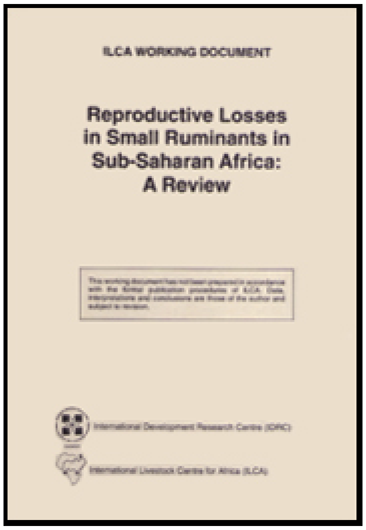
ILCA working document - Reproductive losses in small ruminants in Sub-Saharan Africa: A review



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Chapter I. Introduction

Background

Sub-Saharan Africa (SSA) lies almost entirely between the tropic of Cancer and the tropic of Capricorn and embraces African countries below the southern Sahara desert (Fig. 1.1). It is a vast region with a total area estimated at 21.6 million km^2, a human population of more than 578.316 million in 1993 (FAO, 1993) and a livestock biomass of 202.8 million tropical livestock units in 1992 (FAO, 1993).

SSA is the poorest part of the world as a World Bank report (World Bank, 1981) quoted in Eicher and Baker (1982) shows that 22 of the 36 countries with per caput income of $370 or less (low-income countries) are found in the region. According to ILCA (1987), per caput GDP which grew at 1.3 per cent per annum (p.a.) in the 1960's slowed down to 0.7 per cent in the 1970's and fell in the 1980's. This same source indicates that the gross domestic saving rate went down by a third over the 1970s and the ratio of foreign debt service payments to export earnings went up by about 50 per cent in the 1980's.

Declining per caput food production (Fig 1.2) coupled with inadequate calorie intake usually prevails. In most sub-Saharan African countries, this intake falls below minimal nutritional standards. During the period 1982-84, food production was 8 per cent lower than a decade earlier in 31 out of 39 countries.

Ironically, SSA faces a demand problem as the growth in agriculture and food productivity utterly lags behind that of human population and its increasing food need. The population grew from 2.05 per cent p.a. in the mid-fifties to 2.74 per cent in the late seventies, reached the highest rate of any of the developing regions in early eighties (Christensen et al., 1981), is now rising at more than 3 per cent p.a. and is projected to reach 1,294 million in 2025, almost equivalent to China's projected population for the same year (Winrock International, 1992). Certainly, the United Nations' earlier prediction (U.N., 1987) remains valid, which revealed that SSA is the only developing region where population growth rates will not stop increasing throughout the 1980s and will be the world highest in year 2000 (Fig. 1.3). The low per caput food production coupled with the poor calorie intake and the ever burgeoning human population in most countries of the region has led to what many observers call an "agrarian crisis" or "Africa's food crisis". TAC/CGIAR (1987) refers to it as a "source of considerable alarm."

Poor performance of the livestock sector during most of the last two decades has contributed to the crisis. According to Sandford (1987), the commodity output of livestock in SSA accounts for 25 per cent of total food production. For 1983, FAO (1984) estimated the contributions of livestock to the SSA's overall calorie and protein intakes to be about 8 and 13 per cent, respectively. These figures fall below the world average which amounts to 16 per cent for calories and 23 per cent for protein in 1983. Though it is true that four out of every five people in most of SSA work in agriculture (World Bank, 1982) and that these are the people who suffer the most from poverty and food crisis, efforts have not always been aimed at identifying their true priorities and how they generate income for their subsistence. For example, small ruminants represent one of the major assets contributing to income generation and animal protein supply of resource-poor rural households and yet they have long been neglected.

Economic importance of small ruminants in SSA

The importance of small ruminants for meat and milk production in the tropics is well established (Devendra and Burns 1970; Williamson and Payne, 1974; Haas and Horst, 1979; Matthewman, 1977; Gatenby, 1986). In contrast to cattle which are normally concentrated and remain in the hands of a restricted number of producers, almost every low income rural household invariably owns small ruminants. In the dry areas of Northern Nigeria, fewer than 20 per cent of farmers own cattle (ILCA, 1980). In Côte d'Ivoire, Barry (1985) reported that, on the average, fewer than four cattle are found on the farm where there are ten sheep/goats. This ownership pattern characterizes the legacy of SSA's rural economy as capital constraints limit access to cattle among poor households whilst small ruminants are well suited for their financial and labour resource capabilities.

Small ruminants are a source of food and financial security for the rural poor. According to FAO (1983) quoted in Von Kaufmann et al. (1986), more than 50 per cent of milk produced for human consumption is from sheep and goats in Niger and Somalia. Thirty five per cent of the total Nigerian meat supply are thought to come from small ruminants (Bayer, 1982) and almost 30 per cent of the total meat consumed in the semi-arid zone are from small ruminants (Wilson, 1982). Little (1982) found that in pastoral production systems in Kenya, goats are usually the only source of milk available for households in the dry season when both sheep and cattle have migrated. In Teso (Northern region of Uganda) farmers' revenue from goats is higher than that from other agricultural products with the exception of the cotton and cattle where these are part of the households activities (Kyeyune-Sendage, 1970).

Because of their small size, sheep and goats provide more convenient sources of meat than cattle as shown by Sarniguet et al, quoted in Bayer (1982) who found that small ruminant meat contributes three times more than beef to the total meat consumed in rural areas of Northern Nigeria. It is generally more suitable to slaughter a sheep or a goat to feed community members engaged in communally private field work than a large animal such as a cow. Likewise, while a 10 to 15 kg small ruminant carcass is easily handled by a rural household for either home consumption and/or sale without means of preservation, slaughtering even a steer (when it is available) for the same purposes is generally unpractical and uneconomical and is therefore a rare event.

Where access to cash is limited and livestock marketing is not organized, small ruminants are directly exchanged for grain. Little (1982) observed that in remote areas of Kenya, up to 40 per cent of local grain needs may he met by direct exchange of goats and sheep during the dry season. Small ruminants are often slaughtered in honour of a special guest, a visiting friend or relative, for festivities and religious rituals. In particular, sheep is the only animal consumed during the **Id El Kebir** or **Tabaski** festivals [1]. Sale of Tabaski rams (and to a lesser extent rams slaughtered for baptism) amounted to 9 trillion FCFA, an equivalent of US$30 million in Senegal in 1986 (Abassa and Diop, 1988).

[1] Id El Kebir festivals are also known as Tabaski festivals in West Africa.

Small ruminants are also kept by poor rural households for ready cash income to meet immediate needs such as acquiring agricultural inputs, paying school fees and purchasing larger animals such as cattle. In Uganda, a landlord may sell some part of his land to landless people in exchange for goats (Okello, 1985). In time of cash crisis, rural households find it easier to find a buyer for a goat or a sheep than a bovine. More importantly, small ruminants play a key role in stock association building between non-household members in rural areas. Little (1982) reported that destitute pastoralists in Kenya may call upon stock associates for food assistance or for rebuilding their herds after calamities. This is also true of farmers in the humid area of Senegal (Faugère et al., 1988) and in Uganda (Okello, 1985), where small ruminants serve as a means to cement family relationship or social links which are extremely important for assistance in time of crisis.

From what precedes, one can no longer overlook the importance of small ruminants in the economy of SSA in general and in that of the low income families in particular. That sheep and goats allow poorer households to maintain their subsistence, calls for an urgent need to recognize, as Gatenby (1986) put it, that "if the aim of a development project is to raise the living standard of the poorer sectors of the community, it is much more likely to do so if it concentrates on production from small ruminants".

Population growth and meat production of small ruminants in SSA

Small ruminants are raised in all the ecological zones of SSA. These zones are grouped on the basis of the number of plant growing days per year (Jahnke, 1982). These are the arid zone (less than 90 days), the semi-arid zone (90-180 days), the sub-humid zone (180-270 days) and humid zone(270-365 days). The highlands include semi-arid, sub-humid and humid areas where the mean daily temperature is less than 20°C during the growing period. TAC/CGIAR (1987) estimated at 221 million the number of small ruminants in SSA with 35.95 per cent in the arid zone, 24.6 per cent in the semi-arid zone, 15.45 per cent in the sub-humid zone, 8.8 per cent in the humid zone and 15.2 per cent in the highlands (Table 1.1).

The data presented in Table 1.2 reveal that from 1977 to 1992, SSA's small ruminant population grew at an average annual growth rate of less than 1 per cent and that, over the same period, this performance compares poorly with that of Africa (1.23 per cent), Asia (1.7 per cent), all developing countries (1.44 per cent) and the world (1.01 per cent). In 1982-1992, growth in SSA was 0.77, 1.45, 1.14 and 1.58 per cent p.a. below that in Africa, Asia, all developing countries and the world. Further, the growth was unstable as the number of sheep and goats rose by 2.38 per cent in 1977-1982, -0.17 per cent in 1982-1987, about 0.4 per cent in 1987-1992 and 0.1 per cent in 1982-1992. This, together with available data from literature, particularly from ILCA (1987) according to which small ruminant population growth was 2.5 per cent p.a. from 1963 to 1970 and 0.6 per cent p.a. from 1970 to 1975, seem to indicate that the unsteady pattern mentioned above is a permanent feature of small ruminants' population growth in the region. There is also indications that the picture is one of a continuously decreasing growth throughout the 1980s and that this could be extended at least to the first half of 1990s. Finally it is worth noting that except in Latin America, growth in SSA was the world's poorest over the decade 1982-1992 as the region's performance was 0.77, 1.45, 1.14 and 0.58 per cent p.a. below that of Africa, Asia, developing countries and the world, respectively (Table 1.2). That such picture could worsen the food crisis in the region appears to he indisputable.

