, propylene glycol or sugar, or molasses dissolved in water.

Pseudotuberculosis. Pseudotuberculosis, also called caseous lymphadenitis or cheesy glands, is a moderately widespread bacterial disease in Awassi flocks. It is caused by *Corynebacterium pseudotuberculosis* which produces abscesses in the superior and inner lymph glands of the body, more especially in the lymph glands situated below the mandibles, between these and the maxillaries, below the ears, and in the supramammary, groin, shoulder, flank and thigh glands. Diseased glands are also found in the thoracic and abdominal cavities after slaughter. Ripe abscesses break and discharge a thick greenish-yellow pus which has no particular smell. The pus contains the bacteria which multiply in the tissues of infected sheep and are arrested by the lymph glands. They may also lead a saprophytic existence in the intestinal contents of both infected and healthy sheep and pass out in the faeces, remaining alive outside the animal body in conditions of shade and moisture for as long as two years.

The bacteria enter the sheep through small skin wounds, cuts or abrasions, usually in the course of shearing. The disease is more common therefore in older sheep that have been shorn several times than in younger stock. In order to avoid infection, it is recommended that young lambs be sheared first — as these are rarely infected — and the older sheep last, and that cuts caused during shearing as well as the shears, combs and blades of the shearing machine be disinfected.

Abscesses should be treated with ichthyol and when coming to a point and breaking be cleaned with permanganate of potash or another antiseptic solution, followed by the application of penicillin-streptomycin ointment.

Losses caused by pseudotuberculosis in Awassi flocks are generally small. Only occasionally do the abscesses render breathing and swallowing difficult, and if the disease lasts for a number of months, the lungs, liver, spleen and kidneys may be affected. After slaughter, portions of the carcass must be condemned as unsuitable for human consumption or for aesthetic reasons.

Sheep pox. Pox, caused by the virus *Variola ovina*, is one of the most dangerous infectious diseases of Awassi sheep. In Syria it is widespread (Gadzhiev, 1968). It mostly strikes flocks on pastures where infected sheep have previously grazed or it is introduced into a clean flock by purchases of sheep from an infected flock. The incubation period ranges from four to seven days. The symptoms of the infection are a loss of appetite, a rise in body temperature to 42°C, a swollen head and large pustules all over the body, but especially on the head, inner side of the toes, the pits of forearm and thigh, the naked side of the fat tail and on the udder. In winter the disease generally occurs in a more dangerous form than in summer. Many ewes die or abort, and even in a lighter form of the disease milk production is markedly reduced. In suckling lambs sheep pox is particularly fatal. Secondary afflictions, such as congestion of the lungs, lesions in the alimentary tract, chronic diarrhoea, foot-rot, spoilt udders, blindness or a destroyed nasal septum, are frequent. Animals that have overcome the disease are permanently immune. Permanent or long immunity is also acquired by lambs carried by ewes struck by the infection during pregnancy.

The pustules of sheep pox differ from those of contagious ecthyma in that they do not form large areas but remain separate from one another, a condition particularly apparent on the lips. Again, sheep suffering from pox show a rise in temperature and feel very ill, contrary to those attacked by scabby mouth.

Sheep infected by pox should not go to pasture but remain in the barn in isolation and be fed well. Suckling lambs should be assisted in suckling or be bottle-fed until recovery which is accelerated by

the administration of multiple vitamins. Infected or endangered flocks are immunized by a sensitized or formalized virus vaccine once a year either in autumn or at outbreaks. The protection is extended by the addition of aluminium hydroxide.

Tetanus. Tetanus is caused by the bacillus *Clostridium tetani*, the spores of which may be preserved in sunlight for up to 12 days and in the darkness of soil, manure and dust for several years. The organism is anaerobic, growing only when air is excluded. In cuts caused by shearing, in thorn or nail pricks or ear-tag wounds which heal quickly, the bacilli, freed from the spores introduced by contamination, multiply and excrete a powerful poison which reaches the central nervous system causing tonic spasms of the voluntary muscles of the head, neck, trunk and limbs. The disease, which has an incubation period of four to ten days and sometimes longer, is nearly always fatal in sheep. Infected lambs lie on their sides in a state of complete paralysis. Large doses of tetanus antitoxin injected subcutaneously may save an infected sheep, but the result is uncertain after the symptoms have developed.

Tetanus in Awassi flocks is controlled by the removal of scurfy and gangrenous matter from wounds and their disinfection and by other measures of hygiene. Passive immunity lasting from one to four weeks may be conferred by antitoxin administration; lasting immunization may be achieved by doses of 100 units of tetanus antitoxin and 1 cc of tetanus toxoid for lambs, followed by the injection of 1 cc of tetanus toxoid each year for the following two years.

Urinary calculi. Urinary calculi are mainly formed in two- to six-month-old male Awassi lambs that are being fattened on grain rations with a high phosphorus content or those that for various reasons do not drink enough water. The disease may appear in a number of lambs simultaneously. It also occurs in adult rams, but in female lambs the affection is very rare because their urinary passage is wider and shorter than the male urethra. The principal points at which calculi are formed are at the glans penis, the volutions of the urethra — more especially the sigmoid flexure, that is, the S-shaped curve just behind the scrotum — and the exit of the urethra from the bladder. The *processus urethrae* is of practical importance in relation to urinary calculi, because sometimes a small calculus becomes wedged in the 'worm', preventing the animal from urinating. The formation of calculi takes several weeks or months.

Sheep suffering from urinary calculi show general depression, their belly begins to swell and after a few days assumes the shape of a fluid-filled balloon. An afflicted animal is in great pain which it tries to overcome by kicking against its belly. Urination ceases completely or only a few blood-stained drops are discharged. The tip of the penis becomes covered with blood and pus. When the bladder has become greatly distended with urine, the tubes leading to it from the kidneys or the bladder itself or another portion of the urinary tract may rupture (Belschner, 1951). Before death from poisoning by urine entering the blood stream, the lamb lies in agony on the ground with the smell of urine emanating from its body.

Surgical treatment is possible, but in most cases only expedient if the obstruction is situated in the penial glans or in the urethral process which can be amputated without detriment to the ram's sexual potency.

The disease can be largely prevented by a sufficient supply of fresh drinking water, the addition of 5 percent salt to the concentrate ration of male lambs in order to increase their thirst, and the presence of enough Vitamin A and twice the amount of calcium as that of phosphorus in the concentrate mixture. The addition of 0.5 percent ammonium chloride to the mixture fed to male lambs also reduces the tendency of the urine to form calculi (Rapaport, 1979).

Vaginal and uterine prolapse. Eversion of the vagina and uterus prolapse are rather frequent in well-fed adult Awassi ewes of improved dairy type in which they appear to be caused or promoted by a disturbance in the hormonal balance, estrogen in the feed, or increased pressure in the abdomen by a uterus with twin lambs, a large quantity of feed consumed, and a distended bladder which forces the ewe to strain when urinating. They are rare in unimproved Awassi flocks.

Eversion of the walls of the vagina through the lips of the vulva usually occurs a few days before lambing, but occasionally follows a difficult birth or retention of a dead putrefied foetus. The vagina, turned inside out, appears at the exterior as a red sausage-shaped swelling with a depressed centre. When it occurs after lambing, it is frequently associated with partial or complete eversion of the uterus. If this is not attended to, the ewe may die of gangrene, septicaemia or, if the swollen vagina prevents discharge of the urine, from uraemic poisoning.

Before the beginning of treatment the fat tail is lifted on to the back of the ewe and her hindquarters are raised. The vagina and uterus are cleaned with a weak antiseptic solution and

lubricated with paraffin oil or vaseline. Following this, the uterus and vagina are carefully returned into place, and tetracycline pills or a sulpha preparation in tablets or capsules are introduced in addition to Procaine penicillin G and streptomycin in powder form. To prevent another eversion, the vulva is partially closed with a plastic device, silk thread or a few strands of wool from either side across the vulva. In serious cases the intramuscular injection of penicillin and streptomycin and the subcutaneous injection of calcium borogluconate are recommended. The injection of diethylstilbestrol and post-hypophysis hormone will accelerate the contraction of the uterus.

