4. Milk and milking

Milk

Milk yields of unimproved Awassi sheep. The milk yields of unimproved Awassi ewes have been recorded in a few flocks in Palestine, Lebanon, Syria, Turkey and Iraq under favourable conditions of feeding and management. Hirsch (1933) estimated the annual milk yield of unimproved Awassi ewes in bedouin and fellahin flocks in Palestine at 40 kg, to which about 20 kg consumed by the lamb must be added (Mason, 1967).

In 1928-31 the mean annual milk yields of Awassi flocks in three Jewish communal settlements in Palestine (Aiyelet Hashahar, Tel Yosef and Beyt Alfa) ranged from 45 to 52 kg, exclusive of the milk suckled by the lambs, with only slight annual and local differences. In another flock (in Merhavia), the annual milk yields, recorded in 1932, varied between 30 and 150 kg, with an average of 63.5 kg.

With improved feeding in Jewish settlements, the milk yields of unimproved sheep increased. Thus, four flocks, purchased from Arab breeders, totalling 402 ewes, produced an average of 128 kg of milk annually with a maximum yield of 320 kg, including the milk consumption of the lambs.

In Lebanon, the lactation yields were recorded in the course of six years (1960-65) for two- to seven-year old ewes of an Awassi flock Trom unknown sources' kept at the Terbol Animal Breeding Station on a high level of nutrition (Table 4-1).

TABLE 4-1. **Milk yields of unimproved Awassi ewes on a high level of nutrition in Lebanon**

Lactation	No. of lactations	Mean milk yield (kg)	Maximum milk yield (kg)	Mean length of lactation (days)
1st	78	225	268	217
2nd	117	225	349	183
3rd	128	222	348	200
4th	172	231	397	202
5th	213	*207*	406	*192*
6th	203	*197*	*292*	*179*

Source: Choueiri, Barr & Khalil, 1966

In Syria the average milk yield of well-fed Awassi ewes has been reported to be 168 kg (Khouri, quoted by Mason, 1967). Erokhin (1973) gives an average lactation yield of only 60 kg for Syrian Awassi ewes, but adds that high-yielding animals produce 160-180 kg. At the University of Aleppo School of Agriculture, 60 Awassi yearling and 15 adult ewes acquired from bedouin in various parts of the Syrian desert yielded 108 ±22 kg óf milk on average, with a range of from 30 to 190 kg, in a lactation of 193 ±16 days, in addition to the milk consumed by the lambs in 16 days of full suckling, followed by 42 days during which they had access to their dams only during the day. The milk produced at night during this time was milked in the morning. Throughout the lactation period each

ewe received 400 g of concentrates a day in addition to grazing, and 300 g of cottonseed hulls (Husnaoui & Fox, 1967).

In Turkey average lactation yields ranging from 100 to 185 kg have been recorded in îvesi flocks at several experiment stations. According to Yarkin and Eliçin (1966), the milk yield, apart from the milk consumed by the lambs, for ívesi ewes of all ages averages 103.8 ±4.54 kg (25-180 kg). At the Çukurova state farm, 268 îvesi ewes produced 130 litres on average, including 48 litres consumed by the lambs; record ewes yielded as much as 390 kg (Köseoğlu & Aytuğ, 1961; Yalçin, 1979). An experimental flock at the Aegean University farm had an average lactation yield of 185 ±61.6 kg in the period 1959-63. The record yield of a ewe of this flock was 345 kg (Sönmez & Wassmuth, 1964). At the Ereğli Animal Breeding Research Station in central Anatolia, the lactation yield of ívesi ewes averaged 125 kg in 1966/67 and 134 kg in 1967/68. At the same station îvesi ewes yielded 81.4 kg of saleable milk if their lambs were weaned at 45 days, 72.2 kg with weaning at 60 days, and 54.0 kg at 75 days (Yalçin, Aktas, & Sandikçioglu, 1968). In the Ganziantep district, near the border with Syria, 225 îvesi ewes of three village flocks produced 119.5 kg of milk on average for each lactation (Sidal, 1973). The average lactation yields of 13 different groups of îvesi ewes, reported in 1950-72, ranged from 73.5 to 273.7 kg, with an overall average of 130.3 kg for each lactation for the 2 205 ewes recorded (Lischka, 1976).

Yarkin and Eliçin (1966) claim that the highest annual yield of îvesi ewes is reached at five years, but in a flock of 83 îvesi ewes Aktas, (1970) found that the maximum lactation yield of 149.8 kg was attained at the age of four years. Of the total yield 65.4 percent was obtained in the third month of lactation. After the weaning of the lambs at the age of 75 days, the production of saleable milk came to 61 kg.

In Iraq the Awassi is bred mainly for mutton and not for milk. The milk is usually consumed by the farmers as their main source of animal protein. An Iraqi Awassi flock of 19 ewes, two to five years old, produced 105.9 kg of milk on average in a lactation of 142 days (Eliya & Juma, 1970b). In a test with 31 Awassi ewes of different ages, the milk yield in a lactation of 134 days averaged 115.7 kg. The first lactation yield during the suckling period of 90 days, based on a 12-hour milking interval, was 75.3 kg, and with a four-hour milking interval, 86.1 kg. The largest yield was obtained during the third lactation at the age of four years (Table 4-2).

TABLE 4-2. **Milk yields of Awassi ewes of different ages in Iraq (kg)**

Age (years)	No.	90-day pre-weaning yield	Post-weaning yield	Total lactation yield	Mean length of lactation (days)
2	7	75.3	13.5	88.8	140
3	9	108.1	10.5	118.6	123
4	6	108.9	21.7	130.6	148
5	9	106.7	17.0	123.7	133

Source: Karam *et al.,* 1971

Increase of milk yields in improved Awassi. The relatively large lactation yields of unimproved Awassi ewes maintained on a high plane of nutrition indicate that the improvement of the Awassi in Palestine was based on the favourable genetic potential of the foundation stock. Hence, selection for milk, accompanied by superior feeding and management, led to a speedy increase in average yields and a corresponding increase in the record yields of individual ewes.

The annual mean breeding standard yields (Table 4-4) in milk-recorded Awassi flocks from 1937/ 38 to 1964/65 as well as the annual mean yields of ewes registered in the flock book and the record yield of individual ewes are shown in Table 4-3. The steep increase in yield, figured in the 1955/56 report, resulted from a change in the system of determining the quantity of milk consumed by the lamb (see pp. 184-186). It was found experimentally that the quantity had hitherto been underestimated by about 10 percent and the recording has since been brought into line with the requirements of the Study Commission on Sheep-Breeding of the European Association for Animal Production.

The breeding standard or maximum yield refers to the highest lactation yield of a ewe hitherto attained during her productive life. It may be higher than, or identical with, the recorded yield in a particular year and may increase in subsequent years. In the past, the breeding standard or maximum yield served as the basis for selection in Awassi flocks on the assumption that the maximum lactation yield of a ewe under similar conditions of feeding and maintenance prevailing throughout the flock to

TABLE 4-3. **Numbers and milk yields of Awassi ewes registered in flock book, 1937/38-1964/65**

Year	No. of milk-recorded flocks	No. of milk-recorded ewes	Mean breeding standard yield of milk-recorded ewes (kg)	No. of ewes registered in flock book	Mean annual yield of ewes registered in flock book (kg)	Individual record yield (kg)
1937/38	11	975	131.0	—	—	290
1942/43	14	2 420	181.6	362	279.1	430
1943/44	27	4 337	189.7	785	282.9	490
1944/45	29	4 589	207.6	1 244	290.8	490
1945/46	37	6 093	212.9	1 898	293.3	490
1946/47	38	6 010	227.9	2 298	301.7	610
1947/48	38	6 490	233.4	2 639	308.1	650
1948/49	42	7 866	244.5	2 509	337.7	680
1949/50	57	11 017	233.3	2 942	334.8	680
1950/51	69	13 765	237.7	3 933	333.8	650
1951/52	75	15 178	238.8	4 515	332.3	650
1952/53	88	18 522	239.9	5 636	331.9	650
1953/54	96	19 302	248.3	6 679	335.9	650
1954/55	111	21 849	257.3	8 363	342.9	770
1955/56	109	22 519	280.2	4 589	409.3	890
1956/57	118	24 856	280.6	5 077	412.2	890
1957/58	110	24 281	297.7	6 475	418.1	890
1958/59	108	26 791	309.3	8 306	422.2	1 050
1959/60	97	25 083	328.2	9 690	425.1	1 050
1960/61	100	26 169	345.6	12 368	418.8	1 050
1961/62	86	23 345	347.3	11 577	418.9	1 050
1962/63	77	20 712	353.0	10 991	420.8	1 050
1963/64	52	16 324	346.3	7 732	309.6	800
1964/65	41	13718	355.6	6 494	314.0	900

which she belonged indicated her genetic capability. The average of all maximum or breeding standard yields of a flock expresses its general breeding standard in any particular year. This is not identical with the mean yield of the flock during that year, but it serves a useful purpose for comparison with other flocks. The differences between the maximum or breeding standard yields of flocks and their actual recorded yields are shown in Table 4-4 which refers to the milk-recorded flocks for six different years.

In 1965/66, flock book registration was discontinued and was replaced by the computer recording of all ewes in milk-recorded flocks (Epstein, 1977). (See Table 4-5.)

In 1979/80 the average lactation yield of the ewes of all milk-controlled Awassi flocks was 342 1. One ewe attained an annual yield of 1 463 1 (Fái, 1981).

The improvement in milk production in the course of 30 years is reflected by the number of ewes with yields above 400 kg. In 1942/43 only two ewes, or 0.08 percent of all milk-recorded Awassi sheep, yielded more than 400 kg for each lactation. In 1972/73 such ewes numbered 2 663, or 18.9 percent of all milk-recorded animals. These are grouped in Table 4-6 according to adult, two-year-old and yearling ewes and the type of farm where the flocks were stationed.

In 1953/54 a flock of 204 ewes attained a mean annual yield of 401 kg of milk for the first time. In 1969/70 there were already two flocks with average annual yields of more than 500 kg: one, composed of 780 ewes, with a mean yield of 510 kg, and another with 1 220 ewes of 550 kg of milk. The dry matter of the annual milk yield of these ewes represents approximately 150 percent of their average live weight (Fái, 1972).

In 1971, 86 out of 188 Awassi ewes with maximum milk yields of more than 600 kg for each lactation were stationed in the highest-yielding stud flock of the country ('Eyn Harod) and 69 in the second-best one (Sde Nahum), while the remaining 33 ewes were distributed among 15 other flocks.

In 1973/74 there were five ewes with maximum lactation yields of over 1 000 kg of milk in the 'Eyn Harod flock, with a record yield of 1 282 kg for a two-year-old ewe. As many animals lamb three times

TABLE 4-4. **Average lactation and breeding standard yields in milk-recorded flocks**

Year	No. of milk-recorded ewes	Mean lactation yield (kg)	Breeding standard yield (kg)
1942/43	2 420	169.4	181.6
1951/52	15 178	214.7	238.8
1952/53	18 522	210.1	239.9*
1953/54	19 302	219.5	248.3
1955/56	22 519	255.4	280.2
1958/59	26 791	285.1	309.3

TABLE 4-5. **Numbers and mean yields of milk-recorded Awassi ewes, 1965/66-1973/74**

Year	No. Of milk-recorded flocks	No. Of milk-recorded ewes	Mean annual milk yield (kg)	Individual record yield (kg)
1965/66	43	16 497	331.5	900
1966/67	35	14 080	342.6	1 020
1967/68	32	11 767	359.6	1 010
1968/69	28	11 903	354.0	900
1969/70	35	19 559	331.1	901
1970/71	34	17 682	323.3	978
1971/72	38	16 502	315.3	1 016
1972/73	32	14 939	336.8	1 157
1973/74	26	14 866	335.0	1 282

TABLE 4-6. **Number of ewes with lactation records exceeding 400 kg, 1972/73**

Type of farm	No. of flocks	No. of adult ewes			No. of two-year-old ewes			No.of yearlingewes			Total no. of ewes		
		Total	Yield above 400 kg	% of total	Total	Yield above 400 kg	% of total	Total	Yield above 400 kg	% of total	Total	Yield above 400 kg	% of total
Communal farms	23	7 463	1 835	24.59	2 869	482	16.80	2 068	213	10.30	12 400	2 530	20.40
Experimental farms and schools	6	632	40	6.33	492	54	10.97	204	1	0.49	1 328	95	7.15
Private farms	3	242	33	13.64	65	5	7.69	53	—	—	360	38	10.56
Total	32	8 337	1 908	22.88	3 426	541	15.79	2 325	214	9.20	14 088	2 663	18.90

in the course of two years, the number of ewes with annual milk yields exceeding 1 000 kg was ten. The high quality of these ewes is illustrated by the consecutive lactation yields of three of them: 1) 1 005, 906 and 1 233 kg; 2) 630,954,1 075 and 1 011 kg; 3) 720,788,978,1 016, 688 and 599 kg. In the course of five years, from 1968/69 to 1973/74, the mean milk yields of the stud flock at 'Eyn Harod increased by approximately 60 kg for each lactation (Table 4-7).

TABLE 4-7. **Mean lactation yields of the 'Eyn Harod flock (kg)**

Age of ewes	1968/69	1973/74
1 year	378	444
2 years (1st lambing)	471	531
2 years (2nd lambing)	473	533

TABLE 4-8. **Lactation yields of Awassi ewes in Cyprus (kg)**

Lactation	1969/70	1970/71	1971/72
1st	236 (25)	188 (18)	134 (8)
2nd	281 (30)	257 (19)	211 (10)
3rd and above	__	235 (26)	210 (31)

Note. Number of records in brackets.
Source: Cyprus ARI, 1972; 1973

Milk yields of improved Awassi sheep in Cyprus, Iran, Spain and Yugoslavia.
Cyprus. In Cyprus, improved Awassi ewes imported from Israel or descended from imported Israeli stock had the average completed lactation yields given in Table 4-8 in 1969/70, 1970/71 and 1971/72 (see also Table 4-78).

Iran. In 1965 and 1966, 42 male and 203 female Awassi lambs were imported into Iran from improved flocks in Israel for pure-breeding and also for cross-breeding with local Baluchi and Shal sheep. Table 4-9 gives the lactation yields for the imported ewes and their descendents in Iran for 1967-70 (Wallach & Eyal, 1974). In 1968-70 the average peak daily milk yields of two-year-old and adult ewes were as shown in Table 4-10.

TABLE 4-9. **Average lactation yields of Awassi ewes in Iran (kg)**

Year	Age					
	1 year		2 years		3 years and older	
1967	181	(7)	313	(35)	–	
1968	136	(10)	230	(49)	260	(43)
1969	240	(7)	289	(11)	332	(67)
1970	237	(71)	269	(34)	285	(54)
Total	222.5	(95)	267.8	(129)	297.6	(164)

Note. Number of records in brackets

TABLE 4-10. **Average peak milk production per day of Awassi ewes in Iran (kg)**

Year	Age			
	2 years		3 years and older	
1968	–		2.18	(43)
1969	1.85	(12)	2.42	(70)
1970	2.00	(33)	2.25	(51)
Total	1.96	(45)	2.30	(164)

Note. Number of records in brackets

A report on the development of sheep farming in the Qazvin area of Iran gives the data on the minimum and maximum lactation yields of two-year-old and older Awassi ewes in 1967-69 (Table 4-11).

Spain. In 1971-79, 354 male Awassi lambs were imported into Spain from a single stud in Israel. In 1971, 150 female Awassi lambs were imported from four different flocks, and in 1975 another 111 female lambs from the same stud that supplied the males.

Of the 150 female lambs imported in 1971, 120 were pregnant and lambed as yearlings. Their mean milk yields and length of first lactation in Spain and those of their contemporary flock-mates in Israel were as given in Table 4-12.

Grouping according to graduated lactation yields shows the percentages of the yearlings in Spain (Carasso, personal communication, 1979) (Table 4-13).

The maximum lactation yields in Spain of yearlings from each of the four flocks of Israeli origin and their mean were as given in Tables 4-14 and 4-15.

TABLE 4-11. **Minimum and maximum lactation yields of Awassi ewes in Iran (kg)**

Year	2 years		Adult	
	Minimum	Maximum	Minimum	Maximum
1967	179	442	_	_
1968	55	358	120	411
1969	199	394	139	593

Source: QDA, 1970

TABLE 4-13. **Graduated lactation yields showing percentages of yearlings in Spain**

Lactation yield (kg)	Yearling ewes (%)
Up to 150	4.5
151-200	17.1
201-250	20.7
251-300	28.0
301-350	21.6
351 -400	3.6
401-450	2.7
451-500	0.9
above 500	0.9
Total	100.0

TABLE 4-12. **Mean milk yields and lactation lengths of Awassi yearlings in Spain and of their contemporary flock mates in Israel**

Country	No. of yearlings	No. of lambings	Mean age at lambing (days)	Mean lactation yield (kg)	Mean length of lactation (days)
Spain	150	120	473	308	192
Israel	263	146	471	168	149

Source: Carasso, 1974

TABLE 4-14. **Maximum lactation yields in Spain of Awassi yearlings derived from four flocks in Israel**

Flock	Maximum milk yield (kg)	Length of lactation (days)
I	620	237
II	499	221
III	546	220
IV	454	206
Mean	530	221

Source: Carasso, 1974

TABLE 4-16. **Length of lactation of improved Awassi**

25-day intervals (days)	Lactations in each group	
	Number	%
112-127	7	0.4
128-152	87	5.1
153-177	222	12.9
178-202	581	33.8
203-227	488	28.4
228-252	308	17.9
253-277	23	1.4
278-295	2	0.1
Total	1 718	100.0

TABLE 4-15. **Average milk yields of improved Awassi ewes at different ages in Spain**

Age	Year	Annual lambings	No. of ewes	Length of lactation (days)	Milk yield (kg)
Yearling	1972/73	1	9	180	305
	1973/74		97	191	278
	1974/75		27	181	261
2-year-old	1972/73	1	139	246	384
	1973/74		49	219	340
	1974/75		41	197	275
	1972/73	2nd	3	199	326
	1973/74		3	210	346
	1974/75		–	–	–
Adult	1973/74	1	107	214	307
		2nd	28	194	288
	1974/75	1	72	205	283
		2nd	2	150	154

Yugoslavia. On a state farm in the socialist sector of Macedonia, Yugoslavia, Awassi ewes imported from Israel in 1969/70 at the age of eight to ten months on average produced 235 1 (124.9-420.0 1) of milk with a fat content of 6.8 percent (6.1-7.5 percent) in 209 first lactations of 136.5 days (41-230), shortened for managerial reasons. Of the total production, 150.1 1 were milked and 84.9 1 suckled. The average monthly percentages of the lactation yield were 24.1, 25.6, 22.0, 20.1 and 8.2, respectively. The average daily yield was 1.7 1 and the maximum yield 3.1 1. In summer the ewes were pastured and received an additional ration of concentrates; in winter they subsisted on hay, straw, silage and concentrates. As compared with the Awassi ewes' lactation yield of 150.1 1 of saleable milk, local Pramenka ewes under the same conditions produced only 25 1 in addition to the milk consumed by the lambs (Todorovski, Ristevski & Popovski, 1973a, 1973e).

On a farm in the private sector of Macedonia, five Awassi ewes on average produced 224.6 1 of saleable milk with 7.37 percent fat in the second, third and fourth months of lactation in 1974. On the basis of this yield, Todorovski, Tanic and Stojanovski (1975) estimated their total lactation yield at 421 1, a quantity amounting to seven times the average yield of local Pramenka ewes.

Another farmer in the private sector of Macedonia acquired seven Awassi ewes and one ram in 1974. The sheep were kept on mediocre pasture, hay and concentrates. The breeding aim was not to attain high milk yields but to enlarge the flock quickly. With three lambings in two years, and in some instances two in one year, the flock increased to 70 animals in 1977. In this year the milk of nine ewes was tested in the second, third, fourth and fifth months according to international rules for milk recording. For technical reasons the tests could not be performed during the first and the last months of lactation. The milk yields on the monthly test days were 2.525, 1.492, 1.537 and 1.0851, respectively, giving a total yield of 199.17 1 with 7.73 percent fat in the four months of testing. On the basis of this yield, the production of the ewes during the full lactation period was estimated at 304.8 1 on average (Todorovski, Ristevski & Popovski, 1979). This figure compares with a lactation yield of 72.5 1 with 5.4 percent fat for Macedonian Ovce Polje (Pramenka) ewes (Taskovski, 1962), and 57.2 1 with 6.4 percent fat for Sar Planina (Pramenka) ewes (Todorovski, 1972).