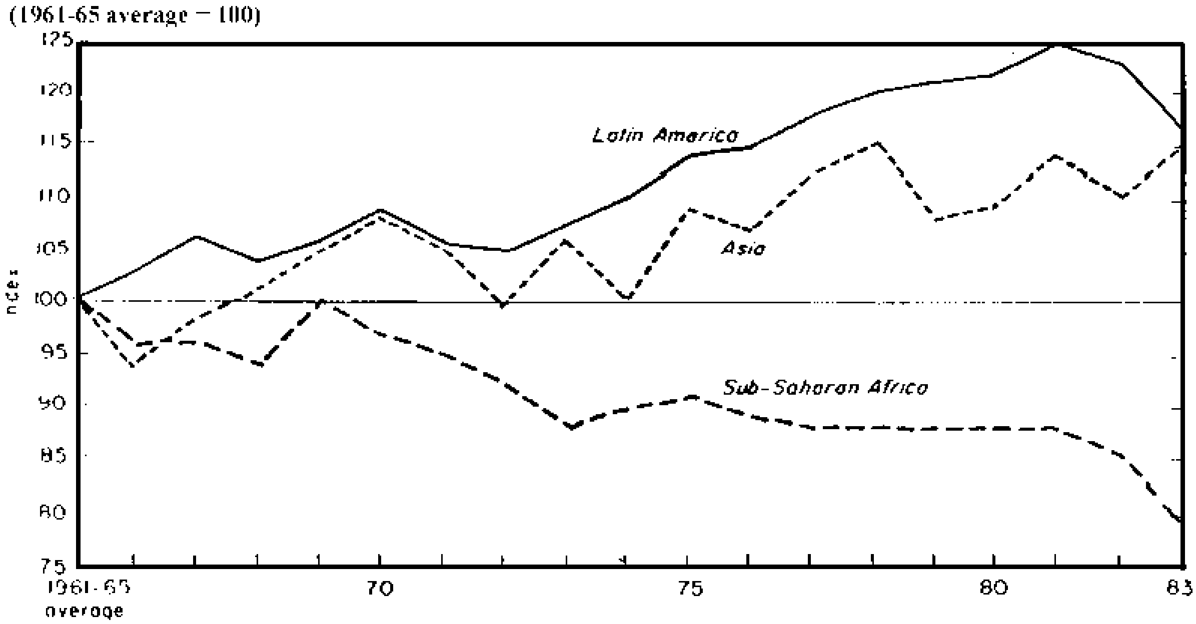
Another factor that could have contributed to the worsening of the food crisis in SSA is the poor output of meat per head of small ruminant, a situation that may indicate that the region has trouble deriving enough meat from its depressed small ruminant population. This is illustrated in table 1.3 which shows that SSA is the only developing region where growth of meat output per animal has been negative over the decade 1982-1992. The table also shows that it is also in SSA that the world poorest meat output per animal in both 1982 and 1992 is found. In 1992 the region's performance was 21.0, 31.5, 39.6, 31.3 and 39.5 kg/TLU below that of Africa as a whole, Asia, Latin America, all developing countries and the world, respectively. Certainly, this poor performance has contributed a great deal to the poor and declining total meat output shown in table 1.4. In fact, such output declined at an average annual rate of about 1 per cent over the decade 1982-1992, which compares poorly with the positive growth of Africa (1.37 per cent), Asia (4.14 per cent), Latin America (0.56 per cent), all developing countries (3.21 per cent) and the world (2.18 per cent). Worst still, the decline seemed to occur at an increasing rate as it jumped from 0.58 per cent p.a. in 1982-1987 to 2.43 per cent p.a. in 1987-1992, indicating that there could he no prospect for acceptable productivity in 1990s if nothing is done to reverse the ongoing trend.

Among the reasons for the above overall poor to mediocre performance are reproductive losses and morbidity. The term reproductive losses in the fullest sense, refers to losses from birth up to first breeding of the offspring (Restall et al., 1976). Such losses are widely recognized as the most important constraint to increased small ruminant production (Dennis, 1974; Willingham et al., 1986; Kelly, 1986). In Africa, it is thought that at least 59 per cent of potential lambs and kids are lost through fertilization failure, embryo and foetal death, stillbirth and mortality from birth to weaning (Charray et al., 1980). Unfortunately, because the related losses have not been compiled in SSA, their overall effect on small ruminant development is unknown. The present review intends to determine the magnitude and causes of reproductive losses in sheep and goats in SSA in order to identify recommendation domains or areas in need of interventions.

The review encompasses 5 chapters which, apart from the introduction, successively covers reproductive performance, prenatal losses, post-natal losses, general conclusions and recommendations.

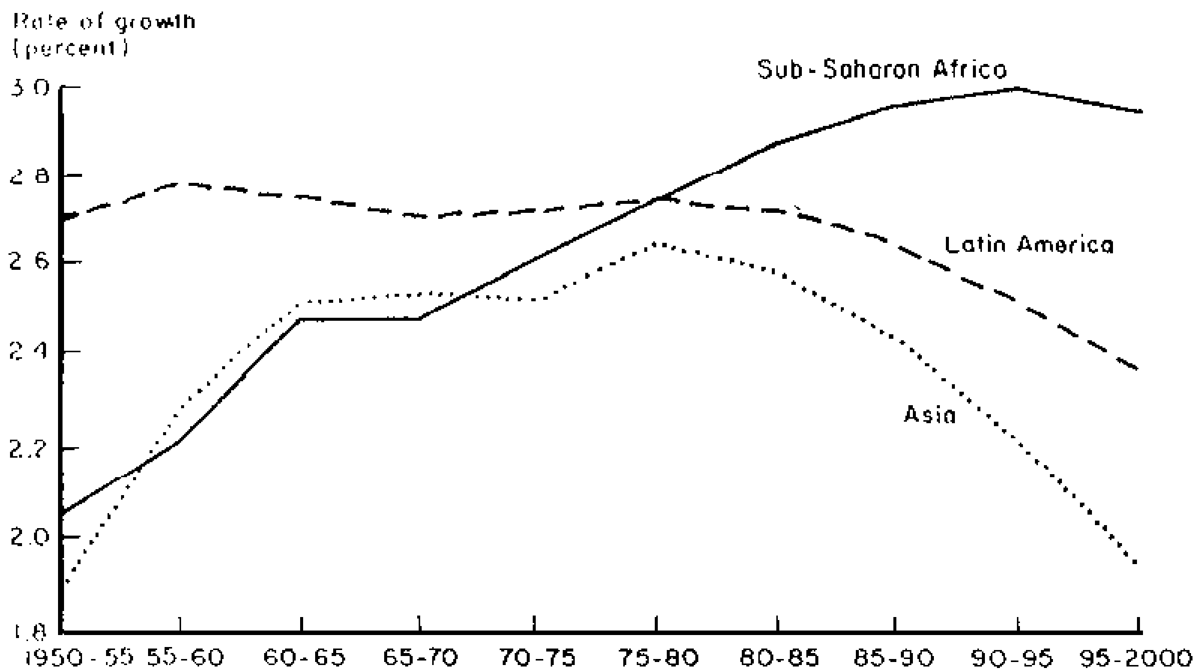
Figure 1.1. ***Sub-Saharan Africa.***

Figure 1.2 ***Index of Per Capita Food Production, 1961-65 to 1983.***



Source: World Bank (1984).

Figure 1.3 ***Population growth rate in sub-Saharan Africa, Asia and Latin America (1960-2000).***



Source: UN, 1987.

Table 1.1. Distribution of sheep and goats by zone in SSA

Zone	% of total population in SSA	
	Sheep	Goats
Arid	33.7	38.2
Semi-arid	22.9	26.3
Sub-humid	14.4	16.5
Humid	8.3	9.4
Highlands	20.7	9.6
Total per cent	100	100
Total No [1]	(98.4)	(122.6)

[1] In million
Source: ILCA (1987).

Table 1.2. Small Ruminant Population and Annual Changes

Location	Stocks (1000 heads)				Average Annual Growth Rate (%)				
	1977	1982	1987	1992	1977-92	1982-92	1977-82	1982-87	1987-92
Africa	231,892	255,579	266,156	278,620	1.23	0.87	1.96	0.81	0.92
SSA	185,975	209,151	207,353	211,320	0.86	0.1	2.38	-0.17	0.38
Latin America	140,782	146,713	145,243	144,383	0.17	-0.16	0.83	-0.2	-0.12
Asia	535,143	590,892	605,465	689,458	1.7	1.55	2	0.49	2.63
Developing Countries	994,059	1,033,890	1,065,086	1,169,456	1.44	1.24	1.83	0.6	1.89
World	1,473,433	1,600,063	1,636,442	1,712,544	1.01	0.68	1.66	0.45	0.91

Source: Adapted from FAO (1979; 1982; 1989; 1992).

Table 1.3. Small Ruminant Meat Production per Head

Location	1982			1992		
	TLU* ('000)	Meat (MT)	Meat/TLU (Kg)	TLU ('000)	Meat (MT)	Meat/TLU (Kg)
Africa	7,971.1	935	117.3	89,822.1	1,094	121.8
SSA	6,117.1	660	107.9	6,083.1	613	100.
Latin America	22,095	2,824	127.8	31,734.9	4,198	132.3
Asia	2,897	384	132.6	3,026.9	425	140.4
Developing Countries	34,356.9	4,370	127.2	45,382.3	5,995	132.1
World	57,046.9	7,928	138.9	70,339.6	9,864	140.3

* TLU: tropical livestock unit; one TLU is equivalent to 250 kg body weight. Each sheep and goat represents 0.1 TLU.

Source: Adapted from FAO (1984; 1992).

Table 1.4. Total Small Ruminant Meat Production and Annual Changes: 1977-1992

Location	Indigenous Sheep and Goat Meat (1000 MT)				Average Annual Changes (%)				
	1977	1982	1987	1992	1977-92	1982-92	1977-82	1982-87	1987-92
Africa	788	972	1,016	1,114	2.33	1.37	4.29	0.89	1.86
SSA	581	721	742	656	0.81	-0.94	4.41	0.58	-2.43
Latin America	2,433	2,724	3,186	4,087	3.52	4.14	2.29	3.18	5.11
Asia	394	384	404	406	0.2	0.56	-0.51	1.02	0.1
Developing Countries	3,776	4,291	4,833	5,883	3	3.21	2.59	2.41	4.01
World	7,411	7,983	8,785	9,902	1.95	2.18	1.5	1.93	2.42

Source: Adapted from FAO (1979; 1984; 1989; 1992).

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Chapter II. Reproductive performance of small ruminants in sub-Saharan Africa

Good reproductive performance is a prerequisite for any successful livestock production programme. Undoubtedly, there is no milk if birth does not occur, no meat and fibre if survival cannot be ensured. It is not surprising that above all, natural selection is directed towards fitness or the ability of every creature to survive and to perpetuate its own kind. Where farm resources are severely limited as it is often the case in SSA, reproduction failure is the first sign of decreased productivity. It seems important, therefore, to determine the actual level of reproductive performance and its variation between and within ecozones, breeds and management systems before characteristics of losses which limit that performance are highlighted.

In small ruminants, reproductive efficiency can be measured by fertility, prolificacy, fecundity and survival. These four parameters together with age at first parturition and parturition interval also measure the reproductive performance. They will now be discussed with the exception of survival which will be covered in Chapters III and IV.

Fertility and parturition interval

Fertility is oftentimes used as synonym of prolificacy. As shown in the next section, however, prolificacy is different from fertility though to be prolific an animal must be highly fertile. Devendra and Burns (1970) who defined fertility as the number of services required per conception for the male, observed that the parameter is difficult to measure. Fertility rate is defined as per cent ewes lambing of ewes bred by Sidwell and Miller (1971). Haumesser (1975b) expresses it as per cent does kidding (or ewes lambing) of breeding females in the herd over the period of a year. Dettmers et al. (1976) call it breeding efficiency which they define as a ratio of ewes lambing to ewes exposed. ILCA (1979) expresses it as per cent parturitions per dam per year while Gatenby (1986) defines it as per cent ewes lambing of ewes available for mating. Awotwi and Fynn (1992) express it as the percentage of females giving birth of females exposed to males. Each of these definitions except that of Haumesser (1975b) failed to specify appropriately either the category of female or the period involved or both. A flock fertility rate calculated over a 6-month period is for instance likely to be different from that based on a one year period even when the same number of breeding females are considered. A more accurate definition of fertility is probably the number of parturitions per female of breeding age [2] and per specified time period. For sound managerial decision making, annual specification appears to be highly indicated. Where breeding is not organized, as it is the case in most SSA's traditional production systems, the average annual number of females of breeding age actually present in the herd should be used.