Vibronic abortion (ovine genital vibriosis). Vibriosis has been observed in Awassi flocks for many years. It is caused by the micro-organism *Vibrio foetus intestinalis* which causes inflammation and decay of the foetal membranes and may be responsible for 5-7 percent of the abortions in infected flocks, although considerably greater losses have been reported. Abortion commonly occurs during the last four to eight weeks of pregnancy, but occasionally at an earlier stage. Lambs carried the full term may be stillborn or weak. Ewes aborting once, but later carrying out their lambs, may remain spreaders of the infection. It is believed that the disease is transmitted by the foetus, afterbirth and discharges of aborting ewes — which infect feedstuffs or drinking water — or by infected rams. Freshly aborted foetuses and foetal membranes are used for diagnosis.

The vaccination of ewes with A bacterin shortly before mating, again eight weeks later and annually thereafter is effective, while penicillin and dihydrostreptomycin will control an outbreak. Oxytetracycline (Terramycin) added to the daily feeding ration over the last eight weeks of pregnancy will reduce the incidence of abortion (MVM, 1973, 1979). Measures to prevent the spread of vibronic abortion consist of sanitation and the isolation of infected sheep. There is no need of the radical measure of complete or partial destruction of flocks as is sometimes necessary in the case of brucellosis.

Virulent foot-rot. Virulent foot-rot is widespread in Awassi flocks. It is caused by an anaerobic microbe, *Fusiformis nodosus*, which, in association with *Sphaerophorus necrophorus*, attacks sheep of all ages, causing pain and lameness and in severe cases may be fatal. In dairy ewes it also leads to a severe reduction in milk yields. In neglected cases foul-smelling, festering wounds appear between the claws, extending to above the level of the horn. If these come into contact with the udder, it may also become infected. The organisms causing foot-rot thrive in moist manure and damp sheds and may survive in the crevices of neglected hoofs for as long as one or two years. As infection usually occurs in the shed, and more rarely in pastures, it is seldom found in the Awassi flocks belonging to bedouin.

Treatment consists of surgery, the medication of infected hoofs and prophylactic measures. Surgery includes the removal of the necrotic parts of the hoof and the opening of the wounds to the ambient air and medicinal substances, such as Formalin, Chloromycetin, Syntomycin (chloram-phenicol), copper sulphate powder, oxytetracycline (Terramycin) ointment, or a sulpha drug. To prevent the spreading of foot-rot from carrier sheep, sick animals should be separated from the flock for ten days following a successful cure. Flocks threatened by infection should be moved slowly through a shallow foot bath containing a 10 percent solution of copper sulphate or 5-10 percent solution of Formalin every three or four days until all the sheep are cured. Before the onset of the rainy season the hoofs should be pared and all overgrown horn removed.

Foot-rot has been differentiated from toe abscess or lamellar suppuration which is caused by a mixed infection of *Sphaerophorus (Fusiformis) necrophorus* and *Corynebacterium pyogenes* and usually affects only a small number of animals in a flock, seldom more than one foot of a sheep, and but rarely lambs. It is favoured by similar environmental conditions to those promoting virulent foot-rot and is also treated by surgery and medication and prevented by the same hygienic measures. Sometimes foot-rot and toe abscesses occur in an Awassi flock simultaneously.

Blowfly (screwworm). The blowfly, *Cochliomyia hominivorax*, is well known to every sheepman in charge of an Awassi flock. It is considerably larger than the common housefly and of a greenish-blue colour with a reddish head. Skin wounds caused by shears, thorns or other objects are immediately attacked by the blowfly. Infected wounds are particularly attractive to it. In the range of the Awassi the blowfly is active only from the beginning of spring to the end of summer and not in winter.

The life cycle of the blowfly consists of four stages: egg, maggot, pupa and adult fly. During her lifetime, which lasts about one month, the female deposits more than 2 000 eggs into open wounds. The maggots or screwworms hatch in a few hours, burrow into the flesh and feed for about six days. They then drop from the enlarged wound to the ground, burrow into it and there change into pupae, to emerge one to eight weeks later as adult flies ready for fertilization and new strikes.

Fly-struck sheep should be treated and the maggots destroyed before they mature and drop off to pupate. The wool should be completely removed from and around the struck area and one of the common dressings for fly strike should be applied to the wound. A copper sulphate solution dabbed with a brush in the open wound and on its surroundings and dry boracic acid powder dusted on the struck area have proved efficacious in killing the maggots and protecting the wound against re-strike while it is healing. The copper sulphate solution may be replaced by a benzene hexachloride ointment and boracic acid by a mixture of sulphur and iodoform powder or diphenylamine.

Leeches (Hirudinea). Leeches infest Awassi sheep grazing in swampy areas or near river beds. The species *Limnatis nilotica*, which is the most common one in the range of the Awassi, is of a greenish-black, earth colour with yellow lines along the sides. This leech invades the mouth of sheep while they are watered and attaches itself to the mucosa of the mouth, gullet or throat. One or a very few leeches are enough to inconvenience a sheep seriously. With its tongue and jaws the affected animal endeavours to get rid of the leeches, and blood oozes from its mouth because the leeches excrete a substance which prevents clotting of the blood. Sheep infested by leeches may stop feeding.

Shepherds noticing the trouble remove the leeches with a hand covered with a rag because the leeches easily slip from bare fingers. Washing the mouth of infested sheep with a sponge soaked in a concentrated salt solution will also remove the leeches. Those that have taken their fill of blood drop out by themselves.

Nose bot. Another fly parasitic upon Awassi sheep is the nasal fly, *Oestrus (Cephalomyia) ovis*, which is smaller than the blowfly and of a greyish-yellow colour. It attacks its host in spring and early summer during the hot hours of windless days. The fertilized female fly deposits maggots of less than 2 mm long at the entrance to the nostrils of the sheep. The young larvae crawl into the nostrils, feeding on the mucus, and pass up the nasal chambers to enter the frontal sinuses where they stay and develop for nearly a year, growing during this time to a length of about 3 cm, divided into eleven distinct segments. The sheep react to the irritation caused by the bots by snuffling, sneezing, giddiness and, if the number of bots is large, by what is known as 'parasitic nasal catarrh'.

When mature, the bots release their hold on the mucous membrane and return to the nasal passage where they are expelled by sneezing. They then burrow into the ground to pupate, the pupal state lasting for several weeks or months, depending on environmental conditions. At the end of this time the mature flies emerge ready to mate and seek new hosts for their larvae.

Sheep attacked by the bot-fly try to defend themselves by sticking their noses into loose soil or the fleeces of other sheep. Since the fly does not attack in the shade, Awassi sheep kept in the barn during the hot hours of spring and summer days are protected. Also, the fly cannot get at the nostrils of sheep standing in clusters with their heads below the bellies or fat tails of their neighbours. Yet there are few mature Awassi sheep which, after slaughter, will not show some bots in their nasal passages or frontal sinuses. In Iraq where *O. ovis* is widespread, as many as 40 nasal bot maggots have been found in a single sheep (Eichler, 1967).

The intramuscular injection of dimethoate is effective against all larval stages of the sheep bot-fly. The same applies to Ruelene and rafoxanide given orally as a drench (MVM, 1973).

Scabies. Scabies in Awassi sheep is caused by two species of small mites of the order *Acarina*, namely, *Sarcoptes scabiei* and *Psoroptes scabiei*. Psoroptic mange is common in the range of the Awassi; in Iraq 5 percent of the sheep are affected by *P. ovis* (Eichler, 1967).

The *Sarcoptes* mite causes sarcoptic mange, the most severe form of scabies. The mite digs through the epidermis to the corium where it settles down. The females burrow cavities in the skin and lay 10-25 eggs in each of these, while the males remain on the surface of the corium. The larvae hatched from the eggs undergo an additional metamorphosis before developing into mature, 0.2- to 0.5-mm-long mites. The entire process takes two to three weeks.

The parasite attacks mainly the woolless parts of the body, usually beginning in the nostrils and mouth, thence passing to the ears and remaining parts of the head. Sometimes the mites also assault the feet, the naked inner side of the fat tail, the scrotum and those parts of the body where the woolly covering is thin. Sheep attacked by the sarcoptic mite rub the affected parts against walls and fences and the lower part of the forelegs. As a result, the skin loses its flexibility and breaks, and open wounds appear which become covered with thick, hard scales.