Length and course of lactation period. Average lactation lengths in Awassi flocks throughout the range of the breed vary between 130 and 220 days. In Syria, 15 adult and 60 yearling Awassi ewes had an average lactation period of 193 ±16 days, ranging from 116 to 262 days (Husnaoui & Fox, 1967).

In the Ganziantep district, 225 ívesi ewes belonging to three village flocks had an average lactation length of 199 days (Sidal, 1973). In an experimental flock of 268 ívesi ewes at the Çukurova stock farm in Turkey, the average lactation length was 159 ±1.82 days (Köseoglu and Aytug, 1961), and at the Ereğli Animal Breeding Research Station 185 days in 1966/67 and 212 days in 1967/68 (Yalçin and Akta§, 1969). In another experimental flock of Ívesi sheep at Izmir, Sönmez and Wassmuth (1964) recorded an average length of 189.7 ±20.7 days in 162 lactations in 1959-63. While the correlation between length of lactation and milk yield was positive, it was not high enough to warrant selection for milk on the basis of lactation length alone, especially since the length of lactation was greatly influenced by environmental factors, particularly by the date of lambing. Early lambing Awassi ewes had considerably longer lactation periods than those lambing late in the season. Yet in an analysis of 1 030 lactation records in the Çukurova ívesi flock, Özcan and Kaymaz (1968) found that while the total milk yield was significantly correlated with lactation length, the date of lambing had no significant effect on milk production.

In a trial with 19 Awassi ewes from four age groups kept on a high plane of nutrition at the Abu-Ghraib Experiment Station in Iraq, an average lactation length of 142.0 days, ranging from 119to 171 days, was recorded. The length of lactation increased from 133.2 days in two-year-old ewes to 157.3 days at four years and fell to 141.6 days in five-year-old animals (Eliya & Juma, 1970b). As the number of ewes in each group was very small (four to five), the usual positive correlation between milk yield and length of lactation in Awassi sheep could not be established.

In a similar test with 31 Awassi ewes conducted at Abu-Ghraib, the length of the lactation period also rose from the second to the fourth year of age of the ewes and decreased in the fifth year. The average lactation period was 134.9 days, varying between 94 and 157 days (Karam *et al.*, 1971). The duration of lactation had a highly significant effect on the total milk yield. The daily milk yield, based on a 12-hour milking interval, gradually declined after the second week of lactation (Fig. 4-1).

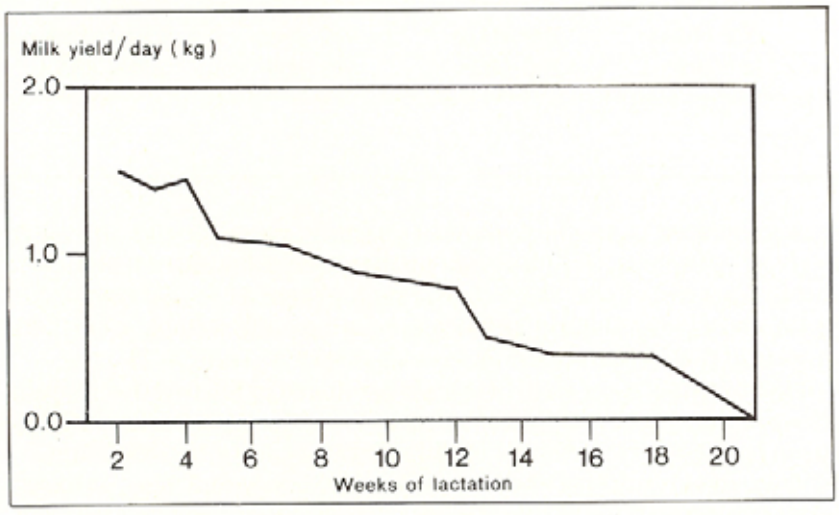

Figure 4-1. Average daily milk yields of Awassi ewes in Iraq in the course of the lactation period. (**Source:** Karam *et al.*, 1971)

Awassi ewes lambing late in the season, in February or March, often have their lactation cut short by a reduced lambing interval. Vice versa, early lambing lengthens the period of lactation. In addition, since a significant correlation exists between the length of lactation and the annual milk yield of the Awassi, the breeding season in the improved type has come to begin one or two months earlier than that of the unimproved type.

Improved Awassi ewes are usually dried off when their daily milk yield drops to below 200 g. Milking is continued a little longer in only a few flocks in view of the very high fat content of the milk toward the end of the lactation period.

To ascertain the average length of lactation in the improved Awassi, Finci (1957) examined 1 718 completed lactations of 235 ewes, representing all age groups up to nearly 11 years. The average lactation period amounted to 200.8 days. Grouped according to 25-day intervals, the numbers and percentages of lactations are set out in Table 4-16.

The first lactation period of two-year-old ewes is the shortest (182.4 days). From then on it rises to the fifth lactation, which exceeds the first by 15 percent (27.4 days). Thereafter it decreases again,

though only slightly, the length of the seventh, eighth and ninth lactations being still approximately 12 percent longer than that of the first.

Finci (1957) also examined the course of 493 lactations at intervals of 30 days in ewes from three different flocks (Table 4-17). In Cyprus the lengths of first, second and subsequent lactations were recorded in Awassi ewes of improved dairy type derived from Israel (Table 4-18).

In Iran, the lactation lengths of three age groups of improved Awassi dairy ewes, imported as lambs from Israel or descended from imported stock, were recorded in 1967-70 (Table 4-19).

TABLE 4-17. **Course of lactation of improved Awassi**

Days after lambing	Milk yield	
	Kg	%
1-30	70.7	19.9
31-60	68.6	19.3
61-90	64.2	18.1
91-120	55.5	15.7
121-150	43.3	12.2
151-180	30.4	8.6
181-210	21.9	6.2
Total	354.6	100.0

TABLE 4-18. **Average lactation lengths of improved Awassi dairy ewes in Cyprus (days)**

Lactation	1969-71	1971/72	Total
1st	176 (43)	121 (8)	148.5 (51)
2nd	192 (49)	192 (10)	192.0 (59)
3rd and above	192 (26)	180 (31)	186.0 (57)

Note. Number of records in brackets.
Source: Cyprus ARI, 1973

TABLE 4-19. **Average length of lactation of improved Awassi dairy ewes in Iran (days)**

Age of ewes	1967	1968	1969	1970	Total
Yearling	180 (7)	163 (10)	203 (7)	227 (70)	214.9 (94)
2 years	227 (35)	202 (49)	239 (11)	230 (34)	219.3 (129)
Adult	—	201 (43)	240 (66)	209 (48)	219.8 (157)

Note. Number of records in brackets.
Source: Wallach & Eyal, 1974

In Spain the average lengths of completed lactation periods of yearling, two-year-old and adult ewes imported from Israel were as given in Table 4-20. In Yugoslavia the average length of lactation of 210 Awassi yearling ewes imported from Israel was 136.5 days, ranging from 41 to 230 days. The lactation was shortened to prepare the ewes for lambing at an earlier, economically suitable time. The percentages of the monthly milk yields in the lactation period were as shown in Table 4-21.

The fact that over 80 percent of the total lactation yield of ewes is produced in the first five months —in addition to the desirable increase in the number of lambs — accounts for the endeavour of many flock-masters, noted in recent years in Israel, to obtain three lambings in two years or two lambings in one year instead of one lambing a year. In two trials to obtain two crops of lambs in a year, Awassi ewes that became pregnant soon after lambing without hormone application yielded only 6-7 percent less milk for each lactation than the ewes that did not conceive within 100 days after lambing (Morag & Eyal, 1971) (see also p. 96, and Table 4-15).

In one of these trials, 83 ewes that had lambed during the first fortnight of September were joined by rams immediately after parturition for a period of 100 days. The ewes were milked twice a day and, concurrently with milking, suckled their lambs during the night, until they were weaned at 40 days. Seventy-four of the 83 ewes conceived in the course of 100 days, while nine did not. The mean milk yields and lengths of lactation of the two groups were as given in Table 4-22.

In a highly improved Awassi flock in Israel, three pregnancies in two years reduced the average lactation length and yield as compared with one lambing a year, but increased the total annual milk yield. In 107 instances of one full lactation a year followed by two successive lactations shortened by early pregnancies, the average lactation lengths and yields, recorded in 1969-74, were as given in Table 4-23.

The weekly rate of milk yielded during the first eight weeks after lambing varies with the age of the ewe. Doron (1954b) recorded the total weekly production, including the milk yielded to the pail

TABLE 4-20. **Average length of lactation of improved Awassi dairy ewes in Spain**

Age of ewes	Number of ewes	Lactation (days)
Yearling	51	189.7
2 years	158	229.1
Adult	104	209.0

TABLE 4-21. **Monthly milk yields of improved Awassi dairy ewes in Yugoslavia** (**% of total milk yield)**

Month of lactation	% of total milk yield
1	24.1
2	25.6
3	22.0
4	20.1
5	8.2

Source: Todorovski, Ristevski & Popovski, 1973a

TABLE 4-22. **Mean milk yields and lactation lengths for Awassi ewes**

Group	Milk yield (kg)			Length of lactation (days)		
	1st lactation	2nd lactation	Total	1st lactation	2nd lactation	Total
A	249±7.6	220±7.1	469±10.7	151±2.6	144±3.1	295±5.1
B	264±20.4	—	—	164 ±13.1	—	—

Note. A - those that conceived within 100 days of lambing.
B - those that did not conceive during this time.

Source: Morag & Eyal, 1971

TABLE 4-23. **Average lactation lengths and yields after a single yearly lambing followed by two lambings in short succession**

Lactation sequence	Lactation length		Lactation yield	
	Days	% of preceding full lactation	Kg	% of preceding full lactation
Preceding full lactation	258.4	100.0	556.7	100.0
1st shortened lactation	156.2	60.4	425.0	76.3
2nd shortened lactation	160.2	62.0	339.2	60.9

TABLE 4-24. **Milk yields of Awassi ewes in the first eight weeks after lambing** (**% of 1 st week's yields)**

Age of ewes	No. of ewes	Week							
		1	2	3	4	5	6	7	8
2 years (1st lambing)	12	100	124	142	136	154	154	152	136
3 years (2nd lambing)	8	100	119	128	117	130	134	132	122
Over 5 years	18	100	103	111	119	121	126	126	109

and the residue suckled by the lambs, at the Acre Experiment Farm in the two seasons of 1952 and 1953. The yields, expressed as percentages of the first week's record, were as given in Table 4-24.

The height of production, at every age, is reached in the sixth week, after which weekly yields decrease. Doron (1954b) concluded from the records that young ewes, lambing for the first and second time, increase their yields more speedily and sharply than older ewes. This, of course, may also be expressed the other way round, namely that older ewes attain a relatively high rate of production soon after lambing.

After the second month of lactation the milk yield of Awassi ewes decreases rapidly. In a test of 350 two- to seven-year-old ewes in 1953-58 and of 145 ewes of the same age groups in 1959/60, Goot (1966) established that the daily yield of milk falls in the third month to about 80 percent and in the fourth month to 52 percent of the mean yields of the first two months. (See Table 4-25 and Fig. 4-2.)

The treatment of lactating ewes with progesterone and PMS causes a serious depression in milk

yield. This is attributed to the inhibitory effect of progesterone on lactation and to the promotive effect of PMS on follicle development, releasing oestrogen which is also an inhibitor of milk secretion. Hence, these hormones are but rarely applied to adult ewes in Awassi dairy flocks. In a trial to obtain two lambings a year in Awassi ewes, hormone treatment from the twelfth to the eighteenth day after lambing reduced the milk yield by 17 percent in those ewes that conceived, and by 26 percent in those that did not conceive (see p. 96, and Tables 4-22 and 4-23) (Morag & Eyal, 1971).

In an Awassi flock at the Ereğli Animal Breeding Research Station in Turkey, the weaning of İvesi lambs at 45,60 or 75 days had no effect on lactation length (Yalçin and Akta§, 1969). However, shorter suckling regimes did influence the length of lactation of Israeli Awassi ewes in Cyprus, where the lactation lengths under three different suckling regimes—the removal of lambs immediately after birth, weaning at two days and weaning at 35 days — were recorded (Table 4-26).

TABLE 4-25. **Average daily milk yields of Awassi ewes in different months of location**

Years	1953-58	1959/60
No. of ewes	350	145
Lactation month	Milk (kg/day)	
1	1.71	1.44
2	1.60	1.42
3	1.28	1.23
4	0.86	0.74
5	0.58	0.52
6	0.37	0.33
7	0.27	0.25
8	0.09	–

Source: Goot, 1966

TABLE 4-26. **Length of lactation of improved Awassi ewes in Cyprus under three suckling regimes**

Suckling period (days)	0	2	35
Length of lactation (days)	169	187	209

Source: Cyprus ARI, 1973

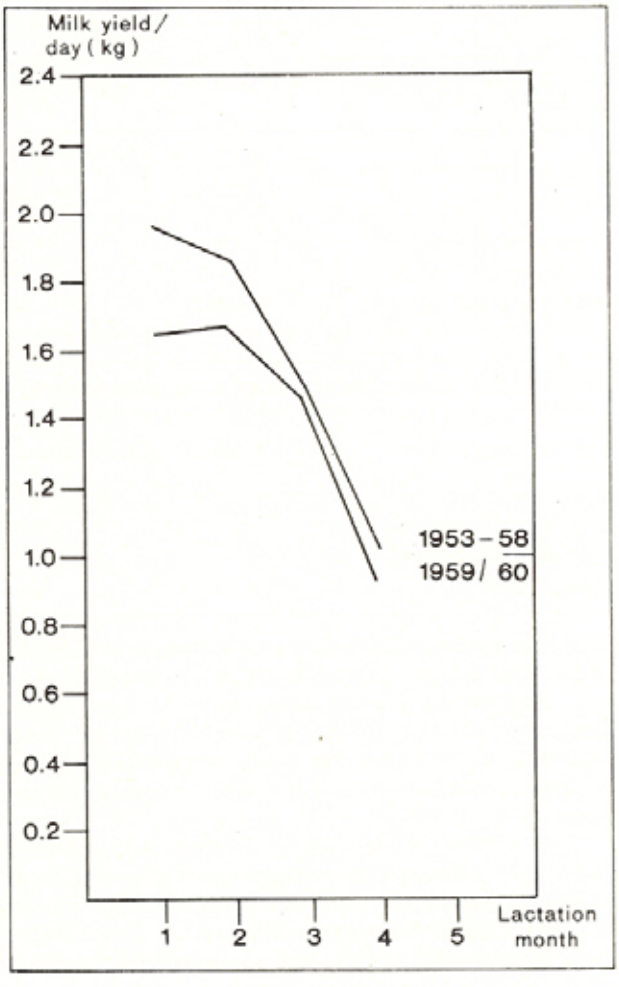

Figure 4-2. Average daily milk yields of 2-and 3-year-old Awassi ewes during first 4 months of lactation period. (**Source:** Goot, 1966)

Maximum daily milk yields. In Syria the maximum 24-hour milk production of a ewe with the highest lactation yield in the desert-bred Awassi flock acquired by the University of Aleppo School of Agriculture was 1.89 kg (Husnaoui & Fox, 1967).

In an İvesi flock at the Faculty of Agriculture of the Ege University Izmir in Turkey, the average peak milk yield in a day was 1.77 kg (Sönmez & Wassmuth, 1964).

In Israel, until 1955/56, the maximum milk yield of improved Awassi ewes in 24 hours was 4.5 kg; of 989 ewes belonging to four highly improved flocks only 24 (or 2.4 percent) exceeded a yield of 4 kg in 24 hours. In 1955/56, several ewes attained maximum yields of up to 6 kg a day (Finci, 1957). In 1973/74 and 1974/75, an improved flock (I) with an average lactation yield of 310 kg for ewes of all ages, and another flock (II) with an average yield of 427 kg, recorded in 1973/74, included the numbers of ewes with maximum yields of 4 kg and more in 24 hours given in Table 4-27.

TABLE 4-27. **Numbers of ewes with maximum milk yields of 4 kg/day and more in two Awassi flocks**

	Flock age	No. of lactations	Maximum milk yield/day (kg)							
			4.0-4.9		5.0-5.9		6.0-6.9		7.0 and more	
			No.	%	No.	%	No.	%	No.	%
I	Yearling	138	—	—	—	—	—	—	—	—
	2-year-old 1st lambing	93	—	—	—	—	—	—	—	—
	2-year-old 2nd lambing	128	2	1.56	—	—	—	—	—	—
	Adult	658	32	4.86	1	0.15	—	—	—	—
	Total/Average	1 017	34	3.34	1	0.10	—	—	—	—
II	Yearling	473	59	12.47	3	0.63	—	—	—	—
	2-year-old 1st lambing	121	39	32.23	13	10.74	2	1.65	—	—
	2-year-old 2nd lambing	225	78	34.67	20	8.89	2	0.89	—	—
	Adult	853	294	34.47	89	10.43	12	1.41	2	0.23
	Total/Average	1 672	471	28.17	125	7.48	16	0.96	2	0.12

Seventy-five and a half percent of the total 2 689 maximum milk yields of 4.0 kg and more a day were attained at the first milk recording of the lactation period, 18.6 percent at the second, 4.4 percent at the third, and 1.5 percent at the fourth recording.

In 1977 a two-year-old stud ewe in her second lactation produced a record yield of 8.0 kg of milk in 24 hours in the second month of recording. As the breeder doubted the exactness of this record, the ewe's milk was again weighed the following day when the yield was 7.8 kg.

From a comparison of the correlation coefficient between the total lactation yield and the daily maximum yield with the correlation coefficient between lactation yield and length of lactation, Finci (1957) arrived at the conclusion that the maximum yield in 24 hours provided the basis for a more precise estimate of the milking capacity of an improved Awassi ewe than did the length of the lactation period.

Lifetime milk yields. The total milk production in the lifetime of Awassi ewes has continuously increased in Israel in the course of improvement of the breed. Over 20 years ago, Finci (1957) recorded the life performance of 739 ewes with six to ten completed lactations chosen at random from 11 flocks and registered in the flock book (see Chapter 7). At the beginning of their first lactation the ewes had reached the age of two; at the time of investigation they were 7-11 years old. (See Table 4-28.) Finci also recorded the lifetime yields of eight selected ewes, 5-12 years old with 4-11 lactations, their average annual performance and their record daily and annual yields (Table 4-29).

In an Awassi flock with high milk yields, a total of 151 ewes were culled in 1974 after completion of one to ten lactations, with an average of 4.22 lactations at culling. The mean and maximum lifetime yields of these ewes, arranged according to number of lactations prior to culling, were as given in Table 4-30. The maximum lifetime yield of 728 kg in one lactation was attained by a ewe that had lambed at two years; that of a yearling ewe was 675 kg.

TABLE 4-28. **Average life performance of Awassi ewes**

Age of ewes (years)	No. of lactations	No. of ewes	Lifetime milk yield (kg)	Average annual milk yield (kg)
7	6	213	1 623	271
8	7	225	1 732	247
9	8	174	1 961	245
10	9	90	2 184	243
11	10	37	2 227	223

TABLE 4-29. **Lifetime, average and maximum lactation yields of eight selected ewes**

No. of lactations	Total lifetime milk yield (kg)	Average lactation yield (kg)	Maximum lactation yield	
			per day (kg)	per year (kg)
4	2 245	561	4.9	810
5	2 246	449	3.8	591
6	3 157	526	5.5	888
7	2 957	422	3.4	544
8	3 283	410	3.1	481
9	3 459	384	3.5	564
10	3 085	309	3.2	472
11	3 140	285	2.7	450

Source: Finci, 1957

TABLE 4-30. **Mean and maximum lifetime milk yields of Awassi ewes culled from a high-yielding flock at the end of their productive lives**

No. of lactations	No. of of ewes	Average lifetime milk yield (kg)	Average lactation yield (kg)	Maximum lifetime milk yield (kg)
10	1	4 494.0	449.4	4 494.0
9	5	3 943.8	438.2	4 981.0
8	6	4111.2	513.9	4 822.0
7	8	3 542.7	506.1	3 992.0
6	23	2 920.8	486.8	4 000.0
5	19	2 510.0	502.0	3 219.0
4	28	2 040.0	510.0	2 888.0
3	25	1 436.1	478.7	2 158.0
2	23	943.8	471.9	1 560.0
1	13	504.0	504.0	728.0
Total	151	2 075.1	491.2	3 284.2

TABLE 4-31. **Influence of age on milk yields**

Age of ewes (years)	Lactation	Mean lactation yields		
		Kg	% of first lactation yield	% of total lactation yields
2	1	223.8	100.0	8.7
3	2	275.6	123.1	10.8
4	3	307.7	137.5	12.0
5	4	328.1	146.6	12.8
6	5	317.0	141.7	12.4
7	6	309.1	138.1	12.1
8	7	281.6	125.8	11.0
9	8	260.0	116.2	10.2
10	9	256.2	114.5	10.0

Influence of age on milk production. The influence on annual milk yields of the age of Awassi ewes was investigated by Finci (1957) in two highly improved flocks. Ewes with seven to nine consecutive lactations were classed in nine groups comprising a total of 1 718 lactations, each age group up to the seventh lactation including over 200, the eighth 124, and the ninth 61 lactations. (See Table 4-31.)