[2] In the continuous breeding system, all females are exposed provided that breeding males are available in the flocks. In the controlled breeding system, only females of breeding age are exposed.

Estimates of fertility for does in SSA are summarized in table 2.1. Overall, they are concentrated between 71.4 per cent for Manny goats of Uganda (Kyeyune-Sendage, 1970) and 160 per cent for the West African Dwarf (WAD) goats in Ghana (Oppong and Yebuah, 1981). Using the scarce data available per ecological zone, the indications are that fertility ranges from 124-155 per cent for the humid zone, 80-124.5 per cent for semi-arid zone, 71.4-160 per cent for sub-humid zone. Estimates are highest in the humid zone for WAD does in Nigeria (Mathewman, 1977), in the semi-arid zone for Sahel does in Niger (Haumesser quoted in Gerbaldi, 1978) and in the sub-humid zone for WAD does in Ghana (Oppong and Yebuah, 1981).

In sheep (Table 2.1), most fertility rates vary from 77.5 to 160 per cent with WAD ewes showing both the highest estimate in Côte d'Ivoire (CNRZ, 1977) and the lowest in Nigeria (Dettmers et al., 1976). Here again, few data are available per ecozone and vary from 77.5 to 160 per cent in the humid zone, 79.1 per cent for Nguni ewes in Mozambique (Makinnon, 1985) to 122 per cent for Mossi ewes in the Semi-arid Burkina Faso (Nianogo, 1992), and from 111 per cent for Yankasa breed to 128.46 per cent for Balami does in the sub-humid Nigeria (Adu and Ngere, 1979). The within ecozone ranges are only indicative. Many of the low fertility rates (lower than 100 per cent) presented may have resulted from serious management problems or failure to define and appropriately specify the parameter.

Table 2.2 shows estimates of parturition interval for does in SSA. In general, these estimates vary from 227.6 days for WAD goats in Côte d'Ivoire (Armbruster, 1988) to 408 days for Landim breed in Mozambique (Wilson et al., 1989; Rocha et al., 1991). In the humid zone, most estimates are between 227.6 and 283 days both for the WAD goats with the lowest estimate obtained in Côte d'Ivoire (Armbruster, 1988) and the highest in Nigeria (Sumberg and Mack, 1985) and in Côte d'Ivoire (Berger, 1979). In the semiarid zone, most data were obtained from does under village management where they range from 238 days for Sudan Desert in Sudan (Wilson, 1982) to 370 days for Zimbabwean Small East African does in Zimbabwe (Nvlovu, 1992). In general, however, the estimates in this zone are between 234 days for station-managed Massakory does (Bertaudière, 1979) and 408 days for still station-managed Landim does in Mozambique (Wilson et al., 1989; Rocha et al., 1991). Available estimates are limited in the other ecozones. They indicate high intervals exceeding 300 days for the highlands and could be between 8 and 11 months in the sub-humid zone.

In sheep (Table 2.2) most parturition intervals are in the range of 213.5 to 373 days. Within this range, they are highest for Landim sheep in the semi-arid Mozambique (Wilson et al., 1989) and lowest for WAD sheep in the humid Côte d'Ivoire (Rombaut and Vlaenderen, 1976). In the humid zone, most estimates vary from 213.5 to 322 days with the highest value obtained for WAD ewes in Nigeria (Mack, 1983; Reynolds and Adeoye, 1985). In the semi-arid zone, intervals are generally between 254 and 373 days with Sahel type sheep in Mali showing the lowest estimate (Wilson, 1982). Estimates obtained under village conditions are mostly in the range of 254 to 366 days in the semi-arid zone and 213.5 to 322 days in the humid zone. Under station management, intervals are between 248 days (Dettmers et al., 1976) and 322 days (Reynolds and Adeoye, 1985) both for WAD ewes in the zone of Nigeria. There is a severe lack of information in the sub-humid and highland zones. However, it is interesting to note that the Kirdi and Mayo-Kebbi breeds of southern sub-humid Chad performed well in view of their average parturition interval of 8 months reported by Guerin (1979).

It appears that fertility in goats and sheep of SSA is rarely reported and that little or no information is available on both fertility and parturition interval in the highlands. Similarly, published reports on parturition interval in the sub-humid areas are scarce. However, there is some evidence suggesting that both parameters may show wide variability within ecological zones due to breed difference and management skills. Parturition interval can be reasonably set in the ranges of 227 to 283 days for WAD goats, 230 to 322 days for WAD sheep with fertility varying from 100-187 per cent in does to 100-160 per cent in ewes. Interestingly, only few data presented here support the well accepted finding that tropical sheep and goats generally produced on the average three lamb/kid crops in two years (Lowe, 1943; Vigo, 1946; Payne and Miles, 1953; Devendra and Burns, 1970). In fact, most does and ewes under uncontrolled breeding management in SSA reproduce at intervals greater than 8 months. Breeds which seem to show the ability for 3 parturitions in 2 years in their natural environment are Sudan Desert (SD), Mayo-Kebbi (MK) and Kirdi (K) goats and, of course, WAD sheep and goats. While more data are needed to confirm this ability in SD, MK and K breeds, evidence was presented which showed that WAD breeds are capable of three or more parturitions in two years (Hill, 1957; Ferguson, 1964; Dettmers et al., 1976; Oppong and Yebuah, 1981). On a research station in Ghana where WAD goats were left free to breed and to forage, Oppong and Yebuah (1981) showed that up to 65 per cent of does gave birth twice in 12 months with parturition intervals ranging from 175 to 183 days. Dettmers et al. (1976) reported individual lambings with 152 and 182 days parturition intervals for WAD ewes in humid Nigeria. There is, therefore, no doubt that WAD sheep and goats are among the most fertile small ruminant breeds in the tropics.

Prolificacy and twinning rate

Prolificacy or litter size is defined as the number of progenies born per parturition (Haumesser, 1975b; Haumesser and Gerbaldi, 1980). Other definitions which specify that the kids/lambs need to be alive at birth may not be appropriate. Average litter size can be calculated on a yearly basis to be consistent with the annual rate of fertility.

Estimates of goat prolificacy in SSA are collated in Table 2.3. They mostly vary from 149 to 187 per cent in the humid zone, 105 to 162 in the semi-arid zone, 118 to 171 per cent in the sub-humid zone and 135 to 175 per cent in the highlands. Overall, SSA's native goats produce litter sizes ranging from 1.05 to 1.87 kid. Lowest records were obtained for WAD does in the humid zone (Reynolds and Adeoye, 1985), Nguni does in the sub-humid zone (Lebbie and Manzini, 1989), Sahel type does in the semi arid zone (ILCA, 1987) and Small East African does in the Highlands (Karua, 1989). Highest records were obtained for WAD goats in the humid zone of Ghana (Otchere and Nimo, 1976), Mayo-Kebbi and Kirdi breeds in the sub-humid zone of Chad (Dumas, 1977; 1980), Landim breed (Makinnon, 1985) followed by Sudan desert does (Wilson, 1982) in the semi-arid zone of Mozambique and Sudan, and Rwandan does in the highlands of Rwanda (Murayi et al., 1987). In the humid zone, estimates obtained at village level are between 149 per cent in Nigeria (Reynolds and Adeoye, 1985) and 162 per cent in Côte d'Ivoire (Armbruster, 1988) for the WAD breed while those found at the station level, albeit limited, seem to be comparatively higher and are above 170 per cent. In the sub-humid and semi-arid zones, most information is obtained at village level and the ranges are those specified earlier for the overall estimates in the zones.

Table 2.3 also shows estimates of prolificacy for ewes in SSA. Most values fall between 101 and 148.7 per cent with Arab sheep in the semi-arid zone of Chad (Dumas, 1980) showing the lowest value and WAD ewes in the sub-humid zone of Togo showing the highest (Amegée, 1978b). In the humid zone, most performances of WAD ewes vary between 110 per cent in Côte d'Ivoire (CNRZ, 1977) and 145.6 per cent in Nigeria (Dettmers et al., 1976). Most estimates obtained in the semi-arid zone are from the family sector and fall between 101 and 116 per cent with Mossi ewes (Nianogo, 1992) showing the highest performance (followed by Sudan Desert ewes). The few estimates available for the sub-humid zone seem to lie between 138.5 per cent for Kirdi ewes in Chad (Dumas, 1980) and 148.7 per cent for WAD ewes in Togo (Amegée, 1978b) though extreme outtier values of 164 and 171 per cent were reported for the Mayo-Kebbi and the Kirdi breeds (Guerin, 1979; Dumas, 1980).

Table 2.4 summarizes the twinning rates for does in SSA. These rates commonly vary from 13.5 per cent for Sahel goats in semi-arid zone of Niger (Wilson and Wagenaar, 1982) to 60.4 per cent for WAD goats in humid zone of Côte d'Ivoire (Armbruster, 1988). The lowest value found in the humid zone was 51.12 per cent (Oppong and Yebuah, 1981). Most records in the sub-humid zone are between 16.4 per cent for Tanzanian native does in Tanzania (Kyomo, 1978) and 59 per cent for WAD breed in Ghana (Oppong and Yebuah, 1981). The highest rates (56.7 and 47.5 per cent) reported in the semi-arid zone were respectively for the Landim in Mozambique (Makinnon, 1985) and the Red Sokoto/Maradi goats in Niger (Gerbaldi, 1978).

Twinning rates among sheep breeds in SSA are also shown in table 2.4. Most estimates are between 4.2 per cent for Sahel type ewes (Wilson and Traore, 1988) and 55 per cent for WAD sheep in the humid zone of Nigeria (Dettmers and Loosly, 1974). Values ranging from 27 per cent (Rombaut and Vlaenderen, 1976; Ademosun, 1973 quoted in Osuagwuh and Akpokodje, 1981) to 55 per cent (Dettmers and Loosly, 1974) are found for WAD breed in the humid zone. In the sub-humid zone, the lowest estimate (6.3 per cent) was recorded for Yankasa breed (Otchere et al., 1987). Apart from the Nguni breed, Sahel type animals seem to show low multiple birth rates in their semi-arid native environment as shown by 4.2 and 4.5 per cent twinning rates reported by Wilson and Traore (1988) and Wilson and Wagenaar (1982), respectively. The 4.2 per cent rate reported by Agyemang et al. (1985) for Ethiopian highland sheep compares very poorly with the higher value of 24 per cent found for the same breed by Mukasa-Mugerwa and Tekelye (1988), indicating a possible error of estimation as regards one or the other value reported.

It appears that prolificacy and twinning are high in many sheep and goats found in SSA, but breed difference exist between and within ecological zones. Sheep in the semi-arid zone have low prolificacy and ewes can be generally considered as single pregnancy bearers. In this zone, although performances of goats are generally higher than those of sheep, the available data presented indicate that only the Landim goats in Mozambique, Red Sokoto of Niger and Nigeria and Sudan Desert goats of Sudan can be considered as prolific breeds. The latter two breeds (ie., Sudan Desert and Red Sokoto) whose prolificacy rates are 156-157 under village conditions with Sokoto does showing 47.5 per cent twinning and 8.5 per cent triplets (Gerbaldi, 1978) may be expected to do well under better management conditions.