Scab mites rapidly pass from sheep to sheep, but at an early stage eradication of the infestation is not difficult. Dipping prevents infestation of unaffected sheep, but as the mites sit in the skin and are often covered with thick scales, the dipping fluid does not reach them. It is therefore necessary to use

medicinal ointments. At the present time benzene hexachloride is successfully employed against scabies of the head. Previously two other ointments were commonly used in Awassi flocks, one compound of 70 percent wood tar, 15 percent yellow sulphur powder and 15 percent methylated spirit, and the second of 40 percent wood tar, 25 percent petroleum, 15 percent sulphur powder, 15 percent methylated spirit, and 5 percent creosote. To these mixtures sheepmen used to add oil, vaseline, soft soap, discarded motorcar oil, or lysol.

The *Psoroptes* mite causes body scab. It is twice as large as the mite attacking the head and is readily seen with the naked eye on a piece of affected skin held against a dark background. *Psoroptes* does not dig into the skin but lives on the epidermis, sucking its food from a deeper layer. It prefers parts of the body thickly covered with wool. The metamorphoses from egg to egg stage are similar to those of the head mite, but the full cycle is completed in half the time.

Affected sheep are restless, rubbing their sides against the ground, walls and fences, and in their endeavour to rid themselves of itching, they pull out staples of wool with their teeth. The wool sometimes gets stuck between the teeth, and in their reaction to this new trouble the sheep may turn round and round while the grazing flock moves on.

The affected areas of the skin show small wounds of a reddish-yellow colour which discharge pus and serum. Mixed with yolk and dandruff this turns into a sticky mass. The wool becomes wet as though perspiring. After a time it is shed, and the infested areas become dry, hard and sore so that the affected sheep may eventually stop eating and lose condition. On cold and wet days sheep infested with scab mites suffer more than in warm sunny weather. After shearing, the infested skin heals outwardly, but the eggs of the mite remain alive and hatch as soon as the wool grows longer.

The mature scab mites and the larvae are sensitive to most dip solutions and easily killed by dipping, but few insecticides also destroy the eggs. Generally, two applications at an interval of ten days are therefore necessary to kill the larvae that have hatched from the live eggs after the first dipping. This applies to arsenical and carbolic dips, lime-sulphur and nicotine sulphate, and to those containing derris root. However, a single dipping or spraying with benzene hexachloride suffices to control psoroptic mange.

Sheep ked. The sheep ked, *Melophagus ovinus*, is a wingless fly about 7 mm long of reddish or greyish brown colour and covered with short bristly hair. Its mouth is adapted for piercing the skin and sucking blood. When feeding, the parasite buries almost its whole head with the proboscis into the skin of the sheep. It migrates readily from one animal to another.

During her lifetime the female deposits in the wool of the sheep about a dozen nearly fully developed larvae which are covered with a white membrane. In less than a day the membrane, attached to the wool by a sticky substance, turns brown and hard, containing the pupal stage of the parasite. The young keds emerge from the pupae about three weeks later to work their way through the wool to the skin of the host. In a week's time the keds reach sexual maturity and in another week the female brings forth the first larva, continuing the process about once a week during the three-to-four-month span of her life.

Sheep heavily infested with keds scratch and rub and bite at the itchy parts. Lambs, with their tender skins, suffer most from the intense irritation caused by the blood-sucking insects, losing condition and showing general unthriftiness. In addition, the fleece is damaged by the 'tick stain' produced by the excrement of the keds.

The pupae encased in the hard membrane withstand the destructive action of many dipping fluids, but benzene hexachloride destroys them along with the adult keds.

Sucking and biting lice. Awassi sheep kept in primitive conditions frequently suffer from infestation by sucking lice, particularly of the species *Haematopinus (Linognathus) ovis*. In Iraqi Awassi sheep blood-sucking lice of the species *L. africanus* are frequent, causing moist itchy lesions of the skin on the back. Toward the end of the dry, hot summer season, sheep in poor and neglected condition are especially vulnerable. Once lice have obtained a footing on one or several sheep, they rapidly spread throughout the flock. Infested sheep scratch and rub the itchy parts of their bodies against walls, fences and trees. Staples of wool, looking like white threads against the darker background of the fleece, sever from the skin. Underneath the loose staples the lice and their numerous eggs or nits are clearly visible. The nits are attached to the wool close to the skin by a viscid substance excreted by the female.

Occasionally Awassi flocks belonging to bedouin or fellahin also suffer from infestation by biting lice, such as the sheep-biting louse, *Damalinia ovis*, and the sheep-foot louse, *Linognathus (Ano-plura) pedalis*. In Iraq, Awassi sheep have been found infested by the biting louse *Lepikeutron ovis*.

Lice and nits are destroyed by a single dipping in a benzene hexachloride dip or by spraying or dusting with an insecticide, such as methoxychlor or toxaphene.

Tick diseases. The commonest genera of ticks infesting Awassi sheep are *Rhipicephalus* and *Hyalomma*. In flocks in Iraq the species *R. sanguineus* and *H. excavatum* are widespread, especially in spring and summer. Awassi sheep are also attacked by other species of ticks, such as *R. bursa*, *H. detritum*, *Boophilus annulatus*, *Amblyomma punctata*, *Dermacentor marginatus*, and *Ornithodoros lahorensis*. The last species occurs mainly in the north of the country in sheep that are housed during the night in winter (Eichler, 1967). Three different tick diseases occur in Awassi sheep, namely, babesiasis, theileriasis and anaplasmosis.

Ovine babesiasis is caused by *Babesia ovis* and *B. motasi*, the haemosporids of which invade, and multiply in, the erythrocytes and may lead to serious losses in Awassi flocks. It is transmitted by the tick *R. bursa* which is most active in the summer months from April to June. *B. ovis* is especially prevalent in marshy areas, while *B. motasi* in Awassi sheep occurs mainly in mountainous regions with calcareous soils. The disease is characterized by acute fever and a lack of appetite, followed by anaemia and icterus. In untreated animals mortality is high. Sheep that recover have permanent immunity but remain carriers of the infection. The disease is effectively treated by the intravenous injection of acriflavine, the subcutaneous or intramuscular injection of quinuronium sulphate, or the intramuscular injection of imidocarb dihydrochloride.

Theileriasis in Awassi sheep is caused by *Theileria ovis* or *hirci* and usually occurs in spring. Like babesiasis, it is transmitted by the tick *R. bursa*, but unlike *Babesia*, *Theileria* does not multiply in the erythrocytes after invasion. The parasites enter the spleen, lymph nodes and liver where they multiply. The haemosporids are released into the bloodstream and again invade the erythrocytes where they remain unchanged until ingested by a tick. Symptoms of the infection are high fever, anaemia and icterus. The mortality rate is high, while recovered sheep are permanently immune. At an early stage of the infection the intravenous injection of chlortetracycline (Aureomycin) or oxytetracycline (Terramycin) inhibits the development of haemosporids in the invaded organs.

Anaplasma ovis in Awassi sheep is relatively non-virulent, but under certain conditions is capable of producing anaplasmosis of mild severity. The infection is transmitted by several species of ticks and also by biting flies. The symptoms include a rise in temperature and a lack of appetite. Aureomycin, Terramycin and Achromycin (tetracycline) have an inhibitory action against the causative agent in the erythrocytes. After recovery the sheep remain carriers.

As in all tick diseases the incidence can be reduced by killing the ticks on the sheep or repelling them with insecticidal sprays in the season of danger.

Worms. Worm infestation in Awassi sheep is widespread throughout the range of the breed. The kind of worms prevalent in different areas varies according to local topographical and climatic conditions. Thus, for example, flocks grazing in semi-desert regions harbour different helminthic populations from those pastured on undrained swampy land. Again, improved Awassi dairy flocks in Israel are relatively free of worms, although at one time some of them became badly infested following the introduction of sheep from southern Anatolia.

The worms found in Awassi sheep belong to two phyla, Nematoda and Platyhelminthes (which includes Trematoda and Cestoda), each of which comprises a number of families, genera and species.

Cestoda. Tapeworms occur in the majority of bedouin and in many fellahin flocks but have become rare in improved Awassi dairy sheep. The reason is that the dogs on farms with improved flocks are not fed the remains of dead sheep, so that the essential link in the life cycle of tapeworms is broken.