The data show an increase in milk yields from the first to the fourth lactation and a gradual decline occurring up to the ninth. However, the older animals, probably owing to an earlier culling of the poorer milkers, still yielded more on average than the two-year-old ewes at their first lactation.

In an experimental flock of improved Awassi sheep, Goot (1966) recorded average lactation yields in 1953-62 (Table 4-32). These show an increase up to the third lactation and a gradual decrease thereafter. In contrast with Finci's records, the older ewes did not reach the yields of the two-year-olds.

In 1973/74, computer records of 2 669 lactation yields in one of the two highly improved flocks investigated by Finci (1957) (Table 4-31) — the other one having meanwhile been crossed with East Friesian—showed a rise in yields from the first lactation of yearling ewes to the third lactation and a decline in subsequent yields. Since the computer records do not go back further than the year 1969/70, the data comprise only a small number of ewes with more than six completed lactations, the records of which were obtained directly from the flock-master. In the course of the two decades since Finci's study, the lambing of yearling ewes was introduced in Awassi flocks in Israel. The first-lambing ewes

TABLE 4-32. **Lactation yields of Awassi ewes in an experimental flock**

Age of ewes	No. of ewes	Average lactation yield (kg)
2-tooth	109	198.9
4-tooth	96	230.2
6-tooth	78	230.7
Full mouth	67	221.5
5½ years	52	197.0
6½ years	39	177.5
Total/Average	441	212.7

TABLE 4-33. **Average lactation yields in a highly improved Awassi flock**

Lactation	No. of - lactations	Average complete lactation yields	
		Kg	% of first lactation yield of yearling ewes
1 Yearling ewes	115	444.00	100.0
2-year-old ewes	208	476.43	107.3
2	742	539.29	121.5
3	580	564.56	127.2
4	444	532.60	120.0
5	295	489.48	110.2
6	171	448.30	101.0
7	69	433.13	97.6
8	33	421.61	95.0
9	10	394.80	88.9
10	2	495.00	111.5

have therefore been separated into yearlings, having lambed before the end of their second year of life, and two-year-old ewes with later lambings. Records of shortened lactations owing to two lambings in a year have been excluded to prevent a distortion of the typical sequence. (See Table 4-33.)

Finci (1957) noted that an Awassi ewe's milking potential may be estimated from her first lactation yield at the age of two. An age correction factor of 1.47 will indicate her probable milk yield at the fourth lactation, which, on average, is the highest one and as such may be used as a basis for selection. Ewes with high first lactation yields usually retain their high milking capacity up to the seventh lactation; even the few available eighth and ninth lactation yields, although considerably lower than earlier ones, still show positive correlation coefficients with the first lactation yield. More recent records indicate a markedly smaller age correction factor than that claimed by Finci for an earlier period.

Body size and milk yield. Taller ewes on average produce more milk than shorter ones. Finci (1957) found that the correlation coefficient between height at withers and the maximum (breeding standard) milk yield of Awassi ewes was significant only at the 5-percent level, whereas that between withers height and the fourth lactation yield was significant at the 1-percent level. In Cyprus Fat-tailed sheep the correlation coefficient between height at withers and milk production was also only slightly significant (Finci, 1938).

The correlation between the body weight of Awassi ewes, recorded in November and December in the course of several years, and the maximum lactation yield was low but still significant at the 1 -percent level, while that between weight and the fourth lactation yield was of an insignificant value (Finci, 1957). Goot (1966), in 1960-61, could not find any correlation between the body weight, taken three days after lambing, of 81, 2- to 7½-year-old improved Awassi ewes of an experimental flock and their yields of marketable milk. This is attributed to the variable nutritional and physiological conditions in the course of the year and in different years.

Yet the fact that breeding for milk in the improved Awassi for more than four decades has led to a very large increase in the body weight of ewes, that is, from about 40 kg to 60-80 kg, indicates that higher milk yields require a larger body, more especially larger heart, lungs and udder and a larger capacity of the digestive organs, capable of coping with larger quantities of feed. The larger body of improved Awassi ewes, acompanying increased milk yields, is also indicated by higher birth weights as compared with those of the unimproved type (see Fig. 3-16, p. 110).

Fat content of Awassi milk. The milk of unimproved Awassi ewes contains 7.5 percent fat on average (Mason, 1967). In Anatolia in 1966-68, the milk of an İvesi flock at the Ereğli Animal Breeding Research Station contained 7.0 percent fat, while the total average fat production for a lactation was

9.4 kg (Yalçin and Aktaş, 1969). Eliçin (1964, quoted by Eliya & Juma, 1970b) recorded a smaller fat percentage in İvesi milk in Turkey, namely 6.13 percent.

At the Abu-Ghraib Experiment Station in Iraq, Nejim (1963) tested the fat percentage of the milk of a flock of Awassi ewes at weekly intervals in the last three months of the lactation period of 1960/61 (Table 4-34). During these months the average fat content was 7.7 percent, ranging from 5.3 to 10.0 percent in the different test weeks. In 1961/62 the fat content of the milk of the same flock was tested during the whole lactation of 5½ months. The average was 6.88 percent, ranging from 4.6 to 11.8 percent in the 21 test days of the period.

Eliya and Juma (1970b) recorded considerably smaller fat percentages of the milk of two- to five-year-old Awassi ewes in Iraq (Table 4-35). The effect of a ewe's age on lactation yield, which ranged from 102.5 to 109.0 kg, was not found to be significant, but this may be because of the small number of ewes in the test.

In Palestine, during the period 1928/29-1930/31 when the local Awassi breed was still on the threshold of improvement, the fat content of the milk of two flocks belonging to communal settlements ranged from 6 percent to 8 percent (Hirsch, 1933). For the next 20 years it remained nearly at the same level, although a slight falling off was already noticeable with the steadily increasing milk yields of the ewes. Since then, however, breeders of the Awassi in Israel in the selection of breeding stock have paid all their attention to the quantity of milk and have neglected fat content. As a result, the latter markedly decreased with increasing milk yields; yet the total fat output for each lactation has become larger because the effect of the increased quantity of milk on total fat production has outweighed the reduction in percentage.

The fat percentage of 1 740 samples of mixed morning and evening milk (mean = 7.54 percent) tested at a central collecting station in 1942/43 showed the range given in Table 4-36.

Finci (1957) reported that in 1950/51 the milk from 612 milk-recorded ewes had a fat content of 6.98 percent. In 1953/54 the milk of 498 ewes, which had been selected from 11 flocks for the

TABLE 4-34. **Average monthly fat percentages of Awassi milk in Iraq**

Month	1960/61		1961/62	
	No. of ewes	Fat	No. of ewes	Fat
December	0	0	8	6.0
January	0	0	10	8.3
February	0	0	172	6.1
March	0	0	182	5.5
April	240	7.1	80	7.3
May	218	7.8	24	7.2
June	96	8.0	14	6.4
July	40	7.5	0	0

TABLE 4-35. **Fat percentage of the milk of Iraqi Awassi ewes at different ages**

Age of ewes (years)	Number of ewes	Milk yield (kg)	Fat (%)
2	5	102.5	4.92
3	5	109.0	5.45
4	4	103.0	5.52
5	5	108.3	5.56
Total/Average	19	105.9	5.41

TABLE 4-36. **Butterfat percentages in 1 740 samples of Awassi milk**

Fat content (%)		Samples		
		Number	%	
Below 5		6	0.4	
5.0-5.9		51	2.9	
6.0-6.9		378	21.7	
7.0-7.4	7.0-7.9	366	21.0	48.1
7.5-7.9		471	27.1	
8.0-8.9		411	23.6	
9.0-10.0		54	3.1	
above 10		3	0.2	

Source: Kern, 1953

TABLE 4-37. **Mean annual fat percentage in the milk of 498 selected Awassi ewes**

Fat (%)	Ewes	
	Number	%
5.8-5.9	1	0.2
6.0-6.4	36	7.2
6.5-6.9	153	30.7
7.0-7.4	218	43.8
7.5-7.9	74	14.9
8.0-8.4	14	2.8
8.5-8.8	2	0.4
Total	498	100.0

production of stud rams and which had a maximum lactation yield of not less than 370 kg, was tested at 7.06 percent on average. The mean annual butterfat percentage, periodically tested during the entire lactation period, showed considerable differences between the milk of individual ewes (Table 4-37).

With milking intervals of unequal length, the fat content of the milk obtained after the shorter interval is higher than the fat percentage of the milk yielded after the longer interval.

The effect on fat percentage of the quantity of milk yielded at the time of testing is shown by a comparison between ewes giving up to 400 g of milk and others yielding more than 450 g at the primary milking. Of the former, 195 samples tested yielded 6.23 percent, and 212 samples of the latter 5.73 percent on average, a difference of 0.5 percent in favour of the milk from the ewes with the lower milk yields (Eyal, Volcani & Sharav, 1958).

A test on the effect of the age of Awassi ewes on the fat content of their milk, made with a small number of animals at regular intervals during six weeks after weaning the lambs, showed a lower fat percentage in the milk of first-lambing ewes than in that from older animals, but the difference was statistically insignificant (Nitsan & Volcani, 1960) (Table 4-38).

In improved Awassi sheep in Israel there has been a continuous fall in the fat percentage of milk over the last 40 years (Table 4-39). The fall from 7.54 percent in 1943/44-1945/46 to 5.44 percent in 1976/77 in the fat content of Awassi milk delivered to central collecting stations in Israel is not only a result of the neglect of this economically important element in the selection of breeding stock. Partly it must also be attributed to the general use of milking machines in improved flocks and the cessation of secondary hand milking. The rich milk thus retained in the udders is left to the lambs for residue suckling. In Yugoslavia the average fat content of the milk of 229 lactations of Awassi ewes imported from Israel in 1969 and stationed in a socialist cooperative combine was 6.84 percent, ranging from 6.1 to 7.5 percent (Todorovski, Ristevski & Popovski, 1973a). On a peasant farm near Skopje in northern Makedonija, the average fat content recorded in four tests of Awassi milk was 7.4 percent (Todorovski, Tanić & Stojanovski, 1975). This high fat percentage is attributed to the feed, which in Yugoslavia consists mainly of high-quality roughage and good grazing, whereas in Israel pastures are poor and the rations of Awassi sheep contain large portions of concentrates (Epstein, 1977).

TABLE 4-38. **Effect of age of Awassi ewes on the fat content of milk**

Lactation	Number of ewes	Milk yield per lactation (kg)	Fat content of milk (%)
1st	4	259	5.52
2nd	6	293	6.18
4th	6	360	6.10

TABLE 4-39. **Decrease in the fat content of Awassi milk in Israel over three decades**

Year	Butterfat (%)
1942/43-1945/46	7.54
1949/50	7.25
1950/51	6.83
1975/76	5.44

The differences in fat percentage of the milk between different improved flocks of similar breeding and feeding are relatively slight. Finci (1957), referring to the statistically insignificant differences in the mean fat content of the milk between two flocks—20 milk-recorded animals with a mean of 6.72 percent in one and 46 similar ewes with 7.37 percent in the other—attributed this to the fact that no selection for the increased fat content of Awassi milk had been carried out in Israel. An additional cause, no doubt, is the use of rams from a single flock. However, in view of the well-established negative correlation between the quantity of milk and the fat percentage, differences in the average milk yield of ewes from different flocks doubtless affect the mean fat percentage ; this may also be influenced by differences in the feed as evidenced by the high fat percentage in the milk of Awassi sheep from Israel in Yugoslavia (see p. 146).

In 1976/77 the average annual fat content of the milk of 27 improved Awassi flocks delivered to central collecting stations in Israel ranged from 4.85 to 6.04 percent, with an average of 5.44 percent (see Table 4-40).

Changes in fat content of Awassi milk in the course of a lactation period. At Abu-Ghraib in Iraq the fat content of 145 samples of milk from 19 hand-milked Awassi ewes in a period of 16 weeks increased from 3.96 percent in the first week to a maximum of 6.66 percent in the thirteenth week. Thereafter it fell to 4.95 percent at the end of the test, the average for the whole period amounting to 5.25 percent (Eliya, Juma & Al-Shabibi, 1972).

Generally the fat content of the milk of Awassi ewes rises from the beginning to the end of the lactation period by approximately 33 percent, a rise similar to that encountered in dairy cows in the course of their lactation.

The average monthly fat content of Awassi milk derived from morning and evening milkings was recorded by Kern (1953) at a central dairy in Palestine in 1943/44-1945/46 and in the whole of Israel in 1949/50 and 1950/51. The average fat content of all Awassi milk deliveries of a total of 1 934 tonnes, received at *central* dairies *in 1976/77,* shows a sharp *decline in monthly fat percentages* in *the course of 25* years. (See Table *4-41.)*

The fact that in the early years of Awassi improvement the fat percentage of the milk delivered to the central dairies was higher in the first months than at the height of the lactation period is attributed to the then-prevailing system of lamb rearing. In the first few weeks of their lives, the female lambs and the few males required for breeding were allowed to suck freely on the return of the ewes from pasture or during the night. Only the very rich milk left over was milked and included in the deliveries to the central dairies.

The tests in 1976/77 show two breaks in the rising line of fat percentage from the lowest in November to the highest in September, namely in May and August. The fall in May is due to the *lambings of yearling ewes in* April, and that *of August to the second lambing of a certain number of* adult ewes that had already lambed the previous October or November.

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TABLE 4-40. **Average annual fat content of Awassi milk delivered to collecting stations, 1976/77**

Fat content of milk (%)	Number of flocks
4.80-5.00	1
5.01-5.20	4
5.21-5.40	5
5.41-5.60	13
5.61-5.80	2
5.81-6.00	1
6.01-6.10	1

TABLE 4-42. **Solids-not-fat in Awassi milk**

Solids-not-fat (%)	Samples	
	Number	%
Below 9.9	2	0.12
9.9-10.4	63	3.62
10.4-10.9	808	46.43
10.9-11.4	833	47.87
11.4-11.9	32	1.84
Above 11.9	2	0.12

TABLE 4-41. **Monthly mean fat percentages of Awassi milk**

Year	1943/44-1945/46		1949/50		1950/51		1976/77	
Month	Fat (%)	Milk in 1 000 kg	Fat (%)	Milk in 1 000 kg	Fat (%)	Milk in 1 000 kg	Fat (%)	
October	—	—	—	—	—	9.6	5.88	
November	—	1.5	7.35	—	—	38.5	4.83	
December	6.70	29.3	7.40	17.8	7.29	141.8	4.86	
January	7.30	167.2	7.52	141.3	6.88	204.3	5.04	
February	6.90	245.3	7.47	358.2	6.57	244.3	5.23	
March	6.80	431.2	6.83	617.0	6.29	282.9	5.35	
April	6.70	412.6	6.55	556.7	6.59	220.1	5.68	
May	8.20	319.6	7.54	415.4	7.29	204.8	5.63	
June	8.40	198.3	7.94	254.5	7.60	175.1	5.80	
July	8.70	98.2	8.05	132.3	7.83	117.1	5.96	
August	9.11	22.9	8.08	32.4	7.53	69.5	5.86	
September	10.00	1.3	8.58	1.4	7.33	26.2	6.02	

Solids-not-fat in Awassi milk. In a test of 1 740 samples of milk in 1942/43, Kern (1953) found that over 94 percent fell within the range of 10.4-11.4 percent solids-not-fat, with an average of 10.9 percent. Only 0.3 percent of the samples deviated from the mean by more than 1 percent. (See Table 4-42.)

Tests of several thousand samples of Awassi milk in a central dairy in Palestine in 1942/43-1945/46 showed that the monthly variations in the solids-not-fat content were also only slight (Table 4-43).

While the total solids-not-fat content of the milk varied but little, generally or monthly, the monthly variations between the different constituents of the solids-not-fat were considerable.

Variations in the fat content of Awassi milk seem to affect the percentage of solids-not-fat more than they affect the percentage of total solids. In an Awassi flock at the Abu-Ghraib Experiment Station in Iraq, Nejim (1963) analysed the total solids and solids-not-fat content in the bulk milk of ewes in two consecutive years. In the first year weekly samples were taken only in the last three months of the lactation period, that is, from May to July; in the second year the milk was tested for the full lactation period of 5V months, from the end of December to the beginning of June. While the average contents of total solids were similar in both seasons, namely 19.78 percent (18.19-24.36) and 19.87 percent (17.34-24.56), the solids-not-fat content differed markedly, amounting to 11.99 percent (10.09-14.36) in the last three months of the first lactation tested, and 12.99 percent (11.11-13.92) during the full lactation of the following year, the difference being mainly owing to the different fat content of the milk (7.70 and 6.88 percent, respectively). Table 4-44 gives the average monthly percentages of total solids and solids-not-fat during the two seasons.

In a further test conducted at Abu-Ghraib over 16 weeks, the average percentage of total solids in 145 samples of milk from 19 Awassi ewes was considerably lower, that is, 16.18 percent, varying between 14.01 and 18.01 percent, the difference of 3.6 or 3.7 percent from the earlier tests being attributed to a different method of sampling. Like the fat content of the milk, the percentage of total solids increased with advancing lactation to a maximum during the thirteenth week. The solids-not-fat content of the milk ranged from 10.07 percent in the second week to 11.66 percent in the sixteenth week of lactation and averaged 10.92 percent (Eliya, Juma & Al-Shabibi, 1972).

Morning milk, obtained 12 hours after the evening milking, contains a smaller percentage of solids-not-fat and a higher percentage of fat than evening milk. The differences, statistically highly significant, were established by Nitsan and Volcani (1960) in the course of six consecutive weeks in an analysis of the morning and evening milk of 16 ewes of different ages that had lambed in the same month (Table 4-45).

The difference in the solids-not-fat content of Awassi milk between the primary and secondary

TABLE 4-43. **Monthly average solids-not-fat contents of Awassi milk**

Month	Solids-not-fat (%)
December	10.39
January	10.71
February	10.86
March	10.72
April	10.87
May	10.95
June	10.01
July	10.92
August	10.45
September	10.55

Source: Kern, 1953

TABLE 4-44. **Total solids and solids-not-fat in Awassi milk in Iraq (%)**

Month	First season		Second season	
	Total solids	Solids-not-fat	Total solids	Solids-not-fat
December	—	—	21.62	15.63
January	—	—	20.82	12.52
February	—	—	19.44	13.41
March	—	—	17.89	12.39
April	—	—	20.20	12.90
May	19.96	12.08	19.92	12.69
June	19.30	11.34	20.30	13.90
July	20.30	12.78	—	—

TABLE 4-45. **Composition of morning and evening milk of Awassi ewes**

Lactation	No. of ewes	Milk yield		Total solids		Solids-not-fat		Fat		Protein	
		Morn. (g)	Even. (g)	Morn. (%)	Even. (%)	Morn. (%)	Even. (%)	Morn. (%)	Even. (%)	Morn. (%)	Even. (%)
1st	4	1 130	690	17.1	17.2	11.3	11.8	5.7	5.4	5.0	5.1
2nd	6	1 220	930	17.5	17.5	11.3	11.6	6.3	6.1	5.6	5.4
4th	6	1 160	970	17.4	17.4	11.1	11.5	6.3	5.9	5.1	5.1

yields has been examined by Sharav (1971) during three 20-day periods of alternate machine milking and machine plus hand milking in two groups of non-suckling ewes in Israel. The results showed that while the fat content of the primary milk is lower than that of the secondary milk, the reverse applies to the solids-not-fat percentage (see Table 4-65).

Proteins and lactose in Awassi milk. Awassi milk contains 5.56 percent protein on average. Kern (1953) recorded the monthly variations in the casein content of 1 740 samples of Awassi milk in 1942/ 43, and of total proteins, casein, albumin and globulin in several thousand samples in 1943/44-1945/46 (Table 4-46). During the lactation period, the total protein content of Awassi milk rises from approximately 5 to 7 percent, while the casein content increases merely from 4 to 5 percent.