Data presented for the sub-humid and humid zones confirm the well accepted findings (FAO, 1980; Hofs et al. 1985; Gatenby, 1986) that WAD breeds are highly prolific and stand up well among the prolific tropical breeds. With records of 59 and 60.4 per cent twinning rate, WAD goats compare well with many well known prolific breeds such as the Kambing Katjang of Malaysia (66 per cent) (Devendra, 1962) and the Barbari in India (69 per cent) (Kaura, 1943) both quoted in Devendra and Burns (1970). This is well illustrated by the fact that, among the pure breeds presented in table 2.5, only the Ma T'ou and Black Bengal outperform WAD goats.

The WAD sheep also compare well with the prolific Priangan of the humid West Java whose twinning rates vary from 25 to 75 per cent (FAO, 1980) and the Black belly sheep with respective twinning and prolificacy estimated of 47 and 209 per cent in Barbados (Patterson, 1978 quoted in FAO, 1980), 33 and 145 per cent in Venezuela (Bodisco et al., 1973), and 48 and 168 per cent in Guyana (FAO, 1980).

Fecundity

Fecundity is defined as the number of offsprings born per female of reproductive age per year. The remarks made earlier on fertility hold true here as it is of paramount importance to specify appropriately the period and the category of female under consideration in order to make sound comparisons.

High fecundity should reflect the performance of a female which exhibits relatively short parturition intervals and is prolific as well since fecundity is a product of fertility and prolificacy (i.e., fecundity = fertility x prolificacy). Certainly, it is more useful to know the level of fecundity than that of fertility and prolificacy (Haumesser, 1975b).

Table 2.6 shows the estimates of fecundity for does in SSA. These estimates mostly range between 65 and 293 per cent with WAD does of the humid zone of Ghana showing the highest value (Buadu, 1972) and White Somali goats of the semi-arid zone of Somalia showing the lowest (Bourzat et., 1992). Available estimates in the humid zone were obtained for WAD breed whose lowest performance was 201 per cent (Sumberg and Mack, 1985). In the semi-arid zone, performances vary from 65 per cent to 181.7 per cent with the highest estimate obtained for Sahel Massakory does in Chad (Bertaudière, 1978 cited in Charray et al., 1980). Records among Sahel type animals in this zone are extremely variable, probably due to genotype and management differences. However, the Massakory type (IEMVT, 1979), the multicolour type (Haumesser quoted in Gerbaldi, 1978) and the Red Sokoto breed have higher performances than the Mossi, the Peul and the Arab types. Little is available on doe fecundity in the highlands. In the sub-humid zone, the few data presented suggest that Kirdi does may have a relatively good potential for high fecundity and may be expected to do well under improved management conditions.

Table 2.6 also shows that in sheep, fecundity is generally lower than in goats as estimates range from 62 per cent for Black-headed Somali ewes in the semi-arid zone of Somali (Bourzat et al., 1992) to 249 per cent in WAD ewes in the humid zone of Nigeria (Dettmers et al., 1976). Estimates, in the humid zone, for the WAD breed are in the range of 115 per cent (Matthewman, 1980) to 249 per cent (Dettmers et al., 1976) in general, and 115 per cent to 208.9 per cent (Armbruster, 1988) under the village management conditions. In the semi-arid zone, estimates are between 62 per cent (Bourzat et al., 1992) and 151.5 per cent (Maiga, 1980). The Peul type sheep, in this zone, generally shows better performances than the arab and the Mossi types. Fecundity in the sub-humid zone varies from 104 per cent for Mossi ewes in Burkina Faso (Dumas and Raymond, 1975) to 165 per cent for Mayo-Kebbi ewes in southern Chad (Dumas, 1980). Overall, animals in the humid zones (WAD essentially) show higher fecundity than those in the semi-arid areas.

It can be concluded that both sheep and goats in the humid zone have high fecundity, that they outperform animals in the other ecological areas and that ewes have a lower fecundity than does within the humid ecological zone. While it is not clear whether does in the sub-humid zone generally have a higher fecundity than those in semi-arid zone, Mayo Kebbi and Kirdi of the sub-humid Chad, Red Sokoto of the semi-arid Niger and Massakory of semi-arid Chad seem likely to have the best potential for high fecundity in the two zones. It is also likely that Kirdi and Mayo-Kebbi ewes have the second highest fecundity after WAD in sub-humid area of SSA.

Age at first parturition

Where breeding males are available in the flocks, age at first parturition is a good indicator of early sexual maturity in does and ewes. It is an economically important trait as greater population turnover and more rapid genetic progress can be obtained when goats and sheep produce their first progenies at an earlier rather than later age. Early maturing females are also known to have a relatively long and fruitful reproductive life. Among the most important parameters affecting age at sexual maturity are genotype and various management components.

Estimates of average age at first parturition for goats of SSA are collated in table 2.7. Most of them are between 303.7 and 555.8 days with Small East African goats of Kenya (Wilson, 1984) showing the poorest performance and Mossi does (Bourzat, 1980) the best. Most data in the humid and sub-humid zones fall between 340 days for Nguni does in Swaziland (Lebbie and Manzini, 1989) and 545 days for WAD does in Nigeria (Mosi et al., 1982). In the semi-arid zone where most available data were collected under village management conditions, most does tend to produce their first kids between 303.7 and 487 days of age. Estimates under these conditions are lowest for Mossi goats (Bourzat, 1980) and highest for Sahel goats (Wilson and Traore, 1988). It is interesting to note that the Sudan Desert and Nguni does seem to have a good potential for giving birth at very early age as evidenced by their performances of 280 and 262 days reported by Wilson (1982) and Lebbie and Manzini (1989), respectively. Also interesting, at least in the context of identification of problem areas, is the fact that the Kirdi and Mayo-Kebbi of southern sub-humid Chad, presented earlier as breeds of potentially good fecundity and prolificacy, may not have their first kids before 15.5 to 16.5 months of age. Little is known about age at first parturition of goats in the highlands. However, the estimate of 971 days reported by Murayi et al. (1987) for Rwandan goats at the Rwerere research station seems surprisingly high.

In sheep (table 2.7), most estimates of age at first parturition are between 335.5 and 685.47 days with both lowest and highest performances being obtained in the semi-arid zone for Peul type sheep in Burkina Faso (Dumas and Raymond, 1975) and Senegal (Garba, 1986). This may reflect the great diversity within the Peul type sheep breed in the semi-arid area of SSA. Similarly, the WAD breed is predominantly found in the humid zone where most estimates of age at first parturition range from 350.75 (Rombaut and Vlaenderen, 1976) to 638 days (Tuah and Baah, 1985). Here, the data seem to indicate lower estimates (351-492 days) for ewes under village production system than for ewes under station management (408-638 days), which is in line with the early mating due to uncontrolled breeding in such a system. Little is published on age at the first lambing in the sub-humid and highland zones. The few data obtained in these zones indicate that Kirdi and Mayo-Kebbi ewes, like the does of the same breed, may not lamb before 15 and 17 months (Dumas, 1980). These data also indicate that highland sheep may lamb for the first time at a later age of 23.4 and over 24 months (Murayi et al., 1987; Agyemang et al., 1985). However, until more information is made available, it is difficult to conclude that the above poor performances are true characteristics of the underlying breeds.

It appears that the average age at first parturition is variable among small ruminants of SSA and that goats tend to have their first offsprings at earlier age (10-18.5 months) than sheep (11-24 months). More research needs to be done in the sub-humid and highland zones where an extreme lack of information exists. In the humid zone, indications are that WAD does may kid for the first time at 11.8-17.9 months and WAD ewes at 11.5-21 months of age. In the semi-rid zone, does may kid at an earlier age (10-16 months) than sheep (11-24 months).

The above average ages at first parturition tend to fall generally in the ranges of 12-24 months reported for tropical goats by Devendra and Burns (1970) and 11-24 months found for West and Central African ewes by Charray et al., (1980). However, the present review shows that WAD sheep and most goat breeds tend to have their first offsprings before they are two years old. In fact, 61.5 per cent of estimates presented for sheep and 77.4 per cent of those for goats do not exceed 518.5 days, indicating that most female sheep and goats in SSA conceive prior to or at 12 months of age. This means that the unknown age at which progenies are bred for the first time could generally be less than or about twelve months. Thus, for practical purposes, reproductive losses in small ruminants as defined in Chapter I and discussed in Chapters III and IV, will refer to losses from birth until 12 months of age of the offsprings in the rest of the present monograph.

Table 2.1. Some Estimates (%) of Fertility of Does and Ewes in Sub-Saharan Africa

Ecological Zone	Country	Breed	Species	Management	Value	Reference
Humid	Ghana	WAD	Goats	Station	154	Buadu, 1972
Humid	Ghana	WAD	Goats	Station	124	Vohradsky et Sada, 1973 quoted in ILCA, 1983
Humid	Nigeria	WAD	Goats	Village	155	Matthewman, 1977
Humid	Cameroon	WAD	Sheep	Village	96	Branckaert, 1977
Humid	Côte d'Ivoire	WAD	Sheep	Station	94.5	Berger & Ginisty, 1980
Humid	Côte d'Ivoire	WAD	Sheep	Village	160	CNRZ, 1977
Humid	Nigeria	WAD	Sheep	Station	77.5	Dettmers et al., 1976
Humid	Nigeria	WAD	Sheep	Station	145	Dettmers et al., 1976
Humid	Nigeria	WAD	Sheep	Village	115	Matthewman, 1980
Humid	Congo	WAD	Sheep	Village	113.7	Batalou-Mbetanie, 1992
Semi-Arid	Chad	Massakory	Goats	Station	114	IEMVT, 1979
Semi-Arid	Chad	Massakory	Goats	Station	121.6	Bertaudière, cited in IEMVT, 1979
Semi-arid	Mozambique	Landim	Goats	Station	92	Makinnon, 1985
Semi-Arid	Niger	Maradi	Goats	Village	114	Haumesser, 1975b
Semi-Arid	Niger	Sahel	Goats	Village	124.5	Haumesser, cited in Gerbaldi, 1978
Semi-Arid	Niger	Sahel	Goats	Village	123.8	Gerbaldi, 1978
Semi-Arid	Niger	Sahel	Goats	Village	80-98	Gerbaldi, 1978
Semi-Arid	Niger	Uda	Sheep	Village	103-109	Haumesser & Gerbaldi, 1980
Semi-Arid	Burkina Faso	Mossi	Sheep	Station	122	Nianogo, 1992
Semi-Arid	Mozambique	Nguni	Sheep	Station	79.1	Makinnon, 1985
Sub-humid	Ghana	WAD	Goats	Station	160	Oppong & Yebuah, 1981
Sub-humid	Malawi	Malawi	Goats	Station	103	Reynolds, 1979
Sub-humid	Nigeria	WAD	Goats	Station	98.6	Bayer, 1986
Sub-humid	Nigeria	Red Sokoto	Goats	Village	124	Otchere et al., 1987