The commonest tapeworm in Awassi sheep in *Echinococcus granulosus*, also called *Taenia echinococcus*. This worm consists of a head or scolex and three or four body segments. The mature worm infests the intestines of dogs and other Canidae which excrete the eggs of the worms with faeces. These may be picked up by sheep in grazing. In the intestines of the sheep the shell of the eggs dissolves, the parasite in the oncosphere phase of its metamorphosis bores through the mucosa of the intestine and invades the bloodstream by which it is carried to the lungs and liver. Here it remains and becomes enveloped by a bladder, first a small one and later a larger one, which contains a yellowish mass of variable consistency, fluid, thick or petrified, in which the scoleces are embedded. In the livers and lungs of slaughtered Awassi sheep in Iraq the cysts or hydatids of *E. granulosus* are common (Eichler, 1967). The scoleces can develop into mature fertile worms only after being swallowed, usually with the discarded pieces of infested lungs or livers of slaughtered or fallen sheep, by dogs, jackals, foxes or wolves. The adults of this tapeworm are common in stray pariah dogs.

The spread of the hydatid disease is prevented by keeping infested lungs and livers out of the way of dogs and wild canids and by regularly dosing the sheep-dogs for tapeworm. The cysts are not very harmful to the sheep unless they take up a large part of the infested organ. They do, however, detract from the value of the slaughtered sheep. A copper sulphate drench with the addition of nicotine sulphate or arsenite of soda will kill tapeworms in sheep. A solution of calomel (mercurous chloride) in water has also proved to be efficacious, and the same applies for lead arsenate and niclosamide.

Another tapeworm, somewhat less common in Awassi sheep than *T. echinococcus*, though frequent in Iraq, is *T. multiceps*. This worm also infests the intestines of dogs and wild canids. Its eggs are passed out with the faeces of these animals and may fall on grass to be eaten by sheep, their intermediate host. Here the parasite is carried by the bloodstream to the brain and spinal cord where it becomes encysted, the cyst containing the larval stage, called *Coenurus cerebralis*. The cysts may grow to a considerable size and disturb the brain of affected sheep, causing a lack of coordination, loss of sense of direction and progressive paralysis of the limbs. Dogs become infested by eating the worm cysts contained in the brain or spinal cord. The surgical treatment of sheep is possible if the cyst is situated superficially on the brain so that it can be felt through the softening bone (Fraser & Stamp, 1961). As in the case of *T. echinococcus*, the spread of *T. multiceps* is prevented by dosing the farm and sheep-dogs with a mixture of thiabendazole and piperazine adipate and by keeping them away from the carcasses of infested sheep.

Nematoda. The phylum Nematoda comprises a considerable number of different families and genera of round worms, many of which infest Awassi sheep. The occurrence of the following species of sheep nematodes has been established in Iraqi flocks (Eichler, 1967): *Haemonchus contortus*, *Ostertagia circumcincta*, *O. trifurcata*, *O. occidentalis*, *Camelostrongylus mentulatus*, *Marshallagia marshalli*, *Trichostrongylus axei*, *T. vitrinus*, *T. colubriformis*, *T. probolurus*, *Bunostomum trigonocephalum*, *Nematodirus filicollis*, *Strongyloides papillosus*, *Chabertia ovina*, *Oesophagostomum venulosum*, *Setaria labiatopapillosa*, and a *Trichocephalus* species.

Contrary to Trematoda and Cestoda, the majority of which are hermaphroditic, Nematoda are separated into males and females. Their life cycle generally consists of four phases. The female worms infest the stomach and intestines of their host laying large numbers of tiny eggs which are passed out with the faeces and contaminate pastures. Here the eggs develop into small larvae which climb up and down pasture plants. At a further stage the larvae are eaten by grazing sheep which thus become infested or reinfested. Finally, in the gastro-intestinal tract, the larvae develop into mature worms which, if present in large numbers, cause anaemia and loss in condition. The most pathogenic gastro-intestinal nematodes belong to the genera *Haemonchus*, *Trichostrongylus*, *Ostertagia* and *Marshallagia*.

In contrast to other countries in the range of the Awassi, in Iraq it is the adult ewes that suffer most from gastro-intestinal nematode infestation, while lambs are less affected and in a better state of health. This is attributed to the fact that the majority of Awassi flocks migrate to the desert after lambing. Hence, the lambs are removed from the areas of heavy parasitic infestation and graze in clean areas during the first six months of their lives (Eichler, 1967).

H. contortus, with a length of 1-2 cm for the male and 2-3 cm for the female, is the largest of the stomach worms. It lives mainly on blood which it sucks from the wall of the stomach, more especially the abomasum, and causes severe anaemia, paleness of the mucous membrane of the eyes and mouth, and whiteness of the skin. The female may lay up to 3 million eggs in the course of 24 hours. The eggs can withstand dryness for months and the larvae may live up to one year under most variable environmental conditions. Sheep are infested by the larvae on pasture grass or in drinking water.

Phenothiazine given as a preventive and curative drench is very effective against haemonchosis. It may be given at any time of the year except to ewes in the last month of pregnancy. The dose for rams and ewes is 25-30 g in 100 g of water, for yearlings 20 g, and for lambs 10 g. It is advisable to repeat the treatment after three months. Of another anthelmintic, thiabendazole, 3 g are given to adult sheep and 1.5 g to lambs; one treatment is sufficient.

Trichostrongylus worms are 6-12 mm long and not thicker than a very fine hair. Although they do not suck blood, they cause irritation of the gastro-intestinal tract and in severe cases acute parasitic gastro-enteritis, dark scour being the most prominent symptom of the infestation. For the prevention and therapeutic treatment of trichostrongylosis, phenothiazine is also used, but as these worms are very resistant to its action, a larger dose than that given for haemonchosis is necessary. Two organophosphates, coumaphos and haloxon, as well as thiabendazole, have proved to be highly effective against *Trichostrongylus*.

Trichostrongylus worms often go together with brown stomach worms of the two species

Ostertagia circumcincta and *O. trifurcata*. Like the twisted stomach worm, *Haemonchus contortus*, these hair-like worms, about 1.0-1.5 cm long, live mainly in the abomasum. The control and treatment of infestation are essentially the same as those for the other worms of the gastro-intestinal tract.

Two other species of Nematoda, *Nematodirus battus* and *N. filicollis*, are occasionally found in Awassi flocks grazing on low-lying pastures. They are 1.5-2.0 cm long and relatively harmless, but a massive invasion in the small intestines of lambs by these parasites at the immature larval stage, burrowing into the lining of the gut, may cause severe irritation and a loss of body fluid. With an acute attack by the larvae the lambs begin to scour and some of them may die of dehydration in spite of an avid intake of water. Nematodiriasis is effectively prevented and cured by bephenium embonate and coumaphos.

Nematoda infest not only the gastro-intestinal tract; some invade the bronchial passages and ramifications of the lungs. The species most common in Awassi sheep is the large or thread lung-worm, *Dictyocaulus filaria*, which ranges up to 10 cm in length and may cause congestion in the lungs, the development of pus and difficult breathing. The development of lung-worms is similar to that of the Nematoda infesting the stomach and intestines. The eggs are coughed up and swallowed; on their passage through the intestines the larvae hatch and are passed out in the droppings of the sheep. In a few days they become infective, and after being swallowed by sheep they burrow through the intestinal wall and are carried by the lymph stream to the aorta and thence by the blood to the lungs where they settle down.

The life cycle of the small or hair lung-worm, *Muellerius capillaris*, includes an intermediate host after passing out of the bowels of the sheep, as the small land snail found in pastures.

The symptoms of heavy lung-worm infestation are an irritating cough, rapid breathing, discharge from the nostrils and progressive loss in condition. The treatment consists of intratracheal injections of various worm-killing liquids, such as tincture of iodine or potassium iodine and glycerine in water, oil of turpentine, oil of creosote and chloroform in olive oil, or picric acid in water, but their effectiveness is not high.

Cyanoacetohydrazide is efficacious against adult lung-worms but not against immature lung-worms, while diethylcarbamazine is effective against immature worms but not against adult forms. Methyridine and tetramisole are effective against all stages of lung-worms (MVM, 1973). Against *M. capillaris* the intramuscular injection of emetine hydrochloride is also effective, while *dictyocaulus* can be combatted by vaccination.