TABLE 4-46. **Monthly variation in the protein contents of Awassi milk**

Month	1942/43	1943/44-1945/46			
	Casein (%)	Total proteins (%)	Casein (%)	Albumir and globulin (%)	Casein as % of total proteins
December	—	5.08	3.83	1.25	75.4
January	4.13	4.78	3.68	1.10	77.0
February	4.16	5.27	4.24	1.03	80.5
March	4.23	5.10	3.92	1.18	76.9
April	4.32	5.29	4.10	1.19	77.5
May	4.39	5.56	4.15	1.41	74.6
June	4.38	6.09	4.79	1.30	78.7
July	4.39	6.05	4.62	1.43	76.4
August	4.76	6.18	4.63	1.55	74.9
September	—	7.17	4.84	2.33	67.5

At the Abu-Ghraib Experiment Station in Iraq, the average protein content of the bulk milk of an Awassi flock, tested at weekly intervals in the last 2½ months of the lactation period, amounted to 6.18 percent (5.85-6.50). The monthly averages were: March 5.85 percent, April 6.23 percent, May 6.31 percent, and June 5.85 percent (Nejim, 1963).

The average lactose content of the milk of the same flock, recorded by Nejim (1963) during a full lactation period of 5½ months, was 5.75 percent, ranging from 4.65 to 7.04 percent.

Ash content of Awassi milk. The ash content of Awassi milk has been analysed by Nejim (1963) in a flock at the Abu-Ghraib Experiment Station at weekly intervals in two consecutive years, in the first season in the last three months of the lactation period and in the following season for the whole lactation. In the first season the milk contained 0.886 percent ash on average, ranging from 0.775 to 0.975 percent; in the following full lactation the average ash content was 0.928 percent, varying between 0.864 and 1.018 percent. The average monthly percentages of total ash, calcium oxide (CaO) and phosphorus pentoxide (P_2O_5) in the milk and ash, and the ratio of calcium oxide *(*= 1) to phosphorus pentoxide are given in Table 4-47. The CaO and P_2O_5 contents of the milk increased until the lambs were about four months old and then showed a slight decline.

Nejim (1963) notes that the milk of Awassi ewes contains about 55 percent more CaO and 45 percent more P_2O_5 than cow milk. Awassi milk contains 112.4 mg of chlorine for every 100 g on average, ranging from 96 to 147 mg (Kern, 1953).

Specific gravity, freezing point, acidity, viscosity, flavour and fat composition of Awassi milk. The specific gravity (SPG) of Awassi milk depends on the proportions between the various constituents, namely, water (SPG 1.000), fat (SPG 0.93), proteins (SPG 1.346), lactose (SPG 1.666) and ash (SPG 5.5) and on their individual and seasonal variations. Therefore the average specific gravity of Awassi milk differs in different months of the year. It is especially affected by the variable fat content of the milk. Kern (1953) recorded an average specific gravity of 1.0371 in Palestine in 1943/44-1945/46, with the monthly variation given in Table 4-48.

A similar variability in the specific gravity of Awassi milk in different months is indicated by the data recorded for an Awassi flock at the Abu-Ghraib Experiment Station in Iraq at weekly intervals in the last three months of the lactation in 1960/61 and the full lactation in 1961/62 (Table 4-49). During

TABLE 4-47. **Average monthly percentages of total ash, CaO and P_2O_5 in milk and ash, and CaO-P_2O_5 ratio in Awassi milk in Iraq**

Month	First season						Second season					
	Ash	CaO in		P_2O_5 in		CaO: P_2O_5	Ash	CaO in		P_2O_5 in		CaO: P_2O_5
		milk	ash	milk	ash			milk	ash	milk	ash	
December	—	—	—	—	—	—	0.905	0.256	28.3	0.300	33.1	1.17
January	—	—	—	—	—	—	0.898	0.287	32.4	0.339	38.1	1.18
February	—	—	—	—	—	—	0.879	0.304	34.6	0.354	30.8	1.16
March	—	—	—	—	—	—	0.980	0.301	30.6	0.354	36.2	1.18
April	0.852	0.275	32.3	—	—	—	0.948	0.299	31.6	0.311	32.8	1.04
May	0.867	0.315	36.4	0.328	38.0	1.04	0.962	0.277	28.8	0.284	29.6	1.03
June	0.911	0.289	31.8	0.316	34.9	1.09	1.018	0.258	—	0.231	22.7	0.90
July	0.887	0.285	32.0	0.315	35.5	1.11	—	—	—	—	—	—

TABLE 4-48. **Monthly variation in mean specific gravity of Awassi milk in Palestine, 1943/44-1945/46**

Month	Specific gravity
December	1.0363
January	1.0360
February	1.0380
March	1.0370
April	1.0382
May	1.0375
June	1.0376
July	1.0374
August	1.0342
September	1.0342

TABLE 4-49. **Monthly variation in average specific gravity of Awassi milk in Iraq**

Month	Specific gravity	
	First season	Second season
December	—	1.0355
January	—	1.0346
February	—	1.0395
March	—	1.0387
April	1.0351	1.0369
May	1.0348	1.0351
June	1.0328	1.0326
July	1.0335	—

the first season of lactation the average specific gravity of the milk was 1.0338 (1.0280-1.0378) and during the second season, 1.0366 (1.0305-1.0415) (Nejim, 1963).

In another test of 145 samples of milk from 19 Awassi ewes at Abu-Ghraib, the specific gravity of the milk ranged from 1.0370 during the second week to 1.0408 in the sixteenth week of lactation (Eliya, Juma & Al-Shabibi, 1972).

The specific gravity of Awassi milk in conjunction with the fat percentage lends itself to an approximate estimate of the solids-not-fat content of the milk according to the following formula proposed by Kern (1953).

$$\text{Solids-not-fat} = \frac{\text{Specific gravity}}{4} + \frac{\text{Fat percentage}}{5}$$

Specific gravity and fat percentage are relatively easy to ascertain, whereas the assessment of the solids content necessitates the drying of the sample and an elaborate chemical analysis.

In an investigation of the freezing point of Awassi milk in Iraq, Eliya, Juma and Al-Shabibi (1972) recorded an average of-0.5699°C. As freezing point depression largely depends on the water content of the milk, its variation at different stages of the lactation period followed the trend of the total solids content.

Awassi milk has a relatively high naturel acidity. In 52 samples recorded at a central dairy in Palestine the acidity varied between 6.2 and 8.2 Soxhlet-Henkel degrees, with an average of 7.02. The average monthly differences in the acidity of Awassi milk were recorded during the period 1943/44-1945/46 (Table 4-50).

The average titratable acidity of the milk of an Awassi flock at the Abu-Ghraib Experiment Station, measured at weekly intervals in a full lactation period of 5V months, was 0.22, ranging from

TABLE 4-50. **Monthly variation in the acidity of Awassi milk in Palestine, 1943/44-1945/46**

Month	Acidity (Soxhlet-Henkel degrees)
December	6.77
January	7.81
February	8.45
March	9.05
April	9.25
May	9.73
June	9.49
July	9.49
August	8.56
September	7.20

Source: Kern, 1953

TABLE 4-51. **Titratable acidity and pH of Awassi milk in Iraq**

Month	Titratable acidity	pH
December	0.22	—
January	0.26	—
February	0.27	6.60
March	0.27	6.57
April	0.19	6.62
May	0.14	6.71
June	0.10	6.90

0.10 to 0.29. The pH, determined from the second month to the end of the lactation, was 6.65, varying between 6.46 and 6.90. The average monthly titratable acidity data show a reduction and the pH data an increase toward the end of the lactation (Table 4-51) (Nejim, 1963).

In another test of the milk of 19 Awassi ewes at Abu-Ghraib, the hydrogen-ion concentration was 6.53 in the first week of lactation and 6.87 in the second week. The average for the whole lactation of 16 weeks was 6.74 (Eliya, Juma & Al-Shabibi, 1972).

The changes in acidity are a result of the changing percentage of solids, more especially casein, in the milk. In general, the natural acidity of fresh Awassi milk is considerably higher than that of the milk of Friesian cows, mainly owing to the higher protein and mineral content of the former. Yet this higher apparent acidity does not cause Awassi milk to sour sooner than cow milk. In fact, bacterial growth is slower in Awassi than in cow milk, since the high percentage of solids acts as a preservative.

Owing to their relatively high fat and protein content, and probably also to their high riboflavin content, Awassi milk and whey have a yellowish colour. Awassi milk has a fatty and adhesive taste. If milked by hand, it often has a peculiar taste and flavour. Its high viscosity renders the ascent of the fat globules very slow and centrifugation difficult, although the fat globules are twice as large as in the milk of Friesian cows. The difficulty can be overcome by the addition of water or skimmed cow milk to Awassi milk prior to centrifugation.

The composition of the butterfat of Awassi milk varies from month to month. During the first five or six months of the lactation period the fat of Awassi milk is particularly rich in butyric acid; toward the end of lactation the butyric acid decreases. The melting point of the fat falls from about 32°C in December to 30°C in March, whence it rises to about 38°C in August and September. Again, the temperature at which Awassi milk fat solidifies rises from 14.5-17.5°C in the months of December to April to 18.6-20.4°C in the period from May to September (Kern, 1953).

Colostrum. In the first few days after lambing the colostrum of the Awassi ewe is characterized by a very high percentage of solids, more especially fat, protein and ash, and a high degree of acidity. On the other hand, it is low in lactose content. Becker (1958) has recorded an analysis of the colostral milk of Awassi ewes, tested in 1943/44 (Table 4-52).

The milk flow of the Awassi ewe. The Awassi ewe does not usually yield all her milk at one milking or at one milking followed by stripping, as is common in dairy cattle and goats. In the course of the machine or hand milking process, the milk flow in the Awassi ewe pauses after about two-thirds of the total amount of milk has been milked. Gall (1975) has pointed out that in machine-milked ewes, the milk often flows in two peaks. Previously it was common practice to remove the teat cups after the first peak, thus allowing time for the alveolar milk to be ejected, and then to put on the teat cups a second time. This procedure results in high labour requirements. Milking routines have now been developed whereby the second application of the cups is suppressed. To restart the flow and initiate the second phase of milking, the udder has to be massaged by hand for about a quarter of a minute while the cups are still on.

TABLE 4-52. **Analysis of colostrum of Awassi ewes**

Days after lambing	Total solids (%)	Fat (%)	Total protein (%)	Casein (%)	Lactose (%)	Ash (%)	Acidity (Soxhlet-Henkel degrees)
Immediately	35.8	13.0	18.5	13.5	2.9	1.40	26.0
1	24.6	9.2	11.0	8.7	3.2	1.06	14.2
2	21.3	9.0	8.0	5.3	3.1	1.01	9.4
3	19.5	7.7	7.9	5.0	3.0	0.84	8.1
4	18.4	7.2	6.6	4.8	3.5	0.95	7.0
5	18.0	6.7	5.9	4.9	4.4	0.92	6.9
6	17.9	6.9	5.9	4.3	4.2	0.93	6.5
7	18.5	7.3	5.7	4.4	4.5	0.95	7.1
8	18.1	6.5	5.9	4.0	4.6	0.93	6.0
9	18.4	6.9	5.6	3.4	4.7	0.90	7.2
30	18.2	6.9	5.4	4.1	4.7	0.95	8.7

For the purpose of obtaining the maximum amount of milk secreted in the period elapsed since the previous milking, it is essential to milk the ewes twice, both by machine and hand in a short interval. The secondary milking does not consist of mere stripping, as in the case of cows and goats, but comprises both milking and stripping.

During the interval between morning and evening or night and noon milkings, there is a gradual rise in udder pressure with a continued secretion and discharge of milk from the cells into the lumina of the alveoli, the ducts and storage spaces of the duct system, and the gland cistern. Owing to the increasing milk pressure on the blood capillaries, which reduces the flow of blood, and to the growing difficulty encountered in discharging the milk content of the cells into the lumen, the cycles of secretion and discharge begin to slow down. After milking, when the pressure is low, the epithelial cells of the alveoli rupture the membrane and discharge their contents. With increasing milk pressure, the cell wall can no longer rupture and the milk is discharged from the cell only as far as it can pass through the semi-permeable cell membrane. The fat suspended in the milk fluid cannot leave the cell and accumulates within it. The milk discharged at this stage is low in fat and, to a lesser extent, in casein, but is normal in sugar and albumin (Turner, 1952). After the primary milking of the ewe, when the milk pressure is released, the cells of the alveoli burst and discharge the accumulated fat globules which descend with the remaining fluid from the lumina of the alveoli into the duct system and are recoverable at the secondary milking and stripping.

Becker (1958) attributes the necessity of the secondary milking to the structure of the udder of the Awassi ewe, which does not permit collection of the major portion of the milk in the cistern and larger ducts. A considerable amount of milk remains in the narrow upper ductules and lumina of the alveoli and is only slowly forced down the duct system after this has been emptied during the primary milking. But this is only one reason for the necessity of the secondary milking. The major factor involved in the slow inflow of the milk into the cistern and larger ducts is doubtless the great viscosity of the ewe's milk owing to the high percentage of solids.

Primary and secondary milking: milk yields. The proportions of the primary to the secondary milk yields of Awassi ewes vary considerably, as they depend on many factors, such as individuality and age of the ewes, position of the teats, machine or hand milking, the skill of the milkers, efficiency of the milking machine, suckling or non-suckling of lambs, the stage of the lactation period, and total milk production. In six tests of night and noon milkings in four different flocks, the secondary milk yield ranged from 20 to 53.7 percent of the primary yield. The total primary yield recorded was 282.5 kg and the secondary milk 95 kg on average, a ratio of approximately 3:1 (Becker, 1958).

In a test with 154 Awassi ewes of an average age of nearly five years conducted in the mornings and evenings of three consecutive days in March and April for the purpose of recording the quantities of primary and secondary milk (Table 4-53), the ewes were divided into five groups of similar size and composition, save for one group which included suckling ewes, while the others were already in the second half of their lactation period (see also Tables 4-55 to 4-57 and Table 4-82) (Sharav, 1959).

In a test with six hand-milked non-suckling ewes, beginning on the fourth day after lambing and lasting for seven weeks, Edelman (1963) recorded average yields of 33.09 kg of primary and 7.68 kg of secondary milk ,or 81.2andl8.8 percent, respectively, of the total yield. Seven non-suckling ewes of

TABLE 4-53. **Mean daily milk yields of Awassi ewes at primary and secondary milkings**

Milking	Milk yields	
	g	%
Primary (by machine)	994.3	78.6
Secondary (by hand)	270.9	21.4
Total	1 265.2	100.0

TABLE 4-55. **Relation between mean yields of primary and secondary milk in Awassi ewes**

No. of ewes tested	Primary milk (g per milking)	Secondary milk (g per milking)	Secondary milk as % of total yield
13	321	113	26.0
27	409	125	23.4
40	468	136	22.5
37	529	139	20.8
19	654	150	18.7

TABLE 4-54. **Mean yields of secondary milk in relation to the setting on of the teats**

Secondary milk yields (g)	50-100	100-130	140-170	above 175
Low set-on teats				
Number of ewes	26	27	17	14
% of ewes	67	61	57	52
High set-on teats				
Number of ewes	13	17	13	13
% of ewes	33	39	43	48
Total				
Number of ewes	39	44	30	27
%of ewes	100	100	100	100

another flock produced — during a 15-day preliminary period and three 20-day test periods commencing after weaning of their lambs at eight weeks of age—56.59 kg of machine-milked primary and 7.93 kg of hand-milked secondary milk on average, or 87.7 and 12.3 percent, respectively, of the total yields.

During the first lactation, when the young ewes have not yet become fully used to being milked, the average quantity of secondary milk is larger than during the second and third lactations, namely 211 g as against 144 g for each milking. In later years there is a further decline in secondary milk yields to 121-129 g, with an average of 125 g for each milking (Sharav, 1959).

Sharav (1959), classing 140 ewes according to their mean yields of secondary milk into four groups, namely 50-100 g, 110-130 g, 140-170 g, and 175 g and above, found no correlation between the quantities of secondary milk and either height at rump, depth of udder, superior udder girth, udder girth at height of teat bases, posterior and anterior udder lengths, or length and diameter of teats, all measurements being taken before as well as after milking. Only a single morphological feature, namely the height of the setting on of the teats, shows a clear correlation with secondary milk yields (Table 4-54).

In conformity with these results, Eyal, Volcani and Sharav (1958) found in a test milking of 160 ewes that on completion of machine milking more milk remained in the udders with high-set-on teats than in those with either oblique or vertical teats set on low, namely 142 g as against 125 g on average. A similar result was obtained in a milking trial conducted by Jatsch and Sagi (1979) in an experimental flock in northern Israel during nine months of lactation. The yields from morning and afternoon milkings, separated into machine milking, machine stripping and hand stripping fractions, showed that ewes with teats obliquely projecting from the bottom of the udder yielded to the machine milking fraction 57 percent of their total yield in the morning and 36 percent in the afternoon, while those with teats located far up on the sides of the udder yielded only 43 percent of the morning and 21 percent of the afternoon milk to the machine milking.

An increase or decrease in total milk yield is not paralleled by its two components, primary and secondary milk. In a trial conducted with 136 Awassi ewes with different total yields, Sharav (1959) found that the general direction of either an increase or a reduction in total yield was reflected in both phases of the milking process, but that the quantity of primary milk followed the trend of total yield much more closely than did the quantity of secondary milk (Table 4-55).

The question as to whether, after machine milking, secondary hand milking and stripping in the Awassi may or may not be dispensed with has been examined by Sharav (1971) in two similar tests: one with two groups of 46 and 58 five-year-old non-suckling Awassi ewes four months after lambing, and the other with two groups of 73 ewes each, which were, however, nearer the end of the lactation period than were the ewes of the first test. During three periods of 20 days each, with intervals of a week between them, the ewes were alternately machine milked, followed by secondary hand milking and stripping, or were only machine milked. The daily milk yields for each ewe were recorded during the three 20-day periods of the tests (Table 4-56).

The mean difference in daily milk yields for each ewe between single machine milking and machine plus hand milking and stripping for all animals included in these tests was 35.9 g in favour of machine plus secondary hand milking. In low-yielding ewes, that is, those yielding below the average of the test groups, it was 59.7 g, and in high-yielding ones, yielding above the average, 13.8 g. The difference is statistically highly significant in ewes with relatively low yields, but not significant in those with high yields.

The trials, performed with non-suckling ewes at advanced stages of lactation, were supplemented by another test with two groups of 65 four and a half- to five-year-old suckling ewes each, comprising animals similar in age, lambing dates and previous-year average milk yields (Sharav, 1971). Each group was tested by the simple switchback method during two 20-day periods with a preparatory period and interval of ten days each, one test period solely with machine milking alternating with the second test period with machine plus secondary hand milking, or vice versa. The lambs were separated from the ewes 24 hours before the test milking. (See Table 4-57.)

Sharav (1971) noted that the average daily loss of milk owing to the omission of secondary hand milking was 173 g for each ewe, 196 g for those with yields above the mean and 155 g for ewes with milk yields below the mean. Other than in the previous test with non-suckling ewes, the rate of loss was statistically highly significant for both groups. A large part of the milk lost by the omission of secondary milking was recovered by the residue-suckling lambs (see p. 168 and Tables 4-69 and 4-70).

The quantities of milk yielded at the different phases of the primary machine and secondary hand milking have been recorded in 24 four-year-old non-suckling ewes during two periods of a fortnight each, with an interval of one week (Table 4-58). Support of the udder by hand or mechanical means during machine milking changes the ratio of primary to secondary milk yields in favour of the former.

In an experiment with ewes having udders with an ill-defined differentiation between the halves, Sagi and Morag (1974) found that insertion of the hand between the two glands changed the angle of teat attachment from a high horizontal to a lower oblique position and increased the percentage of

TABLE 4-56. **Mean daily milk yields of non-suckling ewes in three test periods of machine versus machine plus hand milking (g)**

20-day test period	Group I			Group II		
	Machine-milked	Hand-milked	Total	Machine-milked	Hand-milked	Total
Test I						
First	1 114	—	1 114	987	299	1 286
Second	540	261	801	877	—	877
Third	607	—	607	526	218	744
Test II						
First	914	—	914	804	256	1 060
Second	508	192	700	720	—	720
Third	560	—	560	411	155	566

TABLE 4-57. **Average daily milk yields of suckling ewes during two test periods of machine versus machine plus hand milking (g)**

20-day test period	Group I			Group II		
	Machine-milked	Hand-milked	Total	Machine-milked	Hand-milked	Total
First	1 516	—	1 516	1 391	284	1 675
Second	1 157	224	1 381	1 138	—	1 138

TABLE 4-58. **Average daily milk yields of Awassi ewes at different phases of primary machine and secondary hand milking**

Phase	First period		Second period	
	Milk		Milk	
	g	%	g	%
Machine milking until pause in flow	888	56	792	53
Machine milking after udder massage	444	28	438	29
Secondary hand milking and stripping	256	16	274	18
Total	1 588	100	1 504	100

primary milk from 50 to 69 of the total yield in the morning after a previous interval of 16 hours, and from 34 to 64 in the afternoon after an eight-hour interval between milkings. Conversely, hand support of the udder reduced the secondary yield obtained by machine milking from 35 to 19 percent of the total yield in the morning, and from 50 to 23 percent in the afternoon. While these changes were found to be highly significant, slight differences in the quantities of milk obtained from subsequent hand stripping were not significant.