Sub-humid	Uganda	Manny	Goats	Station	71.4	Kyeyune Sendage, 1970
Sub-humid	Nigeria	Yankasa	Sheep	Station	120	Bayer, 1986
Sub-humid	Nigeria	Balami	Sheep	Village	128.46	Adu & Ngere, 1979
Sub-humid	Nigeria	Uda	Sheep	Village	122.6	Adu & Ngere, 1979
Sub-humid	Nigeria	WAD	Sheep	Village	121.8	Adu & Ngere, 1979
Sub-humid	Nigeria	Yankasa	Sheep	Village	111	Adu & Ngere, 1979
Sub-humid	Nigeria	Yankasa	Sheep	Village	121	Otchere et al., 1987

Table 2.2. Some Estimates (days) of Parturition Interval for Does and Ewes in Sub-Saharan Africa

Ecological Zone	Country	Breed	Species	Management	Value	Reference
Highlands	Cameroon	WAD	Goats	Village	427	Dubois & Hardouin, 1987
Highlands	Rwanda	Rwandan	Goats	Station	343	Murayi et al., 1987
Highlands	Rwanda	Rwandan	Goats	Station	440	Murayi et al., 1987
Highlands	Rwanda	Small East African	Goats	Station	343	Murayi et al., 1987
Highlands	Malawi	Small East African	Goats	Village	314.3	Karua, 1989
Highlands	Ethiopia	Menz	Sheep	Village	350.75	Agyemang et al., 1985
Highlands	Rwanda	African long-fat-tailed	Sheep	Station	406	Murayi et al., 1987
Humid	Cote d'Ivoire	WAD	Goats	Village	227.6	Armbruster, 1988
Humid	Cote d'Ivoire	WAD	Goats	Station	283	Berger, 1979
Humid	Ghana	WAD	Goats	Station	229	Buadu, 1972
Humid	Ghana	WAD	Goats	Station	258	Vohradsky & Sada, 1973 quoted in ILCA, 1983
Humid	Ghana	WAD	Goats	Station	266	Otchere & Nimo, 1976
Humid	Nigeria	WAD	Goats	Village	259	Reynolds & Adeoye, 1985
Humid	Nigeria	WAD	Goats	Village	261	Adeoye, 1985
Humid	Nigeria	WAD	Goats	Village	283	Sumberg & Mack, 1985
Humid	Nigeria	WAD	Goats	Village	259	Mack, 1983
Humid	Nigeria	WAD	Goats	Village	278	Mosi et al., 1982
Humid	Senegal	WAD	Goats	Village	239	Faugère et al., 1988
Humid	Cameroun	WAD	Sheep	Station	247.68	Vallerand and Branckaert, 1975
Humid	Côte d'Ivoire	WAD	Sheep	Village	213.5	Rombaut & Vlaenderen, 1976
Humid	Côte d'Ivoire	WAD	Sheep	Village	230	Armbruster, 1988
Humid	Ghana	WAD	Sheep	Station	264	Tuah & Baah, 1985
Humid	Ghana	WAD	Sheep	Station	256	Oppong-Anane, 1971
Humid	Nigeria	WAD	Sheep	Station	248	Dettmers et al., 1976
Humid	Nigeria	WAD	Sheep	Station	322	Reynolds & Adeoye, 1985
Humid	Nigeria	WAD	Sheep	Station	311	Sumberg & Mack, 1985
Humid	Nigeria	WAD	Sheep	Village	322	Mack, 1983
Humid	Senegal	WAD	Sheep	Station	307	Fall et al., 1983
Humid	Senegal	WAD	Sheep	Village	248	Faugère et al., 1988
Humid	Côte d'Ivoire	WAD	Sheep	Village (improved)		Armbruster et al., 1991
				- continous breeding	230	
				- controlled	275	

				breeding		
Semi-arid	Burkina Faso	Sahel	Goats	Village	328	ILCA, 1987
Semi-arid	Chad	Massakory	Goats	Station	261	IEMVT, 1979
Semi-arid	Chad	Massakory	Goats	Station	234	Bertaudière, 1979
Semi-arid	Kenya	Small EA	Goats	Village	306.1	Wilson, 1984
Semi-arid	Kenya	Small EA	Goats	Village	289	Wilson, 1982
Semi-arid	Kenya	Small EA	Goats	Village	312	Peacock, 1982
Semi-arid	Mali	Sahel	Goats	Village	298	Wilson & Traore, 1988
Semi-arid	Mali	Sahel	Goats	Village	261.2	Wilson, 1984
Semi-arid	Mali	Sahel	Goats	Village	271	Wilson, 1982
Semi-arid	Niger	Maradi	Goats	Village	332.4	Haumesser, 1975b
Semi-arid	Niger	Sokoto	Goats	Village	331	Gerbaldi, 1978
Semi-arid	Niger	Sahel	Goats	Village	258	Bertaudière, 1979
Semi-arid	Sudan	Sudan desert	Goats	Village	242.9	Wilson, 1984
Semi-arid	Sudan	Sudan desert	Goats	Village	238	Wilson, 1982
Semi-arid	Uganda	Mubende	Goats	Village	297	Wilson, 1982
Semi-arid	Mozambique	Landim	Goats	Station	408	Wilson et al., 1989
Semi-arid	Somalia	White Somali	Goats	Village	280.6-600.8	Bouzat et al., 1992
Semi-arid	Zimbabwe	Zimbabwean Small East African	Goats	Village	370	Ndlovu, L. R., 1992
Semi-arid	Mozambique	Landim	Goats	Station	408	Rocha et al., 1991
Semi-arid	Mozambique	Landim	Goats	Station	391	Mckinnon & Rocha, 1985
Semi-arid	Burkina Faso	Sahel	Sheep	Village	290	ILCA, 1987
Semi-arid	Kenya	Masai	Sheep	Village	344	Wilson, 1982
Semi-and	Kenya	Masai	Sheep	Village	306	Peacock, 1982
Semi-arid	Mali	Sahel	Sheep	Village	280	Wilson & Traore, 1988
Semi-arid	Mali	Sahel	Sheep	Village	254	Wilson, 1982
Semi-arid	Niger	Uda	Sheep	Village	305	Haumesser & Gerbaldi, 1980
Semi-arid	Senegal	Peul	Sheep	Station	341.9	Sow et al., 1985
Semi-arid	Senegal	Peul	Sheep	Station	291.54	Garba, 1986
Semi-arid	Senegal	Peul	Sheep	Village	366	Tchakerian, 1979
Semi-arid	Sudan	Sudan desert	Sheep	Village	275	Wilson, 1982
Semi-arid	Uganda	EA fat-tailed	Sheep	Village	257	Wilson, 1982
Semi-arid	Somalia	Black-headed Somali	Sheep	Village	332.5-533.7	Bouzat et al., 1992
Semi-arid	Mozambique	Landim	Sheep	Station	373	Wilson et al., 1989
Semi-arid	Mozambique	Nguni	Sheep	Station	360	Mckinnon & Rocha, 1985
Semi-arid	Mozambique	Landim	Sheep	Station	416	Rocha et al., 1991
Sub-humid	Tanzania	Tanzanian	Goats	Station	302.8	Kyomo, 1978
Sub-humid	Ghana	WAD	Goats	Village	335	Awotwi and Fynn, 1992
Sub-humid	Chad	Kirdi & Mayo-Kebbi	Sheep	Village	244	Guerin, 1979
Sub-humid	Malawi	Small East African	Goats	Ranch	246.4	Karua, 1989
Sub-humid	Swaziland	Nguni	Goats	Village	268	Lebbie and Manzine, 1989

Table 2.3. Some Estimates of Prolificacy for Does and Ewes in Sub-Saharan Africa

Ecological Zone	Country	Breed	Species	Management	Value (%)	Reference
Highlands	Cameroon	WAD	Goats	Village	150	Dubois and Hardouin, 1987
Highlands	Rwanda	Rwandan	Goats	Station	175	Murayi et al., 1987
Highlands	Rwanda	Rwandan	Goats	Station	148	Murayi et al., 1987
Highlands	Rwanda	Rwandan	Goats	Station	143	Murayi et al., 1987
Highlands	Malawi	Small East African	Goats	Village	135	Karua, 1989
Highlands	Rwanda	African long-fat-tailed	Sheep	Station	138	Murayi et al., 1985
Humid	Côte d'Ivoire	WAD	Goats	Village	162	Armbruster, 1988
Humid	Côte d'Ivoire	WAD	Goats	Station	175	Berger, 1979
Humid	Ghana	WAD	Goats	Station	187	Otchere & Nimo, 1976
Humid	Ghana	WAD	Goats	Station	184	Buadu, 1972
Humid	Ghana	WAD	Goats	Station	184	Vohradsky & Sada, 1973 quoted in ILCA, 1983
Humid	Nigeria	WAD	Goats	Village	149	Reynolds & Adeoye, 1985
Humid	Nigeria	WAD	Goats	Village	156	Sumberg & Mack, 1985
Humid	Nigeria	WAD	Goats	Village	160	Adeoye, 1985
Humid	Nigeria	WAD	Goats	Village	160	Mosi et al., 1982
Humid	Nigeria	WAD	Goats	Village	150	Mack, 1983
Humid	Senegal	WAD	Goats	Village	150	Faugère et al., 1988
Humid	Cameroon	WAD	Sheep	Station	117	Vallerand & Branckaert, 1975
Humid	Côte d'Ivoire	WAD	Sheep	Village	111	Berger, 1980
Humid	Cote d'Ivoire	WAD	Sheep	Village	110	CNRZ, 1977
Humid	Côte d'Ivoire	WAD	Sheep	Village	119	Armbruster, 1988
Humid	Côte d'Ivoire	WAD	Sheep	Village	123	Armbruster, 1988
Humid	Côte d'Ivoire	WAD	Sheep	Village	128.7	Armbruster, 1988
Humid	Côte d'Ivoire	WAD	Sheep	Station	118.2	Armbruster et al., 1990
Humid	Ghana	WAD	Sheep	Station	130.6	Tuah & Baah, 1985
Humid	Ghana	WAD	Sheep	Station	143	University of Ghana, 1976 quoted in ILCA, 1983
Humid	Nigeria	WAD	Sheep	Station	145.6	Dettmers et al., 1976
Humid	Nigeria	WAD	Sheep	Station	172	Dettmers et al., 1976
Humid	Nigeria	WAD	Sheep	Village	123	Reynolds & Adeoye, 1985
Humid	Nigeria	WAD	Sheep	Village	129	Sumberg & Mack, 1985
Humid	Nigeria	WAD	Sheep	Village	123	Mack, 1983
Humid	Senegal	WAD	Sheep	Station	112	Fall et al., 1983
Humid	Senegal	WAD	Sheep	Village	117	Faugère et al., 1988
Humid	Congo	WAD	Sheep	Village	104.7	Batalou-Mbetanie, 1992
Semi-Arid	Burkina Faso	Sahel	Goats	Village	105	ILCA, 1987
Semi-Arid	Chad	Massakory	Goats	Station	150	IEMVT, 1978
Semi-Arid	Chad	Sahel	Goats	Village	112	Wilson, 1982
Semi-Arid	Ethiopia	Adal	Goats	Village	110	Wilson, 1982
Semi-Arid	Kenya	Small EA	Goats	Village	116	Wilson, 1982
Semi-Arid	Mali	Sahel	Goats	Village	119	Wilson & Traore, 1988
Semi-Arid	Mali	Sahel	Goats	Village	123	Wilson, 1982