In improved Awassi dairy flocks the use of anthelmintic medicines varies. Some flock-masters worm their sheep once a year in autumn, others in autumn and in spring, while still others worm their flock only when they notice that the sheep actually suffer from worms. However, many well-bred and well-managed flocks are practically clean of worms and do not require vermifuges at any time.

Trematoda. Worms of the class Trematoda are parasites living in the inner organs of sheep. They attack their host by means of special organs which serve for attachment and suction. More than 20 different species of Trematoda are parasitic in sheep, among these *Distomum hepaticum*, *Dicrocoelium lanceolatum*, *D. dendriticum*, *Paramphistomum microbothrium*, and *Schistosoma haematobium* (*Bilharzia haematobia*).

Liver fluke infestation (distomiasis) of Awassi sheep is common in the northern parts of the range of the breed, especially in southern Anatolia, northern Syria and northern Iraq which have comparatively high rainfall, but it is also prevalent in swamps and irrigated areas in the central and southern regions. Fluke disease usually follows a year of abnormally heavy rainfall. In Iraq the area for grazing appears to be immense in relation to the number of sheep, but actually it is greatly limited by the large barren tracts and scarcity of wells. The more fertile areas are therefore severely overstocked and entozoal parasitism is common. The periodic crowding of sheep on the fringes of marshes and pools causes particularly heavy losses from distomiasis (Williamson, 1949). The common species of liver fluke in Iraq is *Fasciola gigantica* which occurs in all areas, but especially in the central and southern *liwas*. In the hilly regions of the north and northeast, *F. hepatica* is widespread in sheep (Eichler, 1967).

The liver fluke, *Distomum hepaticum* (*F. hepatica*), is a leaf-like worm nearly 25 mm long which infests the bile ducts of sheep and, in its immature form, the parenchyma of the liver. The eggs discharged with the faeces die if deposited on dry ground, but if dropped on or near water they develop into larvae (miracidia) which bore into the body of a particular fresh water snail that serves as intermediary host. In Iraq, *Lymnaea euphratica* is suspected to be the vector of *F. gigantica*. After further metamorphoses from the sporocyst to the mother redia, daughter redia and cercaria stages, the cercariae are set free from the intermediate host to swim free in the water or to attach themselves to blades of grass or other plants, where the encysted metacercariae may remain viable for months and

be ingested by sheep with drinking water or plant feed. In acute attacks by the simultaneous invasion of the liver by a large number of immature flukes, death may occur from haemorrhaging. In chronic cases, resulting from irritation in the bile ducts by mature liver flukes, the sheep become anaemic and progressively weaker until they die in two or three months.

An effective treatment for mature fluke infestation is a drench of hexachloroethane, hexachlorophene, carbon tetrachloride or bithionol mixed with liquid paraffin. The destruction of young flukes requires a considerably larger dose than for adult flukes and repeated treatments are necessary. An improvement on the carbon tetrachloride medication is the intramuscular injection of this compound in combination with other chemicals. Recently a number of compounds have become available, such as clioxanide, oxyclozanide, rafoxanide, nitroxynil, brotianide and menichlopholan, which have increased efficacy against immature and adult flukes (MVM, 1973, 1979).

Dicrocoelium lanceolatum and *D. dendriticum* are also widespread in the range of the Awassi. Like *Distomum hepaticum*, they attack the bile duct and liver of sheep, but use different intermediate hosts from those of *D. hepaticum* for their metamorphoses. The eggs of *Dicrocoelium lanceolatum* are spread with the faeces of infested sheep. The larvae (miracidia) are ingested by the first host, the terrestrial snail *Cionella lubrica*, which thrives on dry hill pastures. In the body of the snail they develop into cercariae which are taken up by an ant, *Formica fusca*. The ingestion by grazing sheep of ants infested with encysted metacercariae introduces the latter into the third and final host where the immature flukes migrate through the bile duct to the liver. The anthelmintics used against *F. hepatica* are ineffective against *D. lanceolatum* and *D. dendriticum*, but thiabendazole and two compounds with the proprietary names Hetolin and Hetol have given satisfactory results (MVM, 1973).

Rumen flukes (*Paramphistomum microbothrium*) are present in large numbers of Awassi sheep in Iraq. The young stages, which live in the small intestine, cause enteritis and loss of condition (Eichler, 1967).

Schistosoma haematobium (*Bilharzia haematobia*) is mainly a human disease, but it also attacks sheep. Iraq is one of the world's two major foci of schistosomiasis. In the past *S. haematobium* has also been responsible for severe losses in several improved Awassi flocks in Israel. In Iraq, *Schistosoma bovis* and *Ornithobilharzia turkestanica* are reported to be the two species mainly responsible for the schistosome infestation of Awassi sheep. As in the other worms of this order, the eggs are discharged with the faeces of the sheep. In conditions of sufficient moisture, the larvae hatch and invade a snail. The vector of *S. bovis* is *Bulinus truncatus* which is common in the central and southern parts of Iraq, while *O. turkestanica* uses *Lymnaea euphratica* as its intermediate host (Eichler, 1967). After the metamorphoses, the parasite leaves the body of the snail and attaches itself to a nearby plant. Along with this it is introduced into the digestive tract of the sheep where it penetrates the bloodstream and infests the walls of the veins and the liver, poisoning the host with its toxins.

Poisoning. Poison may affect a few sheep or destroy an entire flock. The poisons that may strike Awassi sheep are of two kinds, plant and mineral. Some plants in the grazing areas of Awassi sheep are poisonous at all times of the year, while others are only dangerous in certain periods or under certain conditions of their growth.

Unimproved Awassi sheep grazing on their natural home pastures generally avoid poisonous plants, such as *Papaveraceae*, *Solanum nigrum*, *Ramunculus arvensis*, *Ferula communis*, *Ecballium elaterium* and *Nerium oleander*. It is only in times of prolonged drought when the pastures do not provide enough nourishment and the sheep go hungry that poisonous plants may be eaten and cause diarrhoea or death if the quantities consumed are sufficiently large.

Awassi flocks grazing on grain sorghum fields may be poisoned by prussic acid which often develops in sorghum at an early phase of growth, especially after a rainless period or if deprived of irrigation. Sometimes this also occurs in Sudan grass. Becker (1958) has recorded that sorghum plants sprouted on poultry droppings close to a hen-house poisoned Awassi sheep which fed on them while passing by. The symptoms of hydrocyanic acid poisoning appear within one or two hours: trembling, weakness in the legs, frothy discharge from the mouth, heavy breathing and, finally, paralysis and speedy death.

Grain feeding and the presence of glucose in the stomach counteract the danger of prussic acid plant poisoning to a certain extent. Therefore a drench of molasses or sugar dissolved in water may be administered as a first measure to save the lives of sheep suffering from this poison. At an early phase of prussic acid poisoning a drench of sodium carbonate and iron sulphate dissolved in water may also be helpful. Belschner (1951) recommends the immediate intravenous injection of 20 cc of a mixture of 50 g of sodium nitrite and 200 g of sodium thiosulphate dissolved in 11 of water or the subcutaneous injection of 5 cc of sulphuric ether.

Awassi sheep have also been poisoned by fenugreek straw or grazing on green fenugreek. The seeds of this plant are used in many parts of the range of the Awassi as a condiment and sometimes the plant as green manure.

The symptoms of fenugreek poisoning are weakness of the leg muscles below the knees and later also below the hocks so that the sheep can no longer stand on their legs. In graver cases the neck and rib muscles are also affected, causing difficulty in eating and breathing. Sometimes oedemas develop below the mandibles and subcutaneously at other parts of the body, and serous fluid accumulates in the heart and abdominal cavity. With the cessation of fenugreek straw or green feeding the sheep usually recover, although slowly, and only a few cases are fatal.

At least one instance is known of Awassi sheep having been poisoned by eating yellow lupin seed to which they accidentally had access (Becker, 1958). Bread in quantities of more than 750 g a head has also proved to be fatal to Awassi sheep, especially to ewes in lamb, through excessive lactic acid fermentation in the stomach.

Mineral poisoning seldom occurs in unimproved Awassi flocks belonging to fellahin or bedouin, but it is not rare in improved dairy flocks where it often results from negligence on the part of the sheepmen or others.