In another experiment with two groups of high-milking dairy ewes, distinguished by different udder conformations (see Fig. 4-3), Sagi (1978) recorded the daily yields with or without mechanical udder support during milking (Table 4-59).

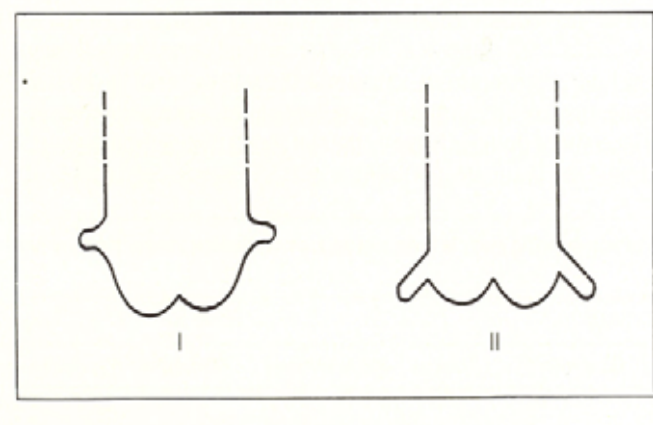

Figure 4-3. Schematic representation of two different udder types

TABLE 4-59. **Average daily milk yields according to udder type and milking with or without mechanical udder support (%)**

Udder type	Primary machine milking	Secondary machine milking	Hand stripping
I: Unsupported Supported	44.0 61.0	43.2 26.0	12.8 13.0
II: Unsupported Supported	60.3 71.0	29.3 17.7	10.4 11.3

Primary and secondary milking: milk composition. The differences between the fat content of the milk derived from successive primary and secondary hand milking are considerable, as shown by two examples of the morning milk of 50 and 11 ewes (Table 4-60).

In five other flocks the combined quantities and fat percentages from successive primary and secondary morning and noon milkings were as given in Table 4-61.

TABLE 4-60. **Quantities and fat content of Awassi milk from primary and secondary morning milkings**

Milking	50 ewes		11 ewes	
	Milk (kg)	Fat (%)	Milk (kg)	Fat (%)
Primary	34.5	6.75	9.3	5.60
Secondary	5.8	9.90	0.8	9.70

Source: Kern, 1953

TABLE 4-61. **Quantities and fat content of Awassi milk from two successive morning and noon milkings**

Milking		Milk (kg)	Fat (%)
Morning	Primary	207.5	6.04
	Secondary	70.0	8.94
Noon	Primary	75.0	7.40
	Secondary	25.0	8.83

Source: Becker, 1958

Eyal, Volcani and Sharav (1958) recorded 6.23 percent fat in 195 samples of milk from primary milkings and 9.03 percent in 424 samples from secondary milkings in non-suckling ewes which, at the time of the test, yielded up to 400 g of milk for each milking. In 25 ewes, which still suckled their lambs at the time of the trial, the average fat content in 568 g of machine-milked primary milk for each milking was 4.05 percent, and in 162 g of hand-milked secondary milk, 7.54 percent.

In a test with two groups of non-suckling ewes over seven weeks beginning on the fourth day after lambing — one group with primary and secondary hand milking, and the other one without secondary milking—the ewes of the latter group produced only 64.8 percent of the total quantity of fat yielded by those with primary and secondary milkings. The fat percentages and relative quantities of milk at the primary and secondary evening milkings of 15 ewes (seven of which suckled their lambs during the night and eight in two residue sucklings) during the first eight weeks of lactation are given in Table 4-62.

TABLE 4-62. **Primary and secondary milk yields and fat percentages**

Milking	Milk as % of total yield	Butterfat (%)
Primary	78.5	4.44
Secondary	21.5	6.62

TABLE 4-63. **Average fat percentages of primary and secondary milk in relation to yields and passage of time since lambing**

No. of ewes	Days since lambing	Milk yield at machine milking (g per milking)	Fat (%)	Milk yield at secondary hand milking (g per milking)	Fat (%)
21	67	675-975	5.1	125	9.1
43	87	490-670	5.3	150	8.9
47	94	375-480	5.6	140	8.9
39	103	160-370	6.1	114	8.6

Source: Sharav, 1959

In the same flock, non-suckling ewes whose lambs had been removed from their dams after the first three days of life to be hand-fed produced 72.4 percent of the total amount of fat at the primary milking and 27.6 percent at the secondary milking in the first seven weeks of lactation. The average fat content in the primary milk was 7.04 percent and in the secondary milk 11.53 percent (Edelman, 1963).

In a test with seven ewes, conducted in another flock over a period of 75 days after weaning of the lambs at the age of eight weeks, Edelman (1963) recorded 8.18 percent fat in the milk obtained in the primary milking and 14.86 percent in the milk from the secondary milking, with an average of 8.87 percent in the combined primary and secondary milk. The quantity of butterfat obtained at the secondary milking and stripping was 19.1 percent of the total amount of butterfat.

The changes in the fat content of primary and secondary milk coming to pass with the growing lapse of time since lambing and the corresponding fall in the quantities of milk have been examined in a trial with 150 ewes (Table 4-63).

The results of this test show that while the percentage of fat in the primary milk rises with the lapse of time since lambing and the decline in milk yields, the fat content of the secondary milk is not affected by these factors to a parallel degree but, on the contrary, shows a reduction.

In grouping ewes according to different yields of secondary milk, the quantities of fat derived from the primary milk show hardly any differences, whereas those of the secondary milk vary greatly (Table 4-64) (Sharav, 1959).

TABLE 4-64. **Variations in fat content of primary and secondary milk with varying yields of secondary milk**

No. of ewes	Average milk yield per secondary milking (g)	Fat content of secondary milk			Fat content of primary milk			Fat content of secondary milk (% of total fat)
		No. of tests	%	g	No. of tests	%	g	
38	86	113	9.2	7.9	109	6.1	26.6	22.9
55	129	109	9.0	11.6	201	5.6	26.1	30.8
23	172	77	8.9	15.3	75	5.6	26.5	36.6
13	229	39	8.6	19.7	35	4.9	27.3	41.9

Both the fat and solids-not-fat content of the primary milk depend on whether or not primary machine or hand milking is followed by secondary hand milking. If the latter is omitted, the milk is richer in fat and to some extent also in solids-not-fat than is the primary milk of ewes which are successively milked twice. Table 4-65 gives the percentages of fat and solids-not-fat recorded in the sole or primary and the secondary milk from two groups of ewes tested in three 20-day periods of alternate machine milking and machine plus hand milking (Sharav, 1971) (see also p. 163 and Table 4-56). This test also showed that while the fat content of primary milk is lower than that of secondary milk, the reverse applies to the solids-not-fat percentage.

TABLE 4-65. **Fat and solids-not-fat contents of Awassi milk during three test periods of machine versus machine plus hand milking**

Sole or primary milk 20-day test period	Fat (%)		Solids-not-fat (%)	
	Group 1	Group II	Group	Group II
First	(–) 7.6	(+) 6.8	(–) 12.3	(+) 12.1
Second	(+) 8.4	(–) 8.8	(+) 11.5	(–) 12.1
Third	(–) 7.9	(+) 7.5	(–) 11-9	(+) 11.9
Average	8.0	7.7	11.9	12.0
Secondary milk	10.1	8.9	11.5	11.9

Note. Machine milking (+) with secondary hand milking.
Machine milking (–) without secondary hand milking.

Sharav (1971) has pointed out that with regard to the fat and solids-not-fat content of their milk, ewes with yields below the mean display a stronger reaction to the omission of secondary milking than those with yields above the mean. In the former group, as a result of secondary hand milking, the primary milk contains 0.5 percent less fat and 0.4 percent less solids-not-fat than does the milk obtained by machine without subsequent hand milking. The sole or primary milk of ewes with yields above the mean does not show any such difference.

Effect of secondary milking on persistency of milk yield. The influence on the persistency of yields of secondary hand milking and stripping following machine milking has been examined by Edelman (1963) by the double reversal method in four groups totalling 30 ewes for 60 days after weaning of their lambs at the age of eight weeks and a 15-day preparatory period. The experiment showed that secondary milking had a favourable influence on the persistency of milk yields which, during three periods of 20 days each, amounted to 76, 59 and 46 percent of the yield recorded in the preparatory period, as against 80, 55 and 41 percent in the ewes milked only once at a milking.

A second investigation of the effect of secondary milking and stripping after primary hand milking on the persistency of yields was conducted with two groups of six ewes each whose lambs were hand-fed during a period of one preliminary week, beginning on the fourth day after lambing, and six weeks of actual test. In this test, secondary milking did not show a clear positive effect on persistency, probably because of the small number of animals included in the test (Table 4-66).

TABLE 4-66. **Milk yields during preliminary period (% of yield)**

Group	Preliminary week	Test weeks					
		1	2	3	4	5	6
Without secondary milking	100	92.8	81.5	68.1	65.8	64.6	68.4
With secondary milking	100	91.9	79.6	69.6	71.5	69.0	65.8

Retention of milk by the Awassi ewe. Cows of primitive breeds frequently yield their milk only in the presence of their calves. In improved dairy breeds it is customary to strip the cows after machine or hand milking to obtain the remainder of the milk not drawn at the main milking. The purpose of stripping is to obtain a larger quantity of milk, more especially since the last-drawn milk from a cow is particularly rich in butterfat, and to prevent a decrease in milk secretion and premature involution of the udder owing to pressure within the ducts and alveoli.

A similar procedure has to be followed in the case of the Awassi ewe. However, in contrast with dairy cattle, the Awassi ewe yields to stripping only part of the milk remaining in the udder after machine or hand milking. A remnant is retained even after thorough and repeated stripping, and is recoverable only by the sucking lamb or the use of oxytocin. Apparently, the stimulation of the Awassi ewe's teats by hand or mechanical milking causes slighter afferent impulses to the central nervous system than suckling, with the result that the oxytocin secreted by the posterior pituitary and supplied by the blood to the mammary glands is insufficient to exercise optimum intraglandular pressure to squeeze the last milk from the alveoli and ductules.

The quantity of milk which Awassi ewes do not yield to the pail but retain in the udder for their lambs was ascertained in fortnightly evening tests of 13 ewes in the first two months of lactation (Folman, Eyal & Volcani, 1960). After primary and secondary milking by experienced milkers, and as soon as no further milk could be obtained by stripping, the lambs were admitted to the ewes and the quantity of residual milk established by weighing the lambs immediately before and after a few minutes' suckling (Table 4-67).

TABLE 4-67. **Residual milk after milking and stripping**

No. of ewes tested	Mean quantity of milk yielded to the pail (kg)	Mean quantity of milk yielded to lambs (kg)	Total milk yield (kg)	Milk yielded to lambs (% of total yield)
13	0.995 ±0.184	0.570 ±0.108	1.565 ±0.180	36.5 ±6.17

The high rate of milk retention by the Awassi ewe is also illustrated by the fact that at the first suckling immediately after milking the lambs on average obtained 39.3 percent of the total quantity of milk consumed by them during a 12-hour suckling period, which, again, amounted to 55 percent of the total 24-hour milk production of their dams. The ratio between the quantity of milk suckled by the lambs in 12 hours and that yielded to the pail after 12 hours' separation from their lambs ranged from 0.84:1 to 1.64:1, pointing to considerable individual differences among Awassi ewes in milk withholding. This has been confirmed in another test in which the differences between Awassi ewes in total lactation yield were found to be much smaller than the differences in the quantities of milk yielded at milking. Four ewes with total milk yields of 1 132, 1 115, 1 100 and 941 g, respectively, retained 128,0,233 and 533 g of these amounts for their lambs. The average yields for each combined morning and evening milking of all 25 ewes included in the test were as given in Table 4-68.

From these data it appears that nearly all Awassi ewes retain some milk in their udders which is not yielded to the milkers. This is connected with their maternal instinct. Some ewes withhold only about 25 percent of the total quantity of milk secreted, while others retain as much as 50 percent. Ewes retaining a small percentage of their total milk are usually, though not always, among the superior milkers. It is believed that at the morning milking the percentage of residual milk in total production is somewhat smaller than at the evening milking.

First-lambing ewes retain a larger proportion of their total production for their lambs than older ewes. In tests with 63 sucklings in 1952 and 250 in 1953, Doron (1954b) recorded residual quantities of 27 and 26 percent, respectively, of the total milk production of ewes that had lambed at least twice, while first-lambing ewes retained 42.5 percent of their total production for their lambs, yielding only

TABLE 4-68. **Milk yields at milking and suckling**

Milking and suckling	Milk		Fat (%)
	g	% of total	
Primary milking by machine	568	60.1	4.05
Secondary milking by hand	162	17.1	7.54
Residue suckling	216	22.8	—
Total	946	100.0	—

Source: Eyal, Volcani & Sharav, 1958

TABLE 4-71. **Fat content of evening milk under different suckling regimes**

Suckling regime	Primary milk (%)	Secondary milk (%)	Residual milk (%)
Two residue sucklings	4.73	6.94	8.66
12-hour night suckling	4.13	6.29	7.70

TABLE 4-69. **Residual daily milk yields after machine and hand milking or machine milking only (g)**

20-day test period	Group			Group II		
	Machine milked yield	Hand milked yield	Residual milk	Machine milked yield	Hand milked yield	Residual milk
First	1 107	—	261	863	294	188
Second	428	244	120	784	—	273
Third	480	—	195	426	201	125
Average	672	244	192	691	248	195

TABLE 4-70. **Residual milk consumption of lambs after machine and hand milking or machine milking only of ewes (g)**

20-day test period	GroupI		Group II	
	Machine milking of ewes	Machine and hand milking of ewes	Machine milking of ewes	Machine and hand milking of ewes
First	—	326	712	—
Second	450	—	—	522
Difference	124		190	

57.5 percent to the pail. The quantities of residual milk consumed by the lambs varied greatly, namely between 100 and 700 g a day.

The quantity of residual milk depends to a considerable degree on the preceding milking system. If it consists of primary machine milking followed by secondary hand milking and stripping, the quantity is smaller than in case of machine milking only. This is shown by the average daily quantities of residual milk for each ewe obtained by Sharav (1971) by oxytocin injection immediately after completion of machine milking or machine and hand milking in two similar groups of 16 non-suckling Awassi ewes each (Table 4-69).

In a test with one group of eight and another one of ten suckling Awassi ewes, which in two 20-day periods were alternately machine milked or machine and hand milked or vice versa (see also p. 163 and Table 4-56), Sharav (1971) recorded the average daily quantities of residual milk consumed by the single lambs given in Table 4-70. The test showed that the quantity of residual milk of ewes that were machine milked without additional hand milking exceeded that available to the suckling lambs after a secondary hand milking of their dams by an average of 157 g a day.

If lambs are not suckled but hand- or self-fed, the residual milk remains in the udder. It remains undecided whether this is available at the following milking (when a similar quantity of residual milk is again retained) without detriment to the milk secretion in the interval between two milkings or whether the residual milk to some extent slows down milk secretion in the udder and thus lowers total production.

While the large retention rate of milk in the Awassi suggests the necessity for genetic selection against this phenomenon, which is doubtless negative in a dairy breed, its high variability (as well as its absence in the modern dairy breeds of cattle and goats) holds out promise of success in this

direction. The residual milk forms the basis of the system of residue suckling, now generally employed by breeders of the improved Awassi sheep of Israel.

Edelman (1963) recorded the average percentage and quantity of butterfat in the milk which the suckling lamb obtains during the first eight weeks of its life under the residue-suckling regime by allowing the lamb to suck, after milking and stripping, the residual milk from one teat and by simultaneously milking the other one to the last drops that can be obtained in this manner. Eight lambs were weighed before and after residue suckling, and the weight difference was compared with the weight of the milk obtained from one teat. From the test of the residual milk the quantity of butterfat consumed by the lambs was calculated for two residue sucklings over a period of eight weeks. The result indicated that the average quantity of residual milk obtained by the lamb during the test period was 24.64 kg with 8.66 percent or 1.960 kg of fat.

However, even with the hand milking of one teat while the lamb sucked the other one, a small amount of milk still remained in the milked-udder half, which could not be drawn by the milker but was yielded to the lamb. This minute quantity would be even richer in fat than the residual milk actually recorded.

The average percentage of fat in the residual milk (in addition to the primary and secondary milk) of this residue-suckling group was compared with that of a similar group of ewes, differing only in the suckling of their lambs 12 hours at night. In the morning the ewes of this group were milked to remove any leftover milk so that both groups started the day with empty udders (Table 4-71) (Edelman, 1963).

The higher fat content of the milk in the residue suckling group than in the 12-hour suckling group is partly or wholly a result of the lower primary, secondary and residual evening yields (345:383 g, 93:106 g, and 353:450 g, respectively) as a consequence, apparently, of the lesser stimulation of production by residue suckling than by 12-hour suckling.

The milk of those ewes that yield the major part to the pail and retain little residual milk for their lambs contains a higher percentage of fat than the milk derived from ewes which at the primary and secondary milking yield a relatively smaller portion of their total production (Eyal, Volcani & Sharav 1958).

In the residual milk obtained by oxytocin injection immediately after milking in two groups of 16 ewes each, milked by machine alternately with or without secondary hand milking, Sharav (1971) recorded 11.2 percent fat in both groups, and 11.8 and 12.3 percent solids-not-fat, respectively.

Milk consumption by lambs under different suckling regimes. Bedouin and fellahin leave the young lamb with its dam until weaning at the age of approximately two months. During this time the ewes are not milked. Under this suckling regime, lambs of unimproved Awassi stock consume approximately 30-40 kg of milk (Mason, 1967, gives an estimate of 20 kg; see p. 141).

During the early years of Awassi improvement, until about 1950, the same suckling system was prevalent among Jewish breeders in Palestine, at any rate with regard to female lambs and males selected as future breeding stock. The majority of the male lambs were sold for slaughter at an early age.

With the improvement in milk yields, the lambs under this suckling regime consumed ever larger quantities of milk. Hence, breeders considered the feasibility of restricting the suckling time. At the Acre Government Farm in a trial with three groups of female lambs, of which one group — in addition to a ration of concentrates, hay and green fodder—received the whole amount of their dams' milk for 60 days, the second group for four weeks and the third group for two weeks followed by night suckling until the age of 60 days, the lambs of the two test groups with partial suckling were not retarded in their growth at weaning (Atzmon & Doron, 1951). With full suckling for a fortnight and partial suckling until the age of 60 days, the lambs consumed between 46 and 771 of milk. During the suckling period, the daily milk consumption ranged from 1.0 to 1.41 f or each lamb, with very little weekly variation. In another trial conducted at the Neve Ya'ar Experiment Farm, Awassi lambs that received a total quantity of 55.651 of milk weighed 21.1 kg on average at weaning, while those that consumed 79.861 weighed 22.3 kg at 60 days (Becker, 1958).

In view of the unnecessarily high milk consumption by lambs under a two months' full suckling regime, breeders began to restrict the suckling period. The lambs then remained with their dams for a fortnight during which the ewes were not milked. During the following six weeks the ewes were milked in the evening after their return from pasture, while the lambs stayed with them for 12 hours at night. In the morning the ewes were again milked for the remainder left over by the lambs.

At the present time several different suckling regimes are current among breeders of the improved Awassi. In a highly improved stud flock the male and female lambs stay with their dams for one week. During this time the ewes are milked twice a day as the lambs are incapable of consuming

all the milk produced by the ewes. After the first week a 12-hour suckling period follows until the lambs are a month old and have attained a live weight of 11-12 kg. From then on they are suckled for eight hours a day, divided into two periods of four hours each or of three and five hours, respectively. When their weight reaches 20 kg, they are put on a four-hour suckling regime, divided into two equal periods after morning and evening milking until they are weaned at a weight of 30-45 kg. During the whole suckling period the lambs of this flock consume 100-150 kg of milk.

Other flock-masters keep the lambs with the ewes for, only three days after lambing so that the lamb may enjoy the full allowance of the colostrum and both lamb and ewe get used to each other. Thereafter the lamb may be put either on a 12-hour suckling regime or on two daily residue sucklings of varying length until the age of two months, and on one residue suckling in the third month, at the end of which the lamb is weaned. In a few flocks the lambs are separated from the ewes soon after birth and reared artificially on a milk substitute, just as is done with calves of dairy breeds.