Semi-arid	Mozambique	Landim	Goats	Station	162	Makinnon, 1985
Semi-Arid	Niger	Red Sokoto	Goats	Village	147	Haumesser, 1975b
Semi-Arid	Niger	Sahel (Touareg)	Goats	Village	126.2	Haumesser cited in Gerbaldi, 1978
Semi-Arid	Niger	Sahel (Peul)	Goats	Village	146.6	Haumesser cited in Gerbaldi, 1978
Semi-Arid	Niger	Sokoto	Goats	Village	156	Gerbaldi, 1978
Semi-Arid	Sudan	Sudan desert	Goats	Village	157	Wilson, 1982
Semi-Arid	Swaziland	Nguni	Goats	Village	116	Lebbie & Mastapha, 1985
Semi-Arid	Uganda	Mubende	Goats	Village	130	Wilson, 1982
Semi-Arid	Chad	Arab	Goats	Village	109	Wilson, 1982
Semi-Arid	Niger	Uda	Sheep	Station	110	Gaillard, 1979
Semi-Arid	Burkina Faso	Mossi	Sheep	Village	102	Wilson and Bourzat, 1986
Semi-Arid	Burkina Faso	Peul	Sheep	Village	105	Wilson and Bourzat, 1986
Semi-Arid	Chad	Arab	Sheep	Village	101	Dumas, 1980
Semi-Arid	Chad	Uda	Sheep	Village	107	Dumas, 1980
Semi-Arid	Chad	Uda	Sheep	Village	107	Dumas, 1977
Semi-Arid	Ethiopia	Adal	Sheep	Village	105	Wilson, 1982
Semi-Arid	Kenya	Masai	Sheep	Village	102	Wilson, 1982
Semi-Arid	Mali	Sahel	Sheep	Village	104	Wilson and Traore, 1988
Semi-Arid	Mali	Sahel	Sheep	Village	105	Wilson, 1982
Semi-Arid	Niger	Uda	Sheep	Village	111	Haumesser, 1975b
Semi-Arid	Niger	Uda	Sheep	Village	107	Haumesser and Gerbaldi, 1980
Semi-Arid	Senegal	Peul	Sheep	Station	108	Garba, 1986
Semi-Arid	Sudan	Sudan desert	Sheep	Village	114	Wilson, 1982
Semi-Arid	Mozambique	Landim	Sheep	Station	136	Rocha et al., 1991
Semi-Arid	Burkina Faso	Mossi	Sheep	Station	116	Nianogo, 1992
Sub-humid	Chad	Kirdi	Goats	Village	150	Dumas, 1980
Sub-humid	Chad	Mayo-Kebbi	Goats	Village	160	Dumas, 1980
Sub-humid	Chad	Mayo-Kebbi	Goats	Village	170	Dumas, 1980
Sub-humid	Chad	Kirdi	Goats	Village	140-150	Dumas, 1980
Sub-humid	Chad	Kirdi	Goats	Village	144-171	Dumas, 1977; Dumas et al., 1977
Sub-humid	Côte d'Ivoire	WAD	Goats	Village	150	Bayer, 1982
Sub-humid	Ghana	WAD	Goats	Station	167	Oppong & Yebuah, 1981
Sub-humid	Nigeria	Red Sokoto	Goats	Village	135	Otchere et al., 1987
Sub-humid	Nigeria	WAD	Goats	Village	150	Bayer, 1982
Sub-humid	Tanzania	Newala	Goats	Village	128	Hendy, 1980
Sub-humid	Malawi	Small East African	Goats	Ranch	138	Karua, 1989
Sub-humid	Swaziland	Nguni	Goats	Village	118	Lebbie and Manzini, 1989
Sub-humid	Chad	Kirdi	Sheep	Village	138.5	Dumas, 1980
Sub-humid	Chad	Mayo-Kebbi	Sheep	Village	164	Dumas, 1980
Sub-humid	Chad	Kirdi	Sheep	Village	140	Dumas, 1977
Sub-humid	Chad	Kirdi & Mayo-	Sheep	Station	171	Guerin, 1979

		Kebbi				
Sub-humid	Nigeria	Yankasa	Sheep	Village	106	Otchere et al., 1987
Sub-humid	Togo	Vogan	Sheep	Village	140	Amegee, 1978a
Sub-humid	Togo	WAD	Sheep	Village	148.7	Amegee, 1978b
Sub-humid	Nigeria	WAD	Sheep	Station	133	Odubote, 1992

Table 2.4. Some Twinning Rates (%) for Does and Ewes in Sub-Saharan Africa

Ecological Zone	Country	Breed	Species	Management	Value	Reference
Highlands	Ethiopia	Menz	Sheep	Village	4.2	Agyemang et al., 1985
Humid	Côte d'Ivoire	WAD	Goats	Village	60.4	Armbruster, 1988
Humid	Ghana	WAD	Goats	Station	53	Vohradsky & Sada, 1973 cited in ILCA, 1983
Humid	Ghana	WAD	Goats	Station	51.12	Oppong and Yebuah, 1981
Humid	Ghana	WAD	Goats	Station	52	Otchere and Nimo, 1976
Humid	Nigeria	WAD	Goats	Station	53	Ademosun, 1973 cited in Osuagwuh and Akpokodje, 1981
Humid	Côte d'Ivoire	WAD	Sheep	Village	27	Rombaut & Vlaenderen, 1976
Humid	Côte d'Ivoire	WAD	Sheep	Village	32	Armbruster, 1988
Humid	Côte d'Ivoire	WAD	Sheep	Village	42.5	Armbruster, 1988
Humid	Côte d'Ivoire	WAD	Sheep	Village	34	Armbruster, 1988
Humid	Ghana	WAD	Sheep	Station	26.4	Tuah and Baah, 1985
Humid	Nigeria	WAD	Sheep	Station	55	Dettmers & Loosly, 1974
Humid	Nigeria	WAD	Sheep	Station	27	Ademosun, 1973 quoted in Osuagwuh and Akpokodje, 1981
Semi-Arid	Burkina Faso	Peul	Goats	Village	27.8	Dumas & Raymond, 1975
Semi-arid	Burkina Faso	Mossi	Goats	Village	16.8	Dumas & Raymond, 1975
Semi-Arid	Chad	Massakory	Goats	Village	43.7	IEMVT, 1979
Semi-Arid	Mali	Sahel	Goats	Village	18	Wilson & Traore, 1988
Semi-Arid	Niger	Sahel	Goats	Village	13.5	Wilson & Wagenaar, 1982
Semi-Arid	Niger	Sahel (Touareg)	Goats	Village	24.8	Haumesser cited in Gerbaldi, 1978
Semi-Arid	Niger	Sahel (Peul)	Goats	Village	44.1	Haumesser cited in Gerbaldi, 1978
Semi-Arid	Niger	Red Sokoto	Goats	Village	47.5	Gerbaldi, 1978
Semi-arid	Mozambique	Landim	Goats	Station	56.7	Makinnon, 1985
Semi-Arid	Swaziland	Native	Goats	Village	21.37	Lebbie and Mastapha, 1985
Semi-Arid	Zimbabwe	Zimbabwean Small East African	Goats	Village	29.75	Ndlovu, 1992
Semi-Arid	Mali	Sahel	Sheep	Village	4.2	Wilson and Traore, 1988
Semi-arid	Mozambique	Nguni	Sheep	Station	44.6	Makinnon, 1985
Semi-Arid	Niger	Sahel	Sheep	Village	4.5	Wilson & Wagenaar, 1982
Sub-humid	Ghana	WAD	Goats	Station	59	Oppong and Yebuah, 1981
Sub-humid	Nigeria	Red Sokoto	Goats	Village	29.5	Otchere et al., 1987
Sub-humid	Nigeria	WAD	Goats	Village	34	Bayer, 1986

Sub-humid	Nigeria	WAD	Goats	Village	38	Bayer, 1982
Sub-humid	Tanzania	Tanzanian	Goats	Station	16.4	Kyomo, 1978
Sub-humid	Tanzania	Newala	Goats	Village	36	Hendy, 1980
Sub-humid	Uganda	Manny	Goats	Station	32.7	Kyeyune-Sendage, 1970
Sub-humid	Ghana	WAD	Goats	Village	45	Awotwi and Fynn, 1992
Sub-humid	Nigeria	Yankasa	Sheep	Village	6.3	Otchere et al., 1987
Sub-humid	Nigeria	Yankasa	Sheep	Village	12	Bayer, 1986
Sub-humid	Togo	Vogan	Sheep	Village	34.42	Amegee, 1978a
Sub-humid	Togo	WAD	Sheep	Village	44	Amegee, 1978b
Sub-humid	Ghana	WAD*	Sheep	Village	26.8	Awotwi and Fynn, 1992

* Most sheep are WAD but farms also have Sudan type sheep and WAD X Sudan crosses.

Table 2.5. Prolificacy of some breeds of goat (number of kids per birth)

Breed	Location	Av. litter	Reference
Maltese and Damascus	Athalassa, Cyprus	1.85	Maule (1949)
Damascus	Cyprus	1.71	Cyprus: Dep. Agric. (1955)
Kilis	Ankara, Turkey	1.27	Yarkin and Eker (1961)
Kambing Katjang Anglo-Nubian Crosses (various grades)	Serdang, Malaysia	1.65 1.43 1.67 to 2.06	Devendra (1962)
Ma T'ou	Hupeh Province (China)	2.24	Epstein (1969)
Syrian Mountain Negev Appenzeller Saanen Damascus Anglo-Nubian Malta	Rehovot, Israel	1.44 1.38 1.27 1.90 1.76 1.75 1.59	Epstein and Herz (1964)
Anglo-Nubian x Local Anglo-Nubian	Palmer, Mauritius	2.45 2.29	Delaitre (1965)
Black Bengal	Haringhata, India	2.04	Moulick et al.

Source: Devendra and Burns (1970).