Arsenic poisoning may be caused either by the consumption of foliage treated with arsenical herbicides such as sodium arsenite and arsenite trioxide (MVM, 1979); by drinking arsenic dipping fluid; or by absorption through open wounds in the skin, which is much more deadly than drinking dipping fluid. Occasionally the licking of arsenic containers or paint tins, or an excessive dosage of arsenical drenches against worms, are responsible for losses.

Sheep poisoned by arsenic have abdominal pain, foul-smelling and sometimes blood-tinged diarrhoea and difficult breathing. In acute cases the animal may die in a few hours; in chronic poisoning from the repeated intake of small quantities of arsenic over a period of time, death may come in up to one week. Post-mortem examination shows intense inflammation of the mucous membrane of the abomasum and congestion of the intestines and liver.

An antidote for arsenic poisoning is the intramuscular injection of 6 mg/1 kg body weight of 2,3-dimercaptopropanol or a drench of 7-14 g of sodium thiosulphate dissolved in 300 cc of water. In addition, 2 g of sodium thiosulphate in a little boiled water may be injected intravenously. Raw linseed oil should be given as a purgative and the sheep should not be watered for at least one day (Belschner, 1951).

In several improved Awassi flocks poisoning has occurred from eating thallium-poisoned bran or grain used against moles in the fields. Such bran or grain contains 2 percent thallium sulphate. Normally 2.5-3.0 kg of grain are spread for each hectare of land, or five to ten grains are inserted in an exit from the burrows of the moles. The fatal dose of thallium sulphate for sheep is 15-25 mg/1 kg live weight. An animal weighing 50 kg has therefore to consume 37.5-62.5 g of poisoned grain for a fatal dose. It is most unlikely that sheep would pick up such a large quantity of grain in fields treated with the quantities of grain prescribed. Hence, thallium poisoning nearly always results from carelessness on a farm where sheep have access to poisoned bran or grain in bags or to spilled grain.

The symptoms of thallium poisoning are loss of appetite, gnashing of teeth, reddening of the mucosa of the eyes and mouth, discharge from the mouth, weakening of the legs and lying down. Postmortem examination shows congestion and ulceration of the stomach and intestines, ulcers being particularly common in the duodenum. The contents of the omasum usually contain red thallium-soaked wheat.

Thallium-poisoned sheep should be purged with magnesium sulphate or paraffin and drenched with diphenylthiocarbazon oral percent solution of sodium iodide in water. In addition, they should receive an intravenous injection of a 10 percent solution of sodium iodide. Sheep that recover from thallium poisoning continue to have diarrhoea for some time and their wool comes loose.

Copper poisoning has been observed in well-fed Awassi dairy flocks in ewes in milk and in lambs six months of age and older. In unimproved flocks kept on natural pasture such poisoning is extremely rare. Copper is an essential trace element in the nutrition of sheep; a pregnant ewe requires 5 mg of copper a day, while ewes' milk contains 0.15 ppm of copper and wool 5 ppm. On the other hand, sheep are easily poisoned by an excessive quantity of copper.

Two kinds of copper poisoning are distinguished, acute and chronic. The acute form may be caused by the ingestion of copper compounds contained in plant or other sprays, anthelmintic medicines or foot baths. Chronic copper poisoning is due mainly to feedstuffs containing small but excessive quantities of copper which are stored in the liver until it is overburdened. This may happen in dairy ewes or fat lambs that obtain most of their nutritional requirements in the form of concentrate mixtures containing copper in a 10 ppm or higher concentration, and little or none from grazing.

The symptoms of copper poisoning are loss of appetite, diarrhoea, red urine, short breathing, trembling, weakness, prostration and death, in acute cases there is severe congestion of the stomach and intestines, while in chronic poisoning the liver, kidneys, spleen and lungs show abnormal changes and there may be generalized jaundice.

The treatment for acute copper poisoning consists of the administration of potassium ferrocyanide or powdered iron with which copper in the stomach and intestines will form an insoluble compound. This should be followed by the administration of magnesium sulphate or raw linseed oil.

In all cases of mineral or plant poisoning, and in particular if the cause of the affection is unknown, a drench of raw linseed oil or magnesium sulphate and sodium bicarbonate dissolved in water should be administered and the white of eggs, milk and stimulants in the form of alcohol or strong coffee should be given.

Buildings for Awassi dairy flocks

Housing for Awassi dairy flocks includes the shed, adjoining yards and storage facilities for roughage, silage and bedding. The bin for concentrates is located in the shed, the silo usually at a distance of 8-10 m from it, and the storage sheds for roughage and bedding not less than double this distance. The entire complex must fit the general plan of the farm, to save labour and promote the health and production of the flock. In addition, it should be close to the road over which the sheep must travel on their way to pasture grounds. Further, the sheep shed should be situated sufficiently far from the cow sheds and cattle yards to minimize the danger of parasites and infectious diseases passing from one to the other. Topographically the shed and the yards should not be located in a hollow, and land with a moderate declivity is preferable to a level area as yards on a well-drained decline dry up soon after a rainfall.

The shed houses the ewes, yearlings and lambs. Attached to it are the milking parlour, milk refrigerator and tank, and a room and sanitary facilities for the workers. The bin for concentrates may be inside or just outside the shed. The pen for the rams may be situated in the shed or in one of the yards.

The floor of the shed should have a declivity of not less than 1.5 percent and not more than 5 percent. The space required in the shed and yard for Awassi sheep of different ages, sex and condition has been given by Becker (1958) (see Table 2-15). With the increase in the average weights of improved Awassi dairy sheep during the last two decades, about 10 percent should be added to these figures.

Awassi sheep in fleece and good condition suffer little from cold, more especially as ambient winter temperatures are not usually very low in their range. The shed should protect them from rain storms in winter and the burning midday sun in summer. As the cooling sea winds come from the direction of the Mediterranean, sheds for dairy sheep were originally built to extend from north to south so that in summer they lay open to the western winds throughout their entire length. This arrangement, however, is no longer recommended, and modern sheds extend from west to east. The advantage of this direction is in the long southern front of the shed opening into the yard or paddocks which, following a downpour of rain, are soon dried by the rays of the sun. Also, the main direction of winter rains is from the west, to which the modern shed offers only a narrow front (see Figs 2-6 to 2-10).

Table 2-15. Floor space required by Awassi sheep in shed and yard (m²)

Type of sheep	Shed	Yard
Dry ewe	0.90	1.30
Pregnant ewe	1.00	1.45
Ewe in milk	1.00	1.45
Ewe and lamb	1.25	1.80
Yearling	0.90	1.30
Weaned lamb	0.80	1.15
Ram in rams'shed	2.00	2.85

Source: Becker, 1958



Figure 2-6. Interior of Awassi sheep shed with roof extension



Figure 2-7. Front of Awassi sheep shed

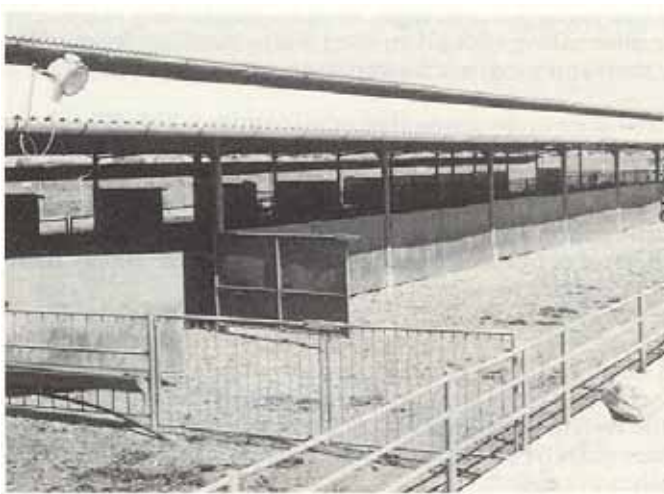


Figure 2-8. Awassi sheep shed with iron-fenced yard



Figure 2-9. Awassi sheep shed without interior roof supports



Figure 2-10. Awassi sheep shed with interior roof supports

The floor of the shed consists of earth, slightly raised above the level of the surroundings. The walls are built either of brick, concrete blocks or solid concrete. The roof rests on iron pillars, 4 m apart, preferably without inside pillars which may hinder the free working of heavy mechanical equipment in the removal of manure.