The quantities of milk consumed by lambs under different suckling systems in improved Awassi flocks vary considerably, as shown by several tests. The milk obtained by single lambs in a dairy flock of improved Awassi sheep with medium milk yields (254.2 kg on average annually) under a 12-hour suckling regime was recorded once a week during a period of eight weeks (Folman, Eyal & Volcani, 1960) (see Table 4-72). The lambs were separated from their dams during the day and joined them at night after evening milking. During the nights of recording the lambs were suckled three times : in the evening, at midnight and at dawn. Each time the lambs were weighed before and after suckling, the weight difference being regarded as the weight of the milk consumed.

TABLE 4-72. **Milk consumption by lambs on a 12-hour suckling regime in an Awassi dairy flock during a suckling period of 8 weeks (kg)**

	No. of lambs	Average milk consumption a day			Total
		Weeks 0-4	Weeks 5-8	Weeks 0-8	Weeks 0-8
Male	6	1.361	1.414	1.388	77.700
Female	7	1.389	1.396	1.392	78.000

TABLE 4-74. **Milk consumption by lambs under different suckling regimes in a high-producing Awassi dairy flock 9-16 weeks after lambing**

Suckling period (weeks)	Sex of lambs	One residue suckling		Two residue sucklings	
		No. of lambs	Milk (kg)	No. of lambs	Milk (kg)
9-12	Male	5	7.7	5	19.6
	Female	11	9.3	11	19.0
13-16	Male	1	8.4	3	20.1
	Female	6	4.5	5	15.8

Source: Folman, Eyal & Volcani, 1966c

TABLE 4-73. **Milk consumption by lambs under different suckling regimes in a high-producing Awassi dairy flock during 8 or 9 weeks after lambing**

Suckling period (weeks)	Sex of lambs	12-hour suckling		4-hour suckling		Two residue sucklings	
		No. of lambs	Milk (kg)	No. of lambs	Milk (kg)	No. of lambs	Milk (kg)
1-8	Male	—	—	8	58	11	50
	Female	—	—	16	52	13	50
1-9	Male	4	101	6	53	8	51
	Female	8	111	6	50	4	48

The milk consumed by the 13 lambs during eight weeks after birth amounted to 55 percent of the total milk production of their dams during this period (Folman, Eyal & Volcani, 1966a). The extention of this experiment to 13 male and 15 female single lambs gave the same result. The average quantity of milk suckled by the lambs of either sex in the course of eight weeks was 78 kg.

In two further trials, conducted not in a medium- but in a high-producing flock (350-380 kg of milk annually for each ewe) for eight and nine weeks, respectively, Folman, Eyal and Volcani (1966c) compared the milk consumption of male and female lambs under three suckling regimes: 12 hours, 4 hours, and two residue sucklings a day of 30 minutes each (Table 4-73). The experiments showed that under the 12-hour suckling regime, the lambs of the high-producing flock obtained approximately

one-third more milk from their dams in nine weeks than did those of the medium-producing flock in eight weeks. The quantities of milk obtained by lambs in four hours of free suckling or at two residue sucklings a day differed only slightly and statistically not significantly in favour of the four-hour suckling.

The milk consumed by the 12 lambs in nine weeks of 12-hour suckling a day amounted to 57 percent of the total yield of the ewes during these weeks, that consumed by 12 lambs in four hours of free suckling to 29 percent, and by 12 lambs under the regime of two residue sucklings to 28 percent of the total yields of their dams over nine weeks.

The 24 lambs under the four-hour suckling regime during eight weeks obtained 37 percent of their dams' total yield and the 24 lambs under the regime of two residue sucklings 34 percent of the total milk production of the ewes during this period (Folman, Eyal & Volcani, 1966a).

The quantities of milk consumed by lambs of the high-producing flock at one or'two residue sucklings a day (along with liberal rations of hay and concentrates) from the ninth to the twelfth and from the thirteenth to the sixteenth week after lambing were as given in Table 4-74.

The suckling percentage, that is, the amount of milk consumed by lambs as a percentage of their dams' total milk production during a given period, amounted on average to 16 percent in one residue suckling and to 30.5 percent in two residue sucklings during weeks 9-12. During weeks 13-16, the sucking percentage was 13 percent in one residue suckling, and 31 percent in two residue sucklings (Folman, Eyal & Volcani, 1966a).

In another trial, Edelman (1963) recorded the quantities of milk consumed by lambs under different suckling regimes in a dairy flock. Group I, comprising eight single lambs, obtained the residual milk of their dams for eight weeks twice a day after milking and stripping. Four of these eight lambs (group Ia) continued one residue suckling a day for another 12 weeks, while the other four lambs (group Ib) were weaned at eight weeks. Group II, composed of seven single lambs, stayed with their dams during eight weeks for 12 hours at night, after they had been hand milked and stripped in the evening. Thereafter, three of these seven lambs (group IIa) continued one residue suckling a day for another 12 weeks, while the other four lambs (group IIb) were weaned at eight weeks, that is, according to the same procedure as in group I. Under these different suckling regimes the lambs obtained the average quantities of milk given in Table 4-75.

During the first eight weeks the lambs that stayed with their dams for 12 hours at night received nearly three times as much milk (71.1 kg) as the lambs on a regime of two residue sucklings a day (24.6 kg). On a regime of one residue suckling a day in the following 12 weeks, the difference in milk consumption between the two groups (22.9 and 27.4 kg) was not statistically significant.

In a mutton flock of improved Awassi sheep in which the ewes were not milked but suckled their lambs until weaning at the age of 16 weeks, Folman, Eyal and Volcani (1960) recorded the quantities

TABLE 4-75. **Milk consumption by Awassi lambs on residue and 12-hour suckling regimes (kg/head)**

Group	I	- Two residue sucklings a day for 8 weeks
	Ia	- One residue suckling a day from weeks 9-20
	Ib	- Weaned at 8 weeks
Group	II	- 12-hournightsucklingfor8weeks
	IIa	- same as Ia
	IIb	- same as Ib

Weeks	Group I		Group II	
	a	b	a	b
1-4	16.06	16.64	35.91	43.66
5-8	9.50	7.07	27.03	35.60
1-8	25.56	23.71	62.94	79.26
9-12	10.60	—	9.20	—
13-16	7.10	—	8.68	
17-20	5.23	—	9.55	
9-20	22.93		27.43	—
0-20	48.49	23.71	90.37	79.26

of milk consumed by single lambs. Until eight weeks the lambs stayed at home and had free access to hay and concentrates. From the age of eight weeks they were pastured for eight hours a day without their dams, and from 12 weeks together with their dams.

The milk consumed by the lambs was recorded once a week save for the fourth month when records were taken once a fortnight. During the days of recording the lambs were suckled three times: in the evening after the return of the ewes from pasture, at midnight, and at dawn before the ewes were taken out to pasture. Each time the lambs were weighed before and after suckling, the weight difference being regarded as the weight of the milk consumed (Table 4-76).

In another publication (Folman *et al.*, 1966), the results of the test were contracted as shown in Table 4-77.

At the first suckling after the return of the ewes from pasture the lambs on average consumed 41 percent of the total quantity of milk suckled in the course of 24 hours, a percentage very close to that obtained at the residue suckling in the dairy flock (39.3 percent) (see p. 167).

TABLE 4-76. **Milk consumption of lambs in an Awassi mutton flock during a suckling period of 16 weeks (kg/head)**

	No. of lambs	Average milk consumption a day					Total consumption	
		Weeks0-4	Weeks 5-8	Weeks 0-8	Weeks 6-12	Weeks 13-16	Weeks 0-16	Weeks 0-8	Weeks 0-16
Male	7	1.686	1.598	1.642	1.589	1.024	1.474	91.952	165.088
Female	7	1.486	1.445	1.466	1.382	0.827	1.285	82.068	143.920

TABLE 4-77. **Average milk consumption by lambs during 16 weeks of suckling**

Weeks	Milk (kg)
0-8	87 ±3.7
9-12	42 ±1.7
13-16	26 ±1.5
Total	155 ±6.1

TABLE 4-78. **Milk yields of Awassi ewes in Cyprus under different suckling regimes (kg)**

Suckling period	0	2	35
35-day yield	63	65	80
150-day yield	172	185	210
Total milk yield	195	212	252

Source: Cyprus ARI, 1973

Effect of suckling on persistency of milk yield. Suckling has a positive effect on the milk yield of Awassi ewes. In an experiment with 33 Awassi ewes descended from improved Israeli stock, the effects of three weaning regimes—immediately after birth, after two days and after 35 days — on 35-day, 150-day and total milk yields were recorded in Cyprus in 1971. The 35-day and 150-day yields of ewes suckling one lamb for 35 days were significantly higher than those of the ewes on the zero or two-day suckling regimes, while the differences between the latter two were not significant (Table 4-78).

After weaning of the lamb at the age of eight weeks or earlier, the milk yield of Awassi ewes tends to decrease abruptly. In ewes in which residue suckling is continued after this date, the yield decreases at a slower rate. In a test in 1952 in which the milk yields of ten ewes whose lambs were weaned at eight weeks were compared with 11 others with continued residue suckling, it was found that suckling had a favourable influence on milk yields until the thirteenth week after lambing. In a similar test with two groups of 19 and nine ewes in 1953, the advantageous effect of suckling continued throughout the

length of the lactation period. The combination of the two tests, with the average yields during the fifth week set at 100, shows the percentages in milk yields given in Table 4-79 in the course of 19 weeks of lactation (Doron, 1954a).

It is notable that the separation of the Awassi lamb from its dam for merely 24 hours on the day of milk recording in itself causes a sharp decline in production in the following days, as shown by a statistically significant difference in yield two days after recording from that five days prior to recording (Folman, Volcani & Eyal, 1962).

TABLE 4-79. **Effect on milk yields of weaning at 8 weeks versus continued residue suckling**

Weeks after lambing	Milk yields of ewes (% of 5th week's yields)	
	Lambs weaned at 8 weeks	Continued residue suckling
5	100.0	100.0
7	98.1	89.0
9	66.4	81.1
11	58.9	66.8
13	52.3	61.3
15	45.6	55.9
17	36.5	45.9
19	32.9	36.6

Awassi milk products

Fresh milk and butter. Owing to its high viscosity and peculiar taste, Awassi milk is not usually consumed as fresh milk. It can be used as such, though, by mixing it at a ratio of 60 parts of milk with 40 parts of water, when it approximates cow milk in composition and cannot easily be distinguished from cow milk in taste. A more preferable means of fitting it for fresh milk consumption is an admixture of 50-60 percent skimmed cow milk. This produces a superior drinking milk if not adulterated by water and a better taste and flavour than an admixture of skimmed Awassi milk.

Butter made from clean, sweet Awassi cream, separated and pasteurized soon after milking and ripened with a clean-flavoured starter prepared from a pure culture of lactic acid bacteria, is very similar in taste and flavour to butter made from cow milk. Its consistency may be less firm, the colour a little paler and the keeping quality poorer. Before centrifugation the milk has to be heated to about 45°C, as otherwise an undue percentage of fat remains in the skimmed milk. The butter must be carefully washed to remove remnants of buttermilk which impair the keeping quality and flavour of the product, and subsequently has to be salted.

In central dairies in Israel, butter made from the milk of Awassi ewes is preserved for the purpose of extending the season of cheese production beyond the main lactation period of the ewes. During this time the milk from Friesian cows with the addition of Awassi butter serves the production of cheese marketed as Kashkaval, or a Provolone- or Roquefort-type cheese purported to be made of sheep milk (Gordin, personal communication, 1982). The butter from Awassi milk is necessary to convey the characteristic flavour and texture of sheep milk cheese, characteristics which result from the partial lipolysis of the fat and the difference between sheep and cow milk in the fatty acid composition, more especially the higher contents of capryl, caprin, laurin and linoleic acids in sheep milk.

Sibdeh* and *samneh* or *deehin. Bedouin and fellahin produce *samneh* (clarified butterfat) from Awassi milk. Its production, usually the work of women (sometimes with the help of an old man) involves two stages: first, *sibdeh,* which resembles ordinary butter, is made. As soon as milked, the fresh milk is poured into a goatskin bag which contains some of the buttermilk that has remained from the previous day's churning. The skin is hung outside the tent or building for the night. Early in the morning the bag, half-filled with the sour and curdled milk, is blown up with air, hung from a tripod and shaken for about one and a half hours until the butter separates from the buttermilk. Toward the second stage, the *sibdeh,* which usually contains larger or smaller amounts of dirt and buttermilk, is removed from

the skin bag and put into a copper vessel where it is salted and spiced with grain, saffron or aromatic herbs. It is then heated over a fire under constant stirring to a temperature of 100°C. In the course of this procedure the water sinks to the bottom or evaporates, some of the dirt rises to the top where it is removed with a wooden spoon, while the heavier dirt settles to the bottom. After an hour or so the *samneh* thus derived is poured through a filtering cloth into a clean vessel and left there for about a day. It is then put into a goatskin bag which is kept in a cool place. Such a bag may contain up to 25 kg of *samneh.* Clean *samneh* with a fat content that may reach 99.7 percent keeps well for a fairly long time.

The large quantities of buttermilk remaining from *sibdeh* production are either consumed fresh or cooked with rice or converted into *kishik* (Hirsch, 1933).

In Iraq, *deehin,* the local term for clarified butterfat *(samneh* or *samnah)* made from Awassi milk, is made as follows (Williamson, 1949). As they are folded in the evening the ewes are milked by the women. The milk is curdled and the cream separated and churned in a skin. The butter is then removed and stored until a sufficient quantity has been collected for clarification by boiling. During this process the water evaporates and the curd solidifies so that it can be removed from the fat, along with other solids separated by skimming. The *deehin* is preserved in a skin for trading. *Deehin* dealers usually pack it, without blending or further processing, in tins or sealed earthenware jars where it may remain in a fair condition for at least a year. In northern Iraq, where ambient temperatures are relatively low, it may not deteriorate for up to two years. Ordinary Awassi ewes yield 1.0-1.5 kg of *deehin* for each lactation, and the superior Awassi type of northern Iraq as much as 3 kg.

Lebben* and *labneh* *(lebbeniya). Considerable quantities of Awassi milk are used by the bedouin and fellahin for the production of *lebben* and *labneh.* For the preparation of *lebben,* fresh milk is boiled and then cooled to a temperature of approximately 60°C. A little *lebben* of good taste from the previous day, containing the micro-organisms necessary for fermentation, is mixed with the milk. The mixture is kept for five to six hours at a temperature of about 25°C when the firm *lebben* is ready for consumption.

Labneh (or *labbeniya)* is prepared from milk that is boiled for a few minutes, cooled to 40-45°C, inoculated with a starter of about 2 percent from a previous batch, and stirred. Within two or three hours the temperature slowly drops to the ambient temperature, the coagulum is kept in a cool place for 10-12 hours and is then transferred to a goatskin or cloth bag that is hung up for about a week to drain the whey. During this time the curd is repeatedly mixed by hand and salt is added in daily portions. At the end of the week a semi-fluid, soft white cheese is obtained which may be consumed fresh or, after keeping it in the sun for partial drying, be formed into balls of about 3 cm in diameter and packed into jars in which it is covered with olive oil. The product, which in Lebanon is called *labneh-ambaris*, can be kept without refrigeration for up to a year.

Labneh from Lebanon, analysed by Baroudi and Collins (1976), had a titratable acidity of 1.05 percent, a pH of approximately 4.25, an ethanol content of 1.25 percent, 4.2 ixg acetaldehyde, and 34 u.g/ml acetoin plus deacetyl. In *labneh* from Israel, Rosenthal *et al.* (1980) ascertained 0.045 milliequivalents/g of free fatty acids and a pH of 3.59.

Five micro-organisms were found to be responsible for the fermentation: *Streptococcus thermophilus, Lactobacillus acidophilus, Leuconostoc lactis, Kenyveromyces fragilis* and *Saccharomyces cerevisiae. S. thermophilus* and *L. acidophilus* were responsible for the acid production, the former also for that of the acetoin, and *K. fragilis* for most of the acetaldehyde (Baroudi & Collins).

Kishik *and* chanklich. To prepare *kishik,* buttermilk, to which salt has been added, is poured into a cloth bag which is hung up for two or three days. During this time it is repeatedly shaken until most of the fluid has drained off. The semi-dry material is formed into round lumps of lemon-size which are dried in the sun until they become very hard and may be kept unspoilt for a long time. *Kishik* is used as an addition to many different dishes.

In Lebanon the term *kishik (kishk* or *kushuk)* is used for *labneh* rubbed with cracked wheat, and the term *chanklich* for *labneh* mixed with herbs and spices, mainly thyme, shaped into balls and partially dried before being packed into jars and covered with olive oil (Tamime & Robinson, 1978). This product is also known *asjub-jub* (Gordin, 1980).

Yoghurt. In yoghurt prepared from Awassi milk by the primitive method common in peasant households, two different bacteria are found, namely *Streptococcus thermophilus* and *Lactobacillus bulgaricus.* In some samples *Streptococcus lacti* also occurs; at a temperature of about 45°C, this

produces considerable quantities of lactic acid, such yoghurt having a very sour taste. The activity of *L. bulgaricus* sets in when there is already a reduction in the pH as a result of the presence of lactic acid. The importance of this micro-organism lies in the specific yoghurt flavour it produces. Yoghurt made in peasant households and small dairies may contain additional micro-organisms that are typical of different regions. Thus, in Turkey yeasts contribute to the alcohol content and alcoholic taste of the local yoghurt. Some of the micro-organisms are found only in fresh yoghurt, for part of them disappear during storage when only those that can stand a pH of 3.7-4.1 remain.

If yoghurt is prepared at the right temperature (above 40°C), the rapid development of lactic acid also inhibits the growth of harmful non-thermophile micro-organisms. In this way satisfactory yoghurt can be produced even from milk that has not been pasteurized. But commonly the milk is heated to 90-95°C and stirred at this temperature for up to two hours to destroy all micro-organisms contained in fresh Awassi milk and to thicken it by evaporation. The milk is then cooled to 45-47°C and approximately 0.5 percent yoghurt is added from a previous batch. The mixture is kept at a temperature of about 40°C for three to four hours until it becomes firm. The curdled mass is poured into another vessel that has been placed as low as possible so as to create a large amount of foam. The foam forms a firm upper crust in which part of the dirt contained in hand-milked Awassi milk accumulates and which isolates the yoghurt from the air. Before consumption the foam is removed. The yoghurt is stored in a cool place, but owing to the high total solids content of Awassi milk, the previous water evaporation, and denaturation of whey proteins, Awassi yoghurt has a firm consistency and the whey does not separate from it even if not stored in a cold room.

In dairies the Awassi milk is heated for five to ten minutes to a temperature of 90-95°C, then cooled to 40-42°C, and 1-2 percent of a pure culture mixture of *S. thermophilus* and *L. bulgaricus,* preferably in a 1:1 ratio, are added (Kosikowski, 1978). The milk is usually poured into plastic containers and kept at a temperature of 40°C. As soon as the yoghurt becomes firm, it is transferred to a cold room.

Cheese production from Awassi milk.

Baladi *cheese.* Fellahin also use Awassi milk for the production of *baladi* cheese. A small piece of kid's or lamb's abomasum is added to fresh, warm milk and the curdled mass put into a cloth bag through which the whey drains. The residue is pressed, cut into small cubes and salted for immediate consumption or preserved in brine.

Bedouin prepare this cheese from Awassi milk in a similar manner. The milk is heated to the near-boiling point, then cooled to about 40°C in winter and 32°C in summer. After the addition of rennet the milk is kept in an earthenware vessel at an ambient shade temperature for approximately three hours. When whey appears on the surface, the curd is considered to be ready for removal to a cloth bag which is suspended in or outside the tent for 12 hours. The bag is then placed on a wooden board, another board is put on top of it and pressed down by weights of approximately 1 kg for each 1 kg of curd for 10-12 hours. The cheese is then removed from the bag and cut into cubes. These are put in layers into a tin with about 10 percent salt of the weight of the cheese spread between the layers. The salted cheese is left undisturbed without any addition of water until enough moisture exudes to cover it. For consumption, pieces of cheese are removed from the tin, warmed in a pan over a fire until nearly melted, and eaten with home-made bread (Gordin, personal communication, 1980).

Brynza. The early development of the improved Awassi sheep in Palestine was closely connected with the production of *brynza* cheese, on the sale of which the economy of sheep farming in communal settlements and on private farms was based. *Brynza* was prepared by the addition of 1 g of calf or lamb rennet extract and sometimes also 30 g of potassium nitrate (saltpetre) to every 7 or 8 kg of Awassi milk held at a temperature of 32°C for 15 minutes to a half hour. The curd was cut into pieces, removed in thin layers from the whey with a strainer, put into cheesecloth and transferred to hoops or forms. Weights of V kg for every 1 kg of milk were placed on the forms for half an hour. Then the pressure was doubled for another eight hours, the cheese was turned over and the pressure reduced. After a further 12 hours the cheese was cut into large pieces which were put into a 12-percent salt solution. A few days later it was packed into large tins, covered with a 14-percent solution of brine and kept in cold store until sale. The taste could be improved by using boiled salted whey instead of water for the brine.