Table 2.6. Some Estimates of Fecundity for Goats and Sheep in Sub-Saharan Africa

Ecological zone	Country	Breed	Species	Management	%	Reference
Highlands	Cameroon	WAD	Goats	Village	130	Dubois & Hardouin, 1987
Highlands	Malawi	Small East African	Goats	Village	107	Karua, 1989
Humid	Côte d'Ivoire	WAD	Goats	Village	250.9	Armbruster, 1988
Humid	Ghana	WAD	Goats	Station	293	Buadu, 1972

Humid	Ghana	WAD	Goats	Station	260	Vohradsky & Sada, 1973 quoted in ILCA, 1983
Humid	Ghana	WAD	Goats	Station	267	Otchere & Nimo, 1976
Humid	Nigeria	WAD	Goats	Village	201	Sumberg & Mack, 1985
Humid	Cameroon	WAD	Sheep	Station	168	Vallerand & Branckaert, 1975
Humid	Côte d'Ivoire	WAD	Sheep	Village	206	Rombaut & Vlaenderen, 1976
Humid	Côte d'Ivoire	WAD	Sheep	Village	175	CNRZ, 1977
Humid	Côte d'Ivoire	WAD	Sheep	Village	208.8	Armbruster, 1988
Humid	Côte d'Ivoire	WAD	Sheep	Village	173.6	Armbruster, 1988
Humid	Côte d'Ivoire	WAD	Sheep	Village	200.8	Armbruster, 1988
Humid	Nigeria	WAD	Sheep	Station	122	Adu & Ngere, 1979
Humid	Nigeria	WAD	Sheep	Station	249	Dettmers et al., 1976
Humid	Nigeria	WAD	Sheep	Village	151	Sumberg & Mack, 1985
Humid	Nigeria	WAD	Sheep	Village	115	Matthewman, 1980
Humid	Congo	WAD	Sheep	Village	119.03	Batalou-Mbetanie, 1992
Semi-arid	Burkina Faso	Mossi	Goats	Village	78.75	Bourzat, 1980
Semi-arid	Burkina Faso	Mossi	Goats	Village	121	SEDES, 1974
Semi-arid	Chad	Massakory	Goats	Village	171	IEMVT, 1979
Semi-arid	Chad	Massakory	Goats	Village	181.7	Bertaudière, 1978 cited in Charray et al., 1980
Semi-arid	Niger	Sahel multi colour	Goats	Village	157.1-181.5	Haumesser cited in Gerbaldi, 1978
Semi-arid	Chad	Sahel (Batha)	Goats	Village	109	Dumas, 1977; Dumas et al., 1977
Semi-arid	Chad	Sahel (Kanem)	Goats	Village	82	Dumas, 1977; Dumas et al., 1977
Semi-arid	Burkina Faso	Peul	Goats	Village	130-152	Dumas & Raymond, 1975
Semi-arid	Burkina Faso	Peul	Goats	Village	74.8	Bourzat, 1980
Semi-arid	Burkina Faso	Sahel	Goats	Village	141	SEDES, 1974
Semi-arid	Chad	Arab	Goats	Village	99	Dumas, 1980
Semi-arid	Mali	Sahel	Goats	Village	112-134	Maiga, 1980
Semi-arid	Mali	Sahel	Goats	Village	93	Maiga, 1980
Semi-arid	Mozambique	Landim	Goats	Station	149.2	Makinnon, 1985
Semi-arid	Niger	Sokoto	Goats	Village	167	Haumesser, 1975 b
Semi-arid	Somalia	White Somali	Goats	Village	65	Bouzat et al., 1992
Semi-arid	Burkina Faso	Mossi	Sheep	Village	70	Bourzat, 1980
Semi-arid	Burkina Faso	Mossi	Sheep	Village	112	SEDES, 1974
Semi-arid	Burkina Faso	Peul	Sheep	Village	81.25	Bourzat, 1980
Semi-arid	Burkina Faso	Peul	Sheep	Village	106	SEDES, 1974
Semi-arid	Chad	Arab	Sheep	Village	84-86	Dumas, 1977; Dumas et al., 1977

Semi-arid	Chad	Arab	Sheep	Village	86	Dumas, 1980
Semi-arid	Chad	Uda	Sheep	Village	105	Dumas, 1980
Semi-arid	Mali	Sahel	Sheep	Village	151.5	Maiga, 1980
Semi-arid	Mali	Sahel	Sheep	Village	102.5	Maiga, 1980
Semi-arid	Mali	Sahel	Sheep	Village	123	Maiga, 1980
Semi-arid	Mozambique	Nguni	Sheep	Station	107.6	Makinnon, 1985
Semi-arid	Niger	Uda	Sheep	Village	114	Haumesser & Gerbaldi, 1980
Semi-arid	Burkina Faso	Mossi	Sheep	Station	139	Nianogo, 1992
Semi-arid	Somalia	Black-headed Somali	Sheep	Village	62	Bouzat et al., 1992
Sub-humid	Malawi	Malawi	Goats	Station	109	Reynolds, 1979
Sub-humid	Tanzania	Newala	Goats	Village	118	Hendy, 1980
Sub-humid	Chad	Kirdi	Goats	Village	164	Dumas, 1977; Dumas et al., 1977
Sub-humid	Malawi	Small East African	Goats	Ranch	175	Karua, 1989
Sub-humid	Burkina Faso	Mossi	Sheep	Village	104	Dumas & Raymond, 1975
Sub-humid	Chad	Kirdi	Sheep	Village	146	Dumas et al., 1977
Sub-humid	Chad	Kirdi	Sheep	Village	141	Dumas, 1980
Sub-humid	Chad	Mayo-Kebbi	Sheep	Village	156	Dumas et al., 1977
Sub-humid	Chad	Kirdi	Sheep	Village	140	Dumas, 1980
Sub-humid	Chad	Mayo-Kebbi	Sheep	Village	156	Dumas, 1980
Sub-humid	Chad	Mayo-Kebbi	Sheep	Village	165	Dumas, 1980
Sub-humid	Nigeria	Balami	Sheep	Station	128.5	Adu & Ngere, 1979
Sub-humid	Nigeria	Uda	Sheep	Station	122.6	Adu & Ngere, 1979
Sub-humid	Nigeria	Yankasa	Sheep	Station	111.4	Adu & Ngere, 1979
Sub-humid	Nigeria	WAD	Sheep	Station	121.8	Adu & Ngere, 1979
Sub-humid	Togo	WAD	Sheep	Village	120	Van Viaenderen, 1985

Table 2.7. Some Estimates of Age at First Parturition for Goats and Sheep in Sub-Saharan Africa

Ecological Zone	Country	Breed	Species	Management	Value (days)	Reference
Highlands	Rwanda	Rwandan	Goats	Station	640	Murayi et al., 1987
Highlands	Rwanda	Rwandan	Goats	Station	971	Murayi et al., 1987
Highlands	Malawi	Malawi local	Goats	Village	457.5	Karua, 1989
Highlands	Ethiopia	Menz	Sheep	Village	>720	Agyemang et al., 1985
Highlands	Rwanda	African long-fat-tailed	Sheep	Station	713.7	Murayi et al., 1985
Humid	Ghana	WAD	Goats	Station	369	Vohradsky and Sada, 1973 quoted in ILCA, 1983
Humid	Nigeria	WAD	Goats	Village	518	Sumberg & Mack, 1985
Humid	Nigeria	WAD	Goats	Village	545	Mosi et al., 1982
Humid	Senegal	WAD	Goats	Village	361	Faugère et al., 1988
Humid	Cameroon	WAD	Sheep	Station	372.1-722.85	Vallerand & Branckaert, 1975
Humid	Côte d'Ivoire	WAD	Sheep	Village	350.75	Rombaut & Vlaenderen, 1976

Humid	Côte d'Ivoire	WAD	Sheep	Village	431.3	Armbruster, 1988
Humid	Ghana	WAD	Sheep	Station	638	Tuah & Baah, 1985
Humid	Ghana	WAD	Sheep	Station	408	Oppong-Anane, 1971
Humid	Nigeria	WAD	Sheep	Station	610	Dettmers & Loosli, 1974
Humid	Nigeria	WAD	Sheep	Station	488	Ngere, 1977 quoted in ILCA, 1983
Humid	Côte d'Ivoire	WAD	Sheep	Village	411.75	Ginistry, 1977
Humid	Nigeria	WAD	Sheep	Station	625.25	Dettmers et al., 1976
Humid	Nigeria	WAD	Sheep	Village	492	Sumberg & Mack, 1985
Humid	Senegal	WAD	Sheep	Station	573.4	Fall et al., 1983
Humid	Senegal	WAD	Sheep	Village	464	Faugère et al., 1988
Humid	Cote d'Ivoire	Djallonké	Sheep	Village improved - continuous breeding - controlled breeding	 431 480	Armbruster et al., 1991
Semi-arid	Burkina Faso	Mossi	Goats	Village	303.7	Bourzat, 1980
Semi-arid	Burkina Faso	Peul	Goats	Village	404.4	Bourzat, 1980
Semi-arid	Burkina Faso	Sahel	Goats	Village	423	ILCA, 1987
Semi-arid	Chad	Arab	Goats	Village	419.4	Dumas, 1980
Semi-arid	Chad	Arab	Goats	Village	415	Wilson, 1982
Semi-arid	Kenya	Small EA	Goats	Village	555.8	Wilson, 1984
Semi-arid	Kenya	Small EA	Goats	Village	456	Wilson, 1984
Semi-arid	Mali	Sahel	Goats	Village	487	Wilson & Traore, 1988
Semi-arid	Mali	Sahel	Goats	Village	472.2	Wilson, 1984
Semi-arid	Mali	Sahel	Goats	Village	484	Wilson, 1982
Semi-arid	Mozambique	Landim	Goats	Station	738	Makinnon & Rocha, 1985
Semi-arid	Niger	Sahel	Goats	Village	457.8	Wilson & Wagenaar, 1982
Semi-arid	Niger	Sahel	Goats	Village	426.7	Haumesser, 1975a
Semi-arid	Sudan	Sudan desert	Goats	Village	280	Wilson, 1982
Semi-arid	Burkina Faso	Peul	Sheep	Village	335.5	Dumas and Raymond, 1975
Semi-arid	Mozambique	Nguni	Sheep	Station	772	Makinnon & Rocha, 1985
Semi-arid	Mozambique	Nguni	Sheep	Station	772	Makinnon, 1985
Semi-arid	Senegal	Peul	Sheep	Village	>732	Tchakerian, 1979
Semi-arid	Senegal	Peul	Sheep	Station	350.75	Tchakerian, 1979
Semi-arid	Burkina Faso	Mossi	Sheep	Village	395.3	Bourzat, 1980
Semi-arid	Burkina Faso	Peul	Sheep	Village	448.35	Bourzat, 1980
Semi-arid	Chad	Arab	Sheep	Village	442.25	Dumas, 1980
Semi-arid	Chad	Uda	Sheep	Village	396.5	Dumas, 1980
Semi-arid	Chad	Arab	Sheep	Village	440	Wilson, 1982
Semi-arid	Kenya	Masai	Sheep	Village	540	Wilson, 1982
Semi-arid	Mali	Sahel	Sheep	Village	470	Wilson, 1982
Semi-arid	Burkina Faso	Sahel	Sheep	Village	455	ILCA, 1987
Semi-arid	Mali	Sahel	Sheep	Village	480	Wilson & Traore, 1988

Semi-arid	Niger	Sahel	Sheep	Village	579.5	Wilson & Wagenaar, 1982
Semi-arid	Niger	Uda	Sheep	Village	488	Haumesser & Gerbaldi, 1980
Semi-arid	Senegal	Peul	Sheep	Station	749.5	Sow et al., 1985
Semi-arid	Senegal	Peul	Sheep	Station	685.47	Garba, 1986
Semi-arid	Sudan	Sudan desert	Sheep	Village	349	Wilson, 1982
Semi-arid	Burkina Faso	Mossi	Sheep	Station	506.9	A.J. Nianogo, 1992
Sub-humid	Chad	Kirdi	Goats	Village	472.75	Dumas, 1980
Sub-humid	Chad	Mayo-Kebbi	Goats	Village	503.25	Dumas, 1980
Sub-humid	Tanzania	Tanzanian	Goats	Station	773	Kyomo, 1978
Sub-humid	Tanzania	Newala	Goats	Village	503.25	Hendy, 1980
Sub-humid	Swaziland	Nguni	Goats	Village	262-340	Lebbie and Manzini, 1989
Sub-humid	Chad	Kirdi	Sheep	Village	518.5	Dumas, 1980
Sub-humid	Chad	Mayo-Kebbi	Sheep	Village	457.5	Dumas, 1980

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Chapter III. Prenatal wastage

Confusion over the identity of prenatal mortality seems to remain a problem despite the clear definitions provided in earlier reports by Hanley (1961) and Edey (1969). According to Edey (1969), prenatal mortality refers to "deaths occurring over the full period of pregnancy". In other reports (Suleiman, 1976; Singh et al., 1986), however, such mortality is expressed as the sum of abortions and stillbirths. In this review, prenatal mortality will be referred to as the total losses occurring from ovulation to parturition including death of the ovum, be it fertilized or not. Prenatal losses will, therefore, encompass fertilization failure, embryo mortality and fetal death.