The southern wall of the shed which faces the yards is 1.2 m high. Half its length may consist of gates with the other half closed, every 4 m a gate alternating with a 4-m-long wall extending from pillar to pillar. The gates, opening toward both sides, shed and yard, are hinged so that they may be raised or lowered as required.

The western and eastern sides of the shed are taken up by gates along their entire width (Fig. 2-11), each gate being 4 m wide and again opening both inwards and outwards. Through these gates feed and bedding are brought into the shed and manure is removed. The height of the gates is 1.8 m. On the side away from the common direction of the rains they are slatted, and toward the side of the winter rains and storms solid. Again, on the rain side the space between the gates and the roof is closed by frames which can be removed in summer or when carts or trucks have to enter the shed. Away from the direction of the rains, the space between the gates and the roof remains open. In one of the gates at each side, east and west, it is advisable to install a wicket door, 1.0-1.5 m wide, for the convenience of workers entering or leaving the shed.

The long northern side of the shed should be closed by a 1.4-m-high wall, above which two or three strands of wire may be stretched lengthwise from east to west up to 1.8 m above the ground. If the shed is built of concrete blocks, this side of the wall may include two or three rows of hollow blocks for ventilation. Every opening in the walls or gates must be closed by woven wire, not more than 15 cm wide, as protection against dogs, jackals and other predators.

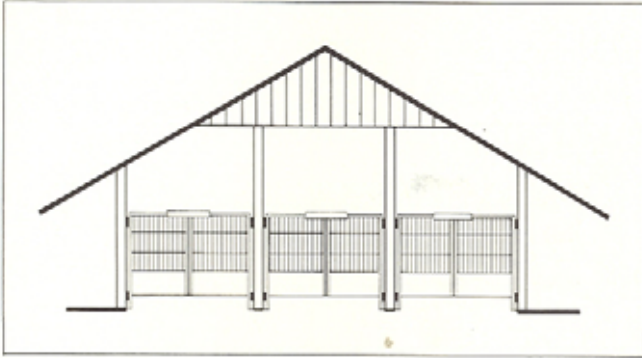


Figure 2 11. Sketch of eastern or western side of Awassi sheep shed. (Source: Becker, 1958)

The height of the roof above the walls should not be less than 2.5 m from the ground, preferably 2.85 m, and the width of a shed housing 200-300 ewes and their lambs 8 m. A smaller width does not permit satisfactory internal arrangements and full utilization of ground space. For large flocks the width of the shed should be 12 m.

It is advisable to use corrugated asbestos plates for the roofing. These provide isolation from the heat of the sun and are relatively light and durable, and for these reasons preferable to corrugated iron sheets.

The roof should extend 2 m beyond the walls of the shed. This prevents the penetration of rain into the shed through the open space between the wall and the roof and renders its closure unnecessary. The protective effect can be enhanced by a downward angulation of the outward extension of the roof. On the southern side of the roof, gutters are installed in order to carry rain-water away from the yards.

If on the northern side of the shed there are no yards similar to those on the southern side, a 2-m-wide passage below the protruding roof is useful on this side for carting feedstuffs and other supplies from the storage places to the shed. The wall is broken by the necessary number of gates, and at every 8-12 m by a 1.0-1.5-m-wide wicket. In sheds where feedstuffs are introduced by a central pathway running from east to west, the passage outside the northern wall and the gates within it are unnecessary; one or two wicket doors are sufficient for the convenience of workers.

For single gates a U-shaped iron bolt with arms 35 cm long and heavy handles on each end is simple, convenient and durable. For gates divided in two halves, a heavy iron bar enclosing the top of the two halves has proved to be most suitable (Fig. 2-12). These cannot be opened easily by the sheep.

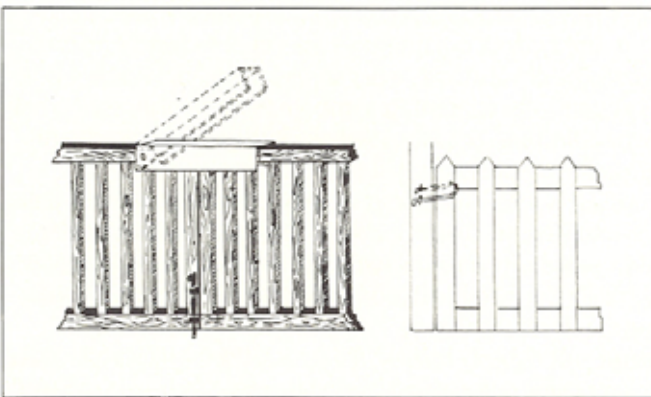


Figure 2-12. Iron bar and bolt for double and single gates. (Source: Becker, 1958)

The partitions in the shed should be separable and movable. Each hurdle should be 1 m high and 4 m long, the latter being the distance between two iron pillars on which the roof rests. One of every three hurdles, which together with the wall form a pen, should include a wicket gate. The hurdles can be connected with one another and with the pillars by chains or cords. In sheds devoid of interior pillars, T-shaped or corner iron stakes are driven into the floor at distances of 4 m to fasten the hurdles, or they may each be furnished with a pedestal at one end (Fig. 2-13). The boards of wooden hurdles should be about 7 cm apart.

A section of the shed is set aside for lambing. This includes a number of movable pens, each 1.5m² large, a water tap, scales, a table, and a small chest for antiseptics, tags, marking fluid and the lambing list. The pens are made of wooden or iron hurdles, hinged together and set in a row along the

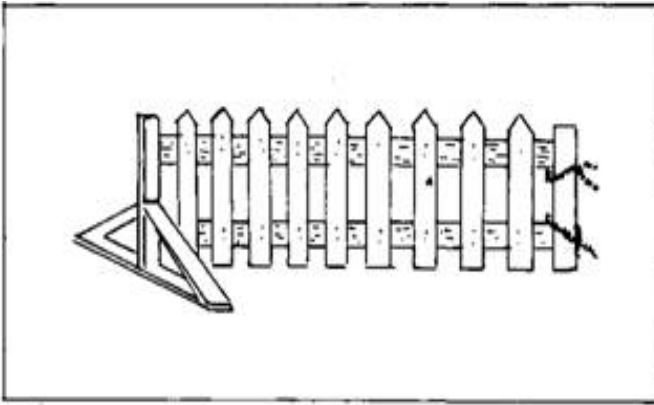


Figure 2-13. Wooden hurdle furnished with a pedestal. (Source: Becker, 1958)

side of the shed, each pen containing a feed rack. Here the ewes give birth and stay with their lambs for a few days until they are properly owned.

In addition to the shed, the complex includes pens for the rams and sick animals, the milking parlour, a place for the milk cooler and milk tank, and a workers' room with shower-bath and toilet.

Since the rams remain at home for a large part of the year, it is advisable to keep them in a shed of their own, either in a corner of the yard or close to it. In the former instance they can use a paddock of the yard as a run when the females are at pasture; otherwise they require a special fold at their shed with a service stand nearby (Fig. 2-14).

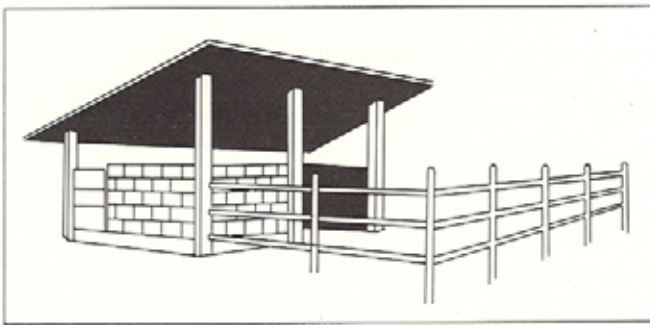


Figure 2-14. Sketch of a ram's shed. (Source: Becker, 1958)

For convenience of treatment or prevention of infection, it is recommended to move sick or wounded animals that cannot go out with the flock to pasture to a sick-bay. This may be made of movable hurdles and located in the shed with a feed rack, water tap and a small run attached to it.

The milking parlour is usually situated in the centre of the yards. It opens toward the shed as well as toward both sides of the yard. In small flocks of up to 400 ewes the parlour is commonly of the row type and in larger flocks of the carousel type (see also pp. 179-181).