For *brynza* to be kept in brine the separated whey is heated to a temperature of 95°C and 15 percent sour whey is added to it. The mixture is kept at 95°C for another few minutes, then cooled to 40°C, strained, combined with a starter and left for 48 hours. Then 20-22 kg of salt are added to every 100 1 of whey and the *brynza* is placed in the brine for 24 hours. At the end of this period it is taken out, salted and kept for four and a half days. The *brynza* is then packed into barrels in layers

with salt on top of each layer. When the barrel is filled, the cheese is covered with a 14-percent salt solution of whey. With an eventual total salt concentration in the whey of 17 percent, the *brynza* will contain 5-6 percent salt and about 50 percent water. It can be kept at a temperature of 15°C for a short time, and at 12°C for a longer period. The barrel has to be turned from time to time to ensure an even distribution of the salt (Kern, 1953).

In large dairies *brynza* is made from pasteurized Awassi milk to which are added 0.5-0.6 percent of a good starter and a 40-percent calcium chloride solution in the proportion of 75 g for every 1001 of milk. A quantity of rennet sufficient to cause curdling within 35-40 minutes is mixed with the milk which is held at a temperature of 30°C in summer and 32°C in winter. The curd is lifted with a flat spoon in layers of about 3-cm thickness on a cheesecloth spread on a table so that the whey may drain from it. Layers of curd are then put one on top of the other to a height of 20 cm and the cheesecloth is tied up. After the whey has percolated, the cloth is untied, the cheese turned over and the cloth tied up again. This is repeated two or three times. The curd is then placed in a press. At first only light pressure is exercized; after about 40 minutes the cheese is turned over and the pressure is increased to approximately 15 kg for every 1 kg of cheese. The finished product is placed in brine made from 26 kg of salt for every 1001 of water at a temperature of about 18°C, where it remains for 24 hours. The *brynza* is then taken out of the brine, salted and packed in barrels or boxes. In summer the brine is changed every seven days and in winter every fortnight. It is not discarded but boiled and filtered, and its acidity neutralized with lime.

Safed *cheese.* This cheese resembles *brynza,* but the milk is thickened at a higher temperature (33-35°C), which produces a firmer curd. The curd, separated from the whey, is put into straw baskets which give the cheese a round shape and leave a characteristic pattern on its surface. It is transferred several times from basket to basket and salted each time. *Safed* cheese can be kept in a cool place for several months if turned over and salted anew from time to time. Its inside is softer than that of *brynza* and it contains a smaller percentage of salt (Kern, 1953).

Feta. To produce *feta*-type cheese (the name is derived from a Greek word) Awassi milk, curdled with rennet or chicken pepsin in large vats, is cut into small pieces of a gelatinous consistency. From the vats it is put into perforated moulds in which it is left without pressure for 24 hours for the whey to percolate. It is then cut into blocks of 1-kg weight, salted and placed in layers in vessels with salt between the layers. After a week it is transferred to canisters holding 16 kg of cheese and covered with salted water. The canisters are then hermetically sealed and kept for a month in cold store at a temperature of 6-8°C for the *feta* cheese to ripen.

Another procedure for the production of *feta* cheese from ewe milk is recommended by Kosikowski (1978). In summer the milk is kept for 10-15 minutes at a temperature of 63°C or is pasteurized at this temperature for 30 minutes. It is then transferred to cheese vats where it is cooled to 34°C in summer and 32°C in winter. A 1-percent lactic acid starter is added and the milk is thoroughly blended with rennet. After 30 minutes a firm curd forms in summer and after 60 minutes in winter. This will drop to the bottom of the vat in 10-55 minutes. It is then scooped into a cloth bag that is hung in a cool room overnight for the curd to drain and mat. Alternatively the curd may be transferred directly into circular moulds, 40 cm in diameter, which are kept at room temperature for four to five hours and frequently turned for the whey to percolate. The properly knitted curd mass is cut into blocks of 10 cm. These are liberally salted on the surfaces, kept on shelves for three to seven days at a temperature of 10-12°C, and turned daily until the salt content of the cheese is approximately 4 percent. At this point the *feta* cheese may be consumed fresh or the salted curd blocks placed for curing in a beechwood barrel to a height of two-thirds of the barrel, and the remaining space filled with saturated brine containing 23 percent salt. In a week's time the cheese blocks are removed from the barrel and washed with water or whey. They can then be preserved for three to six months. Before dispatch to consumers, the excess salt is rinsed off in cold water and the salt further reduced in barrels or pottery receptacles filled with water or boiled Awassi milk containing 8 percent salt, where the cheese acquires a creamy consistency and improved taste. The yield of *feta* cheese from Awassi milk is 24-28 percent.

Provolone-type bashan *cheese.* An Italian Provolone-type cheese, sold in Israel under the name of *bashan,* is produced from Awassi milk that is curdled and cut into small pieces in a similar manner to that of *feta* cheese. After separation of the whey, the curd is deposited in round moulds which are placed in vessels filled with an 18-20 percent salt solution. After 24 hours it is removed from the moulds and put separately into nylon nets in which the cheese is smoked. Instead of smoking, large

factories use solutions with a smoky taste, in which the cheese obtains the characteristic Provolone flavour. The nets with the cheese are suspended in rooms of ambient temperature for a week. Thereafter the cheese is removed from the nets and transferred to plastic bags in which it is vacuum-shrunk for six to seven weeks before sale.

Roquefort-type Galilee (Galil) *cheese. Galil* cheese is a local type of Roquefort cheese made in Israel. To produce this cheese, Awassi milk is blended with rennet and thickened at a temperature of 30°C for 80 minutes. The curd is cut into pieces of approximately hazelnut-size and dipped in a *Penicillium roqueforti* mould. This is commonly prepared from bread made of two-thirds wheat or rye flour and one-third barley flour, which after piercing of the crust is kept at a temperature of 12°C and 85 percent humidity in a dark room. The mouldy bread is dried and pulverized (Spöttel, 1954). The curd treated with the mould is transferred into hoops and held at a temperature of 22°C for 24 hours, when it is pierced by machinery with from 20-60 small needles to facilitate the penetration of oxygen into the cheese and development of the green-marbled appearance of the body of the cheese. The cheese is cured in a store-room at 6-9°C and high humidity for three months. During this period it obtains its characteristic taste and flavour from the mould and the change of part of the milk fat into free fatty acids. For final ripening, it is transferred to a cold store where it is kept at a temperature of 5°C for another three to six months before marketing. Its water content is approximately 35 percent (Kern, 1953).

Kashkaval. *Kashkaval* cheese from Awassi milk, in Turkey called *kashar* and in Israel *gilad,* is made in round forms to a weight of 3-4 kg. After coagulation of the milk by rennet, the curd is heated to 80-90°C for 30-40 minutes, kneaded, and very hot whey or water is poured on it. This causes drainage of much of the water contained in the curd and the curd's dough-like consistency. The curd is transferred into forms and subjected to pressure to exclude any superfluous moisture so that the final product may contain little more than 20 percent water. In the ripening room the cheese is salted daily on both sides until a rind is formed that is impassable to salt. The cheese is ready for marketing in about four to five months. If kept longer, it is apt to deteriorate by the decomposition of fat and acquire a mouldy taste (Kern, 1953).

Composition of Awassi whey. Whey derived from Awassi milk contains 6.7 percent solids on average. The monthly variation in the average composition of whey is given in Table 4-80 (Kern, 1953).

Awassi whey can be used for the production of a soft cheese in a proportion of 5-7 kg of cheese from 100 kg of whey. Some dairies return or sell the whey to farmers for calf-feeding and what remains is turned into dried whey powder.

Relation between Awassi milk fat and cheese fat. Whey obtained in the process of cheese production from Awassi milk contains variable quantities of fat which can be separated. Generally, cheese made from milk containing less than 3 percent fat retains practically all the fat, with hardly any of it going into the whey. With increasing percentages of fat in the milk, progressively more is discharged into the whey, as shown by the percentages of fat found in the total solids of cheese made from Awassi milk (Table 4-81) (Kern, 1953).

TABLE 4-80. **Monthly variation in the composition of Awassi whey** (%)

Month	Total solids	Proteins	Lactose	Ash
December	6.92	1.25	4.85	0.82
January	7.04	1.10	5.00	0.94
February	6.66	1.03	4.70	0.88
March	6.67	1.18	4.60	0.89
April	6.77	1.19	4.82	0.90
May	6.86	1.42	4.75	0.89
June	6.64	1.30	4.37	0.93
July	6.54	1.44	4.34	0.92
August	6.06	1.55	3.56	0.99
September	5.67	2.33	2.30	1.04

TABLE 4-81. **Percentage of fat in total solids of cheese made from Awassi milk containing variable percentages of fat**

% of fat in milk	% of fat in total cheese solids
0.5	6.5
1.0	12.4
1.5	16.7
2.0	23.0
2.5	27.0
3.0	30.0
3.5	35.0
4.0	36.5
4.5	42.5
5.0	42.5
5.5	44.0
6.0	47.8
6.5	50.0
7.0	52.3
7.5	54.5
8.0	56.8

Milking

The bedouin milk their ewes in the open. The animals are placed in two rows opposite each other and are tied together in pairs by a long rope (see Fig. 4-4). This method was adopted by the early Jewish breeders of the Awassi in Palestine and was in use, for example, at Beyt Alfa and Kefar Gil 'adi. But at Tel Yosef, Aiyelet Hashahar and Merhavia the ewes were tied individually with ropes to a long plank. As tying the animals by ropes caused some deaths by strangling, breeders began to use a straight-sided rack with upright movable iron slats to trap and hold the ewes by the neck during milking (Figs 4-5 and 4-6) (Hirsch, 1933).

In the early period of Awassi improvement, two milkers used to milk the same ewes alternately for mutual control and efficiency of milking, one the primary and the other the secondary milk and vice versa. In some flocks the ewes were milked not only twice but three times in succession in order to obtain as much as possible of the last rich milk.

Save for the first days after lambing and the last weeks before drying up, Awassi dairy ewes are generally milked twice a day, at night and noon or in the morning and evening. In the winter, when the ewes are in the first months of their lactation and every daylight hour is important for grazing, they are milked early in the morning before going out to pasture and in the evening after their return to the shed. From April, and throughout the hot and dry summer months, the cool early morning hours are devoted to grazing and the flock returns for a long rest in the shade of the shed at noon, being pastured again late in the afternoon when the heat of the day has passed, until the onset of darkness. During this period the ewes are milked either between 03.00 and 04.00 h and again at 13.00-14.00 h, or at 23.00 and 11.00-12.00 h (Becker, 1958).

Breeders endeavour to arrange equal intervals between the two milkings in order to obtain similar quantities of milk and not to overburden the udder by too long an interval. However, Nitsan and Volcani (1960) have noted that equal intervals between milkings do not necessarily produce equal quantities of milk in the Awassi. The quantity of milk obtained in the morning is usually larger than that of the evening milk, the difference being statistically significant. This is not supported by Sharav's (1959) findings in a test, during three consecutive days, with 154 ewes divided into five groups of similar composition. In this test the variations in yield between morning and evening milkings were variable, generally small, and statistically not significant (Table 4-82).

It would appear that with equal intervals between milkings fluctuations between morning and evening yields result from different conditions of feeding, activities and environment (including ambient temperature) during the day and night.

Figure 4-4. Bedouin women milking Awassi ewes in the Jordanian steppe. (Photograph courtesy of Dr Ilse Köhler-Rollefson)

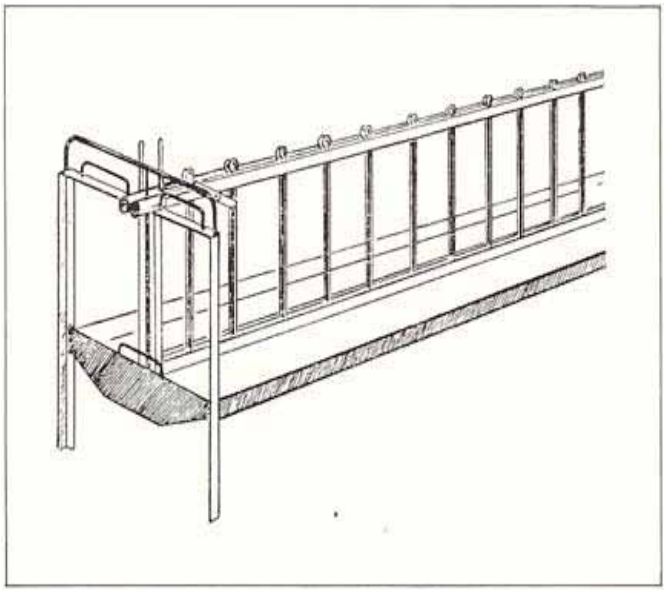

Figure 4-5. Feed rack with movable iron rungs for hand milking

In practice it is not always possible to maintain an equal interval between two milkings, and the lapse of time between two consecutive milkings may be 11 and 13 hours or even ten and 14 hours.

The first milking machine for sheep was imported into Israel from France in 1954. Later on, small portable installations were developed for temporary use. In 1955, two carousels or roundabouts for large flocks were erected in two communal settlements. The carousel is a revolving platform usually operated by hand. On Israeli farms various sizes are now in use, holding 60, 72, 80, 96, 120 and up to 240 ewes at a time. The most common system is for 72 ewes. The platform is divided into four sections: one for machine milking, the second for secondary hand milking and stripping, the third for release of the ewes after completion of milking, and the fourth for the introduction of a new batch of sheep.

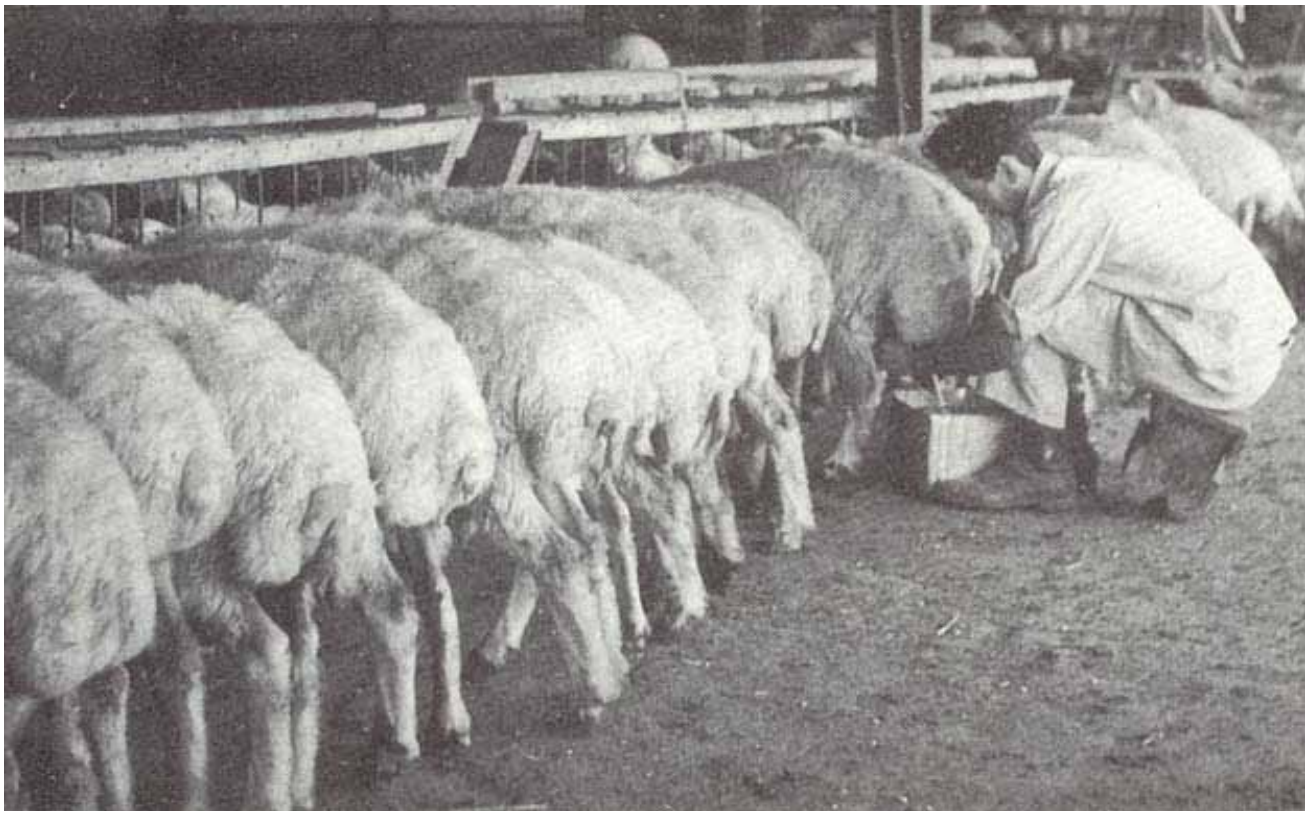

Figure 4-6. Awassi ewes trapped in racks for hand milking

TABLE 4-82. **Mean yields of morning and evening milk in Awassi ewes (g)**

Group	Morning	Evening	Total
I	662.7	692.0	1 354.7
II	670.3	656.6	1 326.9
III	701.0	783.3	1 484.3
IV	559.4	537.0	1 096.4
V	543.6	520.3	1 063.9
Mean	627.4	637.8	1 265.2

In the 72-ewe carousel the machine milking section holds 18 ewes which are milked in three groups by six units, 96 cm apart, each unit milking three ewes in succession. The milking pit is situated around one-quarter of the circumference of the platform and has a length of 5.70 m. The milking is carried out by a single worker in the pit who moves in the opposite direction to the movement of the platform. A second worker, outside the pit, completes the secondary hand milking and stripping, attends to the concentrate feeding and replaces the sheep that have been milked with a new batch.

In the 120-ewe carousel, 32 ewes are successively milked by 16 units. After completion of their milking the carousel is moved forwards. In the larger type of installation, two workers operating the milking machine and massaging the udders and a third one doing the secondary hand milking and stripping can milk 300 ewes in two hours, an average time of 24 seconds a ewe.

In very large flocks two discontinuous rotary parlours have been installed side by side, separated from one another by a single milking pit serving both platforms (Fig. 4-7). An improvement over this system is represented by a central pit which shortens the distance over which the operator has to move from 5.70 to 3 m and facilitates cooperation between the two milkers.

In another system of discontinuous rotary parlours in Israel with platform room for approximately 250 ewes, the ewes are arranged in two circles, an inner and an outer one, each of which is served by a separate milking pit and different workers, but having a common, 60-cm-wide manger. (See Fig. 4-8.)

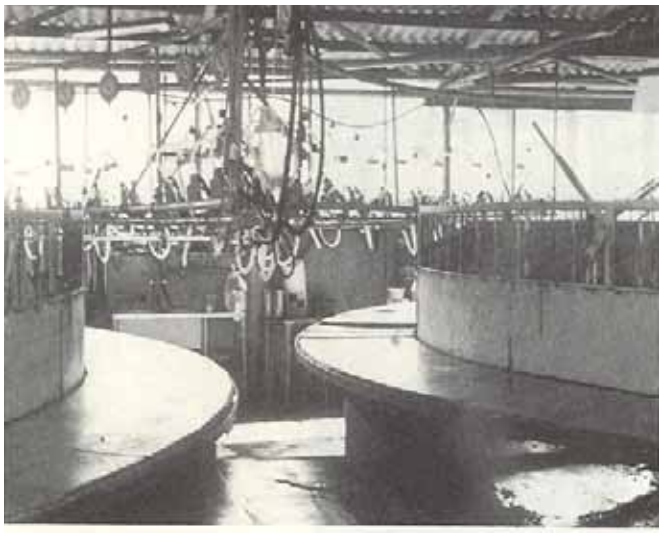

Figure 4-7. Two single-row discontinuous rotary parlours, served by a single milking unit

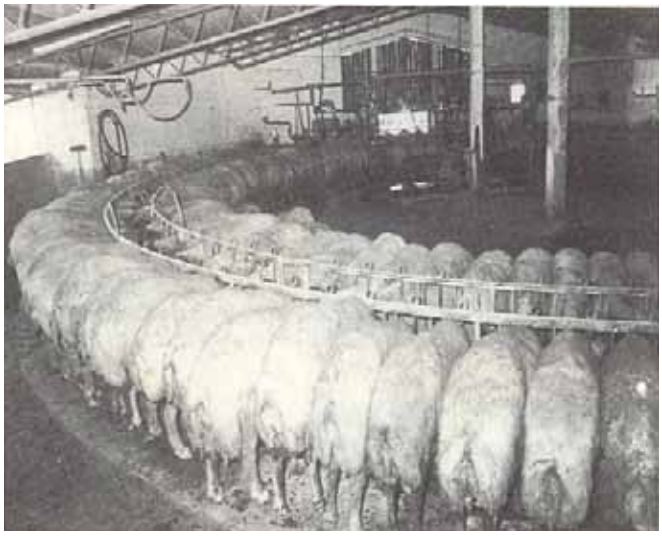

Figure 4-8. Double-row discontinuous rotary parlour, served by separate milking units

In the discontinuous rotary parlour the ewes enter the stationary platform and thrust their heads through the yokes into the feed troughs. When all yokes are occupied they are closed and the platform is rotated to bring a batch of ewes opposite the milking pit. Here the platform is stopped and the ewes are milked. After completion of milking, the parlour is again rotated to bring yet another group of ewes into the milking position and to move those that have been milked on for stripping. The platform is then rotated once more, the yokes are opened and the ewes released.

A more recently developed continuous rotary parlour greatly reduces the time and labour of the milking operation. The platform is divided into sections, each with a trough for concentrates, facing the perimeter. The ewe enters an empty section of the rotating parlour through a race and is there constrained by the neck by means of a top rail and lateral plates. The operator in the centre of the parlour massages the udder and applies the teat cups of the milking unit, suspended under the platform, to each ewe as she passes. The vacuum and milk lines run to swivel manifolds in the centre. On completion of milking, the teat cups are removed and returned to their original position under the rotary platform where they are drawn through a bath for cleaning and disinfection in preparation for a new cycle. The top rail for the confinement of the ewe rises as it approaches the exit, and the ewe departs from the platform. The partition plates with the attached troughs pass beneath the exit and entrance ramps, the empty troughs are filled automatically with new concentrates, and the partition plates and troughs return to the platform to receive further ewes for milking (Figs 4-9 to 4-14) (Morag *et al., 1972).*

In view of the high cost of rotary parlours and the considerable labour involved in milking with portable installations, three different row types of mechanized milking parlours have been introduced for smaller Awassi flocks: single row, little row, and double little row.

Row pits are installed for either 36, 48 or 72-80 ewes, and double pits for 96 animals. On small

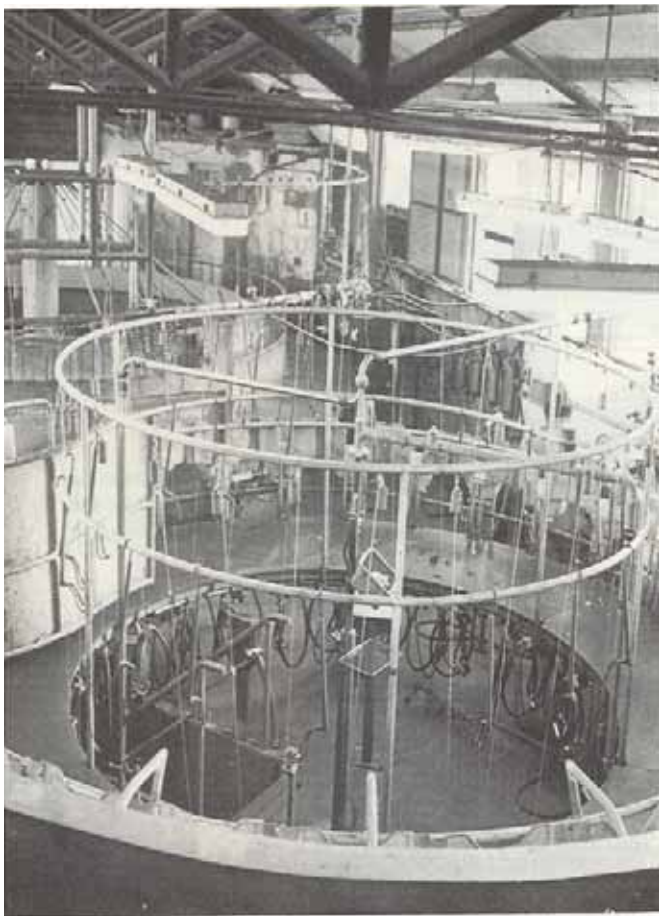

Figure 4-9. Milking units below platform and upper vacuum and milk lines of continuous rotary parlour

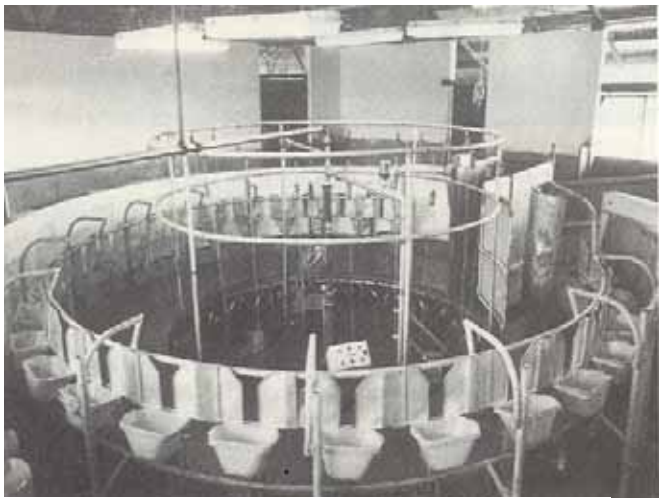

Figure 4-10. Continuous rotary parlour

family farms row pits for 36 ewes are in use. In larger flocks the 48-ewe unit is the accepted system for new installations, or two parallel row pits are installed.

The row pit has two covers which are either closed using a hand lever or operated by pneumatic or electric mechanisms. While 24 ewes are machine milked in the open section, another 24 sheep, after completion of secondary hand milking and stripping, are replaced in the covered part by a new batch. The sheep enter and leave from two sides of the platform.

The operation of machine milking in the double-row system consists of the following actions:

1) Distribution of concentrate rations, entry of ewes into the milking stalls, closing of neck locks.
2) Grasping of teat cups, opening of tap for the cluster cups, application of cups to udder.
3) Udder massage until removal of teat cups and, if necessitated by a high setting of the teats and

Figure 4-11. Continuous rotary parlour with Awassi-East Friesian cross-bred ewes

Figure 4-12. Entrance to continuous rotary parlour

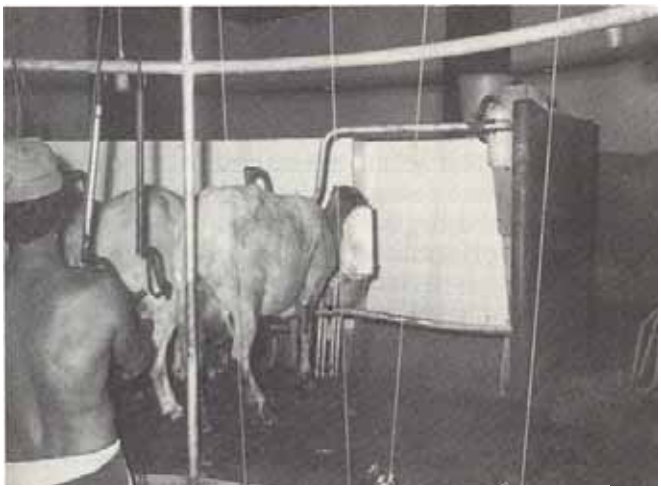

Figure 4-13. Exit from continuous rotary parlour

low position of the milk cisterns, lifting of the bottom of the udder by the lifting device suspended by a string from the upper frame of the milking unit.

4) Milker proceeds to next sheep and applies teat cups.
5) At the end of the milking pit, transfer of the cups to the ewe on the opposite side of the pit.
6) After milking of all ewes on both sides of the pit, removal of teat cups and closing of unit tap.

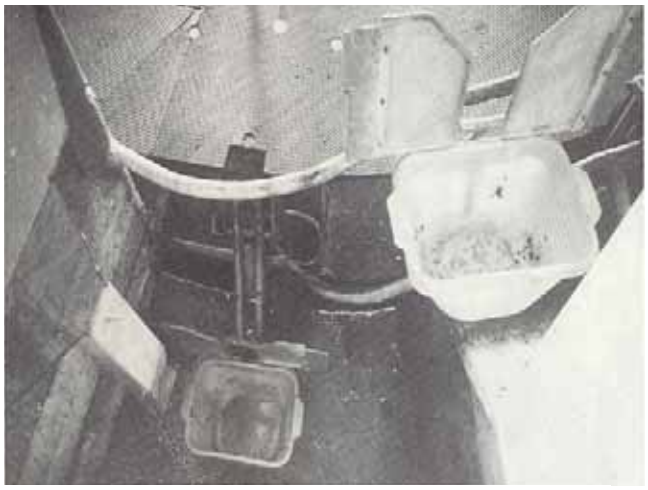

Figure 4-14. Automatic filling of trough beneath platform

7) Release of neck lock device, removal of milked sheep, distribution of concentrate feed in troughs, introduction of another batch of ewes.

As compared with the discontinuous rotary parlour, in which only one-quarter of the working space is utilized at a time, the row system permits full use of the working space (Figs 4-15 to 4-17). It is easy to increase the number of milking units and the number of workers, and the space taken up by the installation is small.

While the differences in the cost of investment between the various types of installation are large, the differences in time required for milking are slight (Sharav, 1959 ; 1973b). This does not apply to the continuous rotary parlour in which the milking operation takes far less time than in the row system or the discontinuous rotary parlour.

Milk and butterfat recording

Milk recording of Awassi sheep was initiated in Palestine in 1930. The systematic control of flocks dates from 1937, when the annual meeting of the Sheep Breeders' Association adopted a comprehensive control plan. The association had to decide if control should be restricted to a relatively small number of flocks, which would allow employment of official controllers, or if the number of milk-controlled flocks should be as large as possible, even at the risk of certain inaccuracies. The latter course was adopted. Originally it was decided that control be carried out twice a week, but as this demanded an excessive amount of labour, the control was finally limited to once a month.

The quantity of milk consumed by the lamb during the suckling period was determined by multiplication of the yield on the first day of control after weaning with the number of days that had elapsed between lambing and weaning. At that time the lambs still obtained the entire milk of the ewes during the suckling period. However, the length of the latter differed between lambs reared for slaughter and females and selected males destined for breeding. Slaughter lambs were weaned earlier than breeding animals. In case of the death of a lamb during the suckling period, the latter would be shorter, while ewes with stillborn lambs were milked from the beginning. In most instances of weaning after more than 60 days the lactation curve was already on the downgrade from the point at which the milk yield would normally have been recorded for the first time. In these cases the estimate of the quantity of milk consumed by the lamb, from the daily yield at the first milk control after weaning, was lower than in reality. For this reason it was decided not to permit the first control to be carried out later than 75 days after lambing.

This system of milk control was in vogue during the period 1937/38-1953/54, that is, for 16 years. In the meantime the milk yields of the Awassi had increased considerably and Atzmon and Doron (1951) demonstrated experimentally that there was little difference in the mean weight increase between three groups of lambs that received (1) the entire milk of their dams for eight weeks, (2) all the milk for four weeks and half the milk for another four weeks, and (3) all the milk for two weeks and half the milk for six weeks. Many breeders, therefore, adopted a regime of restricted suckling.

Experiments conducted at the Acre Government Farm in 1951/52 and 1952/53 confirmed that suckling Awassi lambs obtained considerably larger quantities of milk than had hitherto been assumed (see p. 167, last paragraph). The average quantity of milk consumed during the suckling

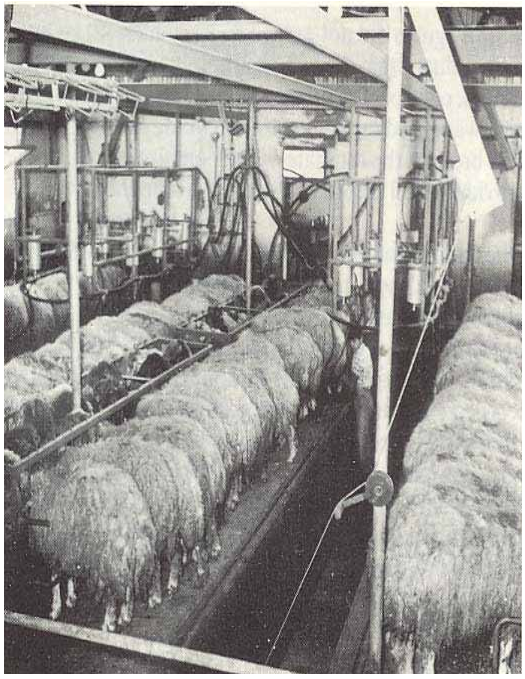

Figure 4-15. Awassi milking parlour in use. Double-row system

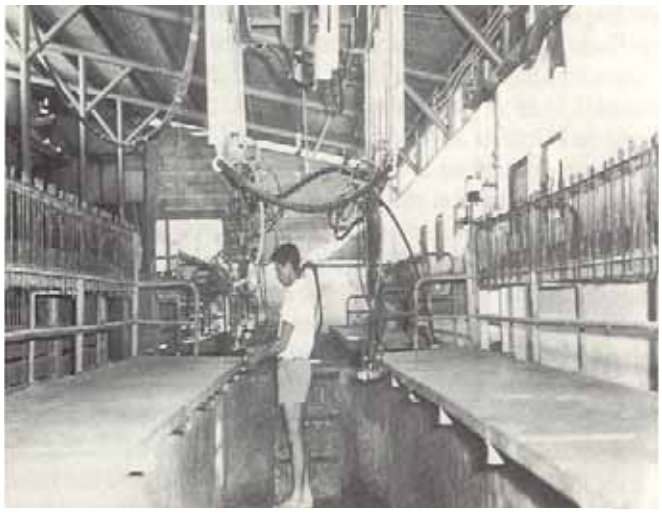

Figure 4-16. Awassi milking parlour. Double-row system

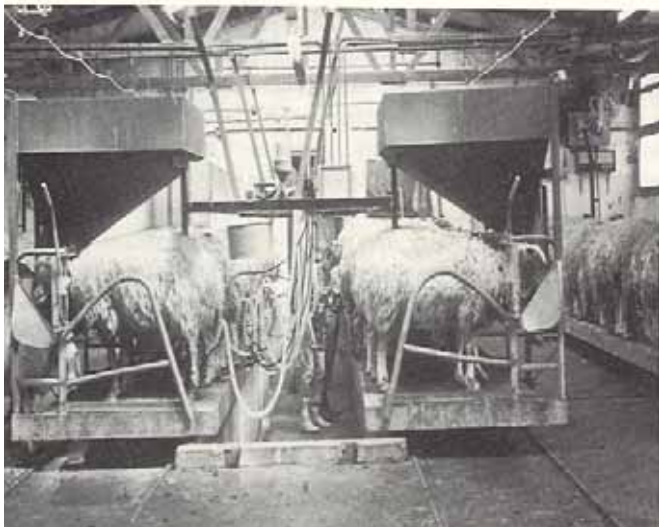

Figure 4-17. Awassi milking parlour. Double-row system with additional parallel platforms

period of eight weeks was 125 kg, while the control figures did not exceed 85 kg, that is, 40 kg or 32 percent less (Doron, 1954b). From this it could be deduced that the factual lactation yields surpassed those registered in the flock book on the basis of milk control. To correct this inaccuracy, a new system of milk control was introduced in 1954/55, which was based on the separation of the suckling lambs from their dams during 24 hours of control. This brought the estimate of the quantity of milk consumed by the lamb nearer to reality and provided a full record of the yield during the entire lactation period.

However, trials for the purpose of testing the accuracy attained by the new system of assessing the lactation yields of ewes, conducted in 1958/59 and 1959/60 (see Tables 4-67 and 4-69), showed that the estimates obtained by the new system, although closer to reality than those received under the earlier system, still lacked exactness owing to the quantity of milk not yielded to the pail but retained by the ewe for her lamb during the 24 hours of separation. This residue, while exhibiting a wide range of individual variability, caused the figures of recorded yield in every instance to be lower than actual production. Folman, Volcani and Eyal (1962) therefore proposed an improved system of assessment of yields based on a number of factors, the essence of which was the addition of the recorded lactation yield to the difference between birth and weaning weights of the lamb multiplied by a milk conversion factor, the sum thus obtained to represent the total annual production of the ewe for the purpose of registration. This proposed system was put into trial practice in 1960/61, but at the following annual meeting of the Sheep Breeders' Association it was rejected as impracticable and contrary to the tenets of Awassi improvement which aim at the elimination of milk retention by ewes.

In 1961/62, milk control of the Awassi was brought back to the earlier system, subject to the following rules. The control had to be supervised by the Sheep Breeders' Association. It had to be carried out by the breeders themselves on the fourteenth, fifteenth or sixteenth of each month, and never on any other date. The recording had to be inspected by the district instructors for sheep husbandry. In the small number of flocks selected for the production of Awassi stud rams, milk control could not be carried out by the breeders themselves but by officers appointed by the Sheep Breeders' Association. In milk-recorded flocks all ewes had to be included in the recording. The annual period of control had to begin on 1 October and end on 30 September. On the day of control the ewes were to be maintained in the same conditions as on other days of the month. The control milking had to begin and end exactly at the same times at which the ewes were milked on other days. Feeding conditions on the day of control were to be similar to those normally maintained. The control had to comprise the total milk yield of the ewes in 24 hours. The lambs had to be separated from the ewes after the last milking preceding the 24-hour control period. The ewes had to commence at the time of separation and end on the following day at normal suckling time. The quantity of milk had to be measured by weight to an accuracy of 20 g. At the end of the month the total 24-hour yield, consisting of the sum of the morning and evening milk, was multiplied by the number of days of the respective month in order to assess the monthly yield. The day following lambing was reckoned as the first day of lactation. The first control was not to be carried out before the fourth day after lambing; if, for example, a ewe had lambed on the thirteenth of a month, the first control of her yield had to be postponed to the following month. In order to verify the accuracy of the individual control weighings, the sum of the latter was compared with the total weight of the milk yielded by the flock on the day of control (Fái, 1972).

In 1972/73, following the decisions of the Symposium on Milk Recording Practices for Sheep and Goats in memoriam of Dr M. Finci, held in Israel in March 1972, the international rules for milk recording adopted at the symposium replaced the previous recording method in the improved Awassi flocks in Israel. These rules set down that milk control is to be carried out by the breeders themselves, while the supervision of it rests with the Ministry of Agriculture. The ewes of every milk-controlled flock must be marked with two tattoo numbers, the number of the ewe in the right ear and the number of her dam in the left ear. In addition to these marks, ear tags may be used. The lambs should be tattooed not later than at the age of two months with consecutive numbers, the first female lamb born in a certain year or season carrying the number following that given to the lamb last born at the previous lambing time. It is prohibited to give the lambs numbers of ewes removed from the flock earlier. If for some reason a ewe or female lamb cannot be identified by her ear tattoo, she shall be given a new number as though she represents a recent addition to the flock. The first recording in a lactation period shall be carried out not before the thirtieth nor later than the sixtieth day after lambing, and every milk-yielding animal of a milk-recorded flock, which has passed 30 days from lambing, must be included in the recording.

The following procedure shall be observed at the recording: On the preceding evening the lambs may be suckled for one hour after milking. They are then separated from their dams for 24 hours. The

first record weighing is carried out on the following morning and the second one in the evening of the same day. Thereafter the lambs are admitted to the ewes for suckling. During the lactation period the milk yield of every ewe has to be recorded in this manner as long as her yield does not fall below 200 g or 0.2 1 a day. The milk may be measured either by weight or volume to an accuracy of 20 g or 0.02 1. If, for technical reasons, it is impossible to weigh the secondary milk of every ewe separately, the secondary milk from all ewes of the flock shall be weighed or measured collectively and proportionally added to the quantity of primary milk of every individual ewe. On the day of recording, milking shall be carried out in the same manner and at the same times as on other days. If a ewe shows signs of udder disease, this shall be noted in the record. For purposes of calculation, the last day of consecutive milking, on which the ewe was milked at least once in 24 hours, shall be reckoned as the last day of the lactation. A full lactation period comprises not less than 150 days (Fái, 1972).

The fat content of the milk of Awassi ewes is not tested in Israel along with the recording of the milk yield. It was only for a few years in the early 1950s that the milk of ewes with lactation yields exceeding 370 kg (e.g. 612 ewes in 1950/51 and 498 in 1953/54), which had been selected from among 11 flocks for the production of stud and flock rams, was tested for butterfat content (see p. 154, last paragraph, and Table 4-37). The butterfat test was discontinued mainly because of the labour involved and a lack of interest on the part of the breeders in the fat content of the milk of individual ewes, which has since been disregarded in the selection programme. Breeders now have to be content with the monthly reports furnished by the central dairies on the fat percentage of the milk delivered to them by various suppliers.