Contiguous with the milking parlour is a place for milking utensils, refrigerator and milk tank, and a room for workers. This room consists of solid walls, a concrete floor and windows looking toward the interior of the shed and the outside. It contains clothes pegs, a medicine chest, a chest for the flock lists, a table and chair, and shelves for utensils needed for the treatment of sheep. A corner of the room is reserved for tools, such as forks and shovels.

On farms where there is no danger of predatory animals, the yards along the sides of the sheep shed may be fenced in by horizontal iron pipes, rods or bars or by wooden panels fastened to posts of steel or concrete. However, where such a danger does exist, the yards should be surrounded by 1.8-m-high walls which may be made of concrete blocks or prefabricated concrete plates. To ensure sufficient ventilation of the yards, rows of blocks with the solid side inwards and outwards may alternate with others with the open holes turned in these directions. The 1.8-m-high wall may be substituted by one 1 m high, above which strands of barbed wire, 15 cm distant from one another, extend parallel to the wall to the required height. However, Becker notes that a wall made entirely of blocks or plates is preferable to one composed of blocks and barbed wire, as the wires soon slacken and cease to be an obstacle to beasts of prey.

The yard is divided into paddocks that correspond approximately to those inside the shed so that every pen in the shed is connected with a paddock of its own. Each paddock is furnished with a double gate, 4 m wide, through which the sheep pass on their way to pasture (Fig. 2-15). The posts to which

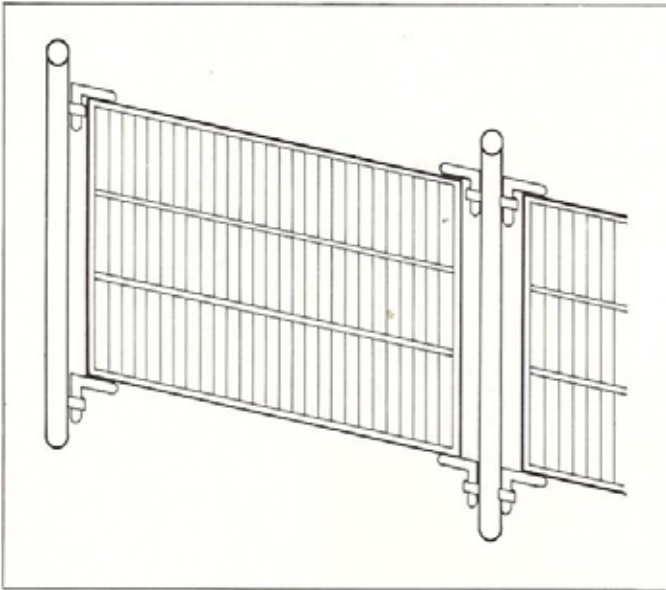


Figure 2-15. Separable yard gate. (Source: Becker, 1958)

the gates are hinged may consist of corner irons or iron pipes and the railings of iron rods 7 cm apart. Between the gates it may be useful to have a 1-m-wide wicket door.

To avoid the development of too large a space between the ground and the gate, which could facilitate the intrusion of predatory animals, it is advisable to build a rounded-off, concrete threshold, 15 cm above ground level at its apex, just below the bottom of the gate and 7-10 cm below it, the threshold to decline from the highest point below the gate toward both the inside of the yard and outside.

The partitions in the yard may be permanent or consist of movable, 1-m-high hurdles. If hurdles are used, permanent posts to which the hurdles can be fastened when required must be set up every 4 m over the entire length of the yard.

To prevent the collection of rain-water in the yard, drains should be suitably placed.

The barn for hay, straw and screenings, off the eastern or western side of the shed, requires a space of 200 m³ for every 100 sheep, while the silo is best situated near the pathway on the northern side of the shed.

The feed racks in common use in the sheds of Awassi dairy flocks are of two types, one elongated and the other six-cornered. Both are made of iron and serve the purpose of feeding concentrates and roughage, including hay, straw and green fodder (Fig. 2-16).

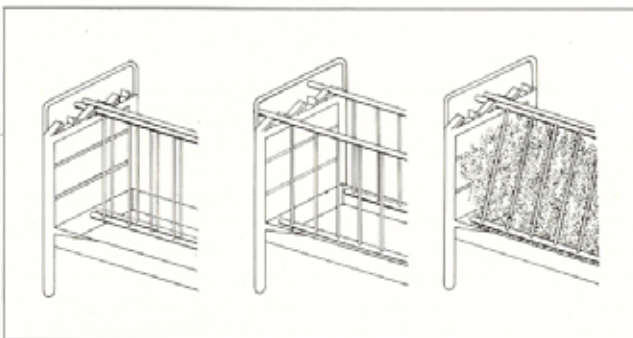


Figure 2-16. Feed rack for Awassi dairy sheep in three positions. (Source: Becker, 1958)

The standard length of the elongated rack is 3 m. Larger racks are too heavy for convenient handling and shorter ones are easily turned over by the sheep. The height of the rack is 80 cm and its width 70 cm. The bars of the railings are 10 cm distant from one another. When feeding concentrates, vegetables, citrus peel, silage or screenings, the railings hang in the centre close to each other. When dry roughage or green fodder is to be introduced in the rack, the railings are placed in the outermost

notches and when the rack is full, they are put back in the central notch. As the rack is being emptied by the feeding sheep, the railings move more and more to the central position. This type of rack permits the sheep to get at the roughage only through the interstices between the iron rungs and not from the top as well, as is the case with an open bunk. A 3-m-long rack of this type can serve 18 Awassi sheep, nine on each side, each sheep occupying a space of about 33 cm.

The six-cornered feed rack has been in use in Awassi dairy sheds for many years, but because of its shortcomings a number flock-masters have lately discarded it (Fig. 2-17). It is easily overturned by the sheep and feed is freely scattered from it; also it has proved dangerous to horned animals which are often caught by their horns between the iron rungs, with the result that some of them have been suffocated. Finally, in modern sheds without interior pillar supports of the roof, it cannot be used for the fastening of movable hurdles, for which the heavy 3-m-long feed rack is eminently serviceable.



Figure 2-17. Six-cornered feed rack

There should be a water trough in every paddock, or one to serve two paddocks. The long side of the trough should form an angle of 90° with the long side of the shed, so that sheep passing from the shed to the yards and from the yards outside or vice versa should not be hindered in their movement by the troughs. Standard troughs in paddocks of Awassi dairy flocks are made of concrete and are 4 m long, 50 cm wide on the inside, 35 cm high and 25 cm deep. Troughs serving two paddocks are 70 cm wide on the inside. To facilitate cleaning of the troughs, the bottom is rounded. The outflow of the water is connected with an underground pipe that carries the water out of the yard. This kind of trough can also serve lambs, but as it may be too high for them, a 10-12 cm high movable platform may be placed for their convenience on the concrete base of the trough.

There should be a 30/70-cm-wide and 15-cm-high concrete box for the salt lick in each paddock. It is usually placed on an iron stand with 35-cm-high legs. On rainy days the salt licks are moved from the paddocks into the shed.

A concrete dipping vat is usually located just outside the yard, more rarely in a corner of it. In the latter instance the vat is covered when not in use so as not to reduce the space allocated to the sheep in the yard. During dipping operations, shed or yard hurdles can serve as fences for the entrance paddock, drain platform and drying yard.

In addition to this equipment, Becker recommends the construction of a small slaughter shed in a corner of the yard nearest the centre of the farm or in a corner of the farmyard nearest the sheep shed. The slaughter shed should have a ground space of 4×4 m, three or four walls, and a roof for protection from sun and rain. The shed should be furnished with a water tap, a drain for blood and water from the floor and a horizontal iron bar at a convenient height with a pulley and hook for hoisting the carcass and hanging it up for skinning and removal of the digestive tract and inner organs. In addition, the slaughter shed should contain a rostrum, 120 cm long, 60 cm wide and 40 cm high, with two 10- to 15-cm-high supports, on which to skin the carcass partly before raising it on to the hook. Further, a table for cutting up the carcass, a wooden block for cutting the bones, and an electric light to be used in forced slaughters at night are recommended. Adjoining the slaughter shed it is convenient to have a roofed place where salt and wooden barrels or boxes can be kept for salting and preserving skins.