Fertilization involves the successful fusion of the sperm and the ovum. The embryo is the conceptus from the moment of syngamy to the time of implantation and the foetus is the conceptus from implantation to parturition (Wilmut et al., 1985). Pregnancy has three periods which are the period of ovum, that of the embryo and that of the foetus (Winters et al., 1942; Green and Winters, 1945). The period of ovum also known as pre-attachment or pre-implantation period is the time from fertilization to the first loose attachment of the blastocyst to the endometrium and is thought to last until about Day 14-15 in sheep (Edgy, 1969; Kelly, 1984). The embryonic period lasts until about Day 40 when the differentiation of the embryonic parts and placenta is concluded (Edey, 1976). The foetal period corresponds to the rest of the pregnancy which, according to Kelly (1986) begins on Day 30-40. Death during the period of ovum can be reasonably referred to as early embryonic loss whilst that occurring during the embryonic period can be named late embryonic loss. A ewe will have a cycle of normal length if the embryos die before Day 12 when maternal recognition of pregnancy occurs (Moor & Rowson, 1964). Edey (1967) pointed out that embryo mortality occurring before this recognition day is unlikely to be distinguished from failure of fertilization.

It appears from the preceding that embryo mortality should refer to death of fertilized ova (or embryos) before the completion of organogenesis and foetal mortality to deaths occurring from the end of organogenesis to birth.

While fertilization failure and embryo mortality are probably equally important in both sheep and goats, studies have concentrated on sheep which are always the preferred experimental animals. It is, therefore, within this constraint, that these two components (i.e. fertilization failure and embryo mortality) of reproductive losses will be discussed.

Fertilization failure

There is no published report on fertilization failure in sheep and goats of SSA, perhaps because this source of losses is costly and time consuming to measure. Reproduction in sheep is, however, a very wasteful process in view of the large difference between potential production and progenies produced. Kelly (1986) stated that while a ewe can only produce five to ten offsprings in her lifetime, she "could produce about 4,000 lambs if all the potential eggs in her ovaries developed". Restall et al. (1976) quoted in Willingham et al. (1986) found that 30 per cent of infertility in adult ewes and 34 per cent in maiden ewes were ascribed to a failure of the ewe to mate. A fertilization failure rate of 30 per cent has been assumed for sheep and goats in Africa (Charray et al., 1980) and may result from lack of breeding rams and bucks, high temperature and/or low live-weight of ewes and does.

Fertilization failure due to lack or quality of stud male

That flocks under the traditional production system often lack males of breeding age is overwhelmingly acknowledged (Wilson and Wagenaar, 1982; Branckaert et al., 1986; Dubois and Hardouin, 1987; von Kaufmann et al., 1986). Bayer (1986) reported that in the sub-humid zone of Nigeria, crop farmers may keep their small flocks for several months without a fertile male. Hendy (1980) found in Makonde Plateau of Tanzania that 56 per cent of goat flocks had no male over one year of age and in some cases, access to breeding males was a constraint to reproductive performance. In the highlands of Cameroon, Dubois and Hardouin (1987) observed that the long parturition interval (14 months) prevailing in goat flocks was ascribed not to abortions or temporary barrenness but to lack of a buck. Does under these conditions are put to bucks only during certain periods of the year when the farmers' financial resources permit. It is generally accepted that the early removal of males from the flocks is a means whereby producers minimize the risk of having them stolen or damaging neighbours' crops. However, farmers assume that bucks and rams will always be available in the communal grazing system, and this may be the major reason for the lack of stud males in the traditional production systems.

Moreover, there are indications that rams and bucks in SSA's traditional production systems are very fertile (ILCA, 1983). However, male fertility can be low due to immaturity or be lowered by chronic morbidity due to various pathologies or seasonal environment changes which may affect sperm quality and quantity. In this case and particularly when fewer than required breeding males are available, the fertilization process could be adversely affected. Lack of stud males appears to be a particular problem of these production systems.

It could be concluded that where the above situations prevail, failure to mate will undoubtedly play an important role in reproductive losses.

Fertilization failure due to high temperature

The depressive effect of high temperature on the behaviour and mating activities of both females and males has been reported as source of fertilization failure elsewhere in the tropics (Braden and Mattner, 1970; Devendra and Burns, 1983; Kelly, 1986). It has also been reported elsewhere that ram fertility is affected most severely 2-3 weeks later after he is exposed to high ambient temperatures (Waites and Setchell 1969; Braden and Mattner 1970; Smith, 1971). In SSA where research on the subject is neglected, a few reports (Wilson, 1976; Reynolds, 1979) claimed no adverse effects of temperature on male libido. Wilson (1976) working in southern Darfur of Sudan reported that ram libido appeared to be high at all times. Studies on fertility of Peul ewes in the semi-arid zone of Niger showed, however, that during the period of increasing temperature, silent ovulations are frequent and complete anestrus common (Yenikoye, 1984). In this case, the studies reveal, that native ewes and does do not exhibit oestrus in spite of the evidence that they ovulate. Behavioral oestrus is shown and reproductive activity is maximal only during parts of the year.

More evidence from on-farm studies of both male and female reproductive performance is needed to confirm the above suggestion that temperature has no depressive effect on male libido in SSA. Further, should the total lack of such adverse effects become established, which is unlikely, chances are that fertilization failure remains a problem in parts of SSA where widespread nutritional and housing constraints prevail and where temperature depresses the female's reproductive activity. Under village conditions and particularly in sahelian and arid zones of SSA, the temperature's depressive role on reproductive performance may involve an important reduction in the proportion of ewes in oestrous throughout the year (Guerra et al., 1972), an increase in the anestrus period (Haresign, 1981) and a failure to mate due to absence of behavioral oestrus.

Fertilization failure due to light body weight

Poor body weight of ewes and does can be a source of fertilization failure. Kelly (1986) reported that the number of ewes that fail to lamb increases as their bodyweight decreases. Weight loss, however, is a common feature of growth pattern of individual animals in the tropics in general and in SSA in particular. Its magnitude is highly affected by the degree of morbidity in the flocks and varies with the seasonal availability of forage resources, the nutritional and health status, and the general management practices. Van Vlaenderen (1985) observed that adult sheep raised under the traditional system of the sub-humid Northern Togo lose 22 per cent of their body weight during the first half of the rainy season. During this period which also corresponds to the cropping season, animals are tethered. At Bunda stations of Malawi, lactating ewes lose 13.6 to 15.6 per cent of their live weight during the dry season (Kamwanja et al., 1985) which is far beyond the tolerable level of 5-7 per cent suggested by Scott (1975). It is unlikely that, under village conditions, such excessive losses are followed by a fast recovery and successful mating after weaning or after the tethering season has ended.

It could be concluded that research activities into the adverse effects of inadequate female weight along with heat stress and lack or questionable quality of stud male on sheep and goat productivity in the sub-Saharan Africa region have been poor or inexistent. Where such effects prevail, however, failure of fertilization may continue to play a silent role in lowering the reproductive efficiency of the region's small ruminants. Whether this role is to be assumed negligible because of the all-year round breeding system prevailing in the region is yet to be investigated.

Embryo mortality

The failure of a fertilized egg to develop normally has been investigated by many authors (Hammond, 1921; Corner, 1923; Crew, 1925; Overall, 1955; Hanley, 1961; Bishop, 1964; Quinlivan et al., 1966; Mattner and Braden, 1967; Edey 1969; Wilkins et al., 1984). Edey (1969), supported later by Wilkins et al. (1984) summarized estimates of prenatal loss (Table 3.1) and concluded that 20-30 per cent of embryos are normally lost during pregnancy with most losses occurring in the first 30 days. The normally occurring embryonic death is called basal embryonic mortality. It is the loss that occurs under normal and stress-free conditions. The questions as to why such loss occurs even in well managed flocks and why no factor or combination of factors investigated and controlled have not been able to eliminate it, remain unanswered. Bishop (1964) stated that the basal embryonic death may be a "perfectly normal way of eliminating unfit genotypes at low biological cost". It could be that asynchrony between ewe and embryo causes the latter to become abnormal (Wilmut and Sales, 1981) and be expelled from the uterus which is unable to prevent luteolysis (Lawson et al., 1983). For

Hanley (1961), there is some "universally active factor" which seems to be responsible for the relatively constant residual death of fertilized ova. Edey (1969) concluded that until such a factor is discovered, many embryos will continue to die within the first 30 days of pregnancy in their native environment, the uterus.

It is now generally accepted, however, that identifiable factors exist which cause embryo death rate to rise beyond the basal limit. These factors which include ovulation rate, dam age, nutrition, hormonal conditions, site of ovulation, litter size, temperature and genotype have been well documented (Macfarlane et al., 1959; Edey, 1970; Braden, 1971; Gunn et al., 1972; Scalon, 1972; Lindsay, 1976; Brien et al., 1981; White et al., 1981; Hanrahan, 1983; Wilmut et al., 1985). Periods of particular vulnerability for the embryo are also well documented (Robinson, 1951; Moor et al., 1960; Edgar, 1962; Dutt, 1963; Quinlivan et al., 1966; Mattner and Braden, 1967; Edey, 1969). These are the early cleavage stage (Dutt, 1963), the time of maternal recognition or Day 12 (Edey, 1969), and about Day 18 when the transfer from yolk sea to allantoic placentation occurs (Robinson, 1951; Moor et al., 1960; Quinlivan et al., 1966). Generally, more than half of the loss occurs before Day 13 and most of the remainder by Day 18 (Edey, 1967; 1969; 1976). Loss after commencement of implantation may simply be a continuation of a process initiated long before (Robinson, 1951).

No elaborated study has been carried out on embryo mortality in sheep and goats of SSA. In one of the two available reports, Wilson and Traore (1988) using abattoir material in Mali claimed that "although it is not possible to establish exactly the rate of embryo mortality by the method used, indications are that these were not very high". The authors did not specify what these indications were but reported early embryo deaths of 6.6 per cent in goats and none in sheep. In the second and more reliable report, Pathiraja and Oyedipe (unpublished data), using the abattoir material, found that about 30 per cent of fertilized ova in Yankasa ewes failed to be represented as lambs at birth. The abattoir material, however, has many shortfalls. Among these, are the impossibility to distinguish between failure of fertilization and early embryo death and the resulting underestimation of the latter. Where early embryonic mortality and resorption have occurred, a corpus luteum might still be seen and such cases cannot be differentiated from cyclic corpora in unmated ewes (Edey, 1969).

It can be concluded that, at this point, we have a poor knowledge of the extent of embryo death in sheep and goats in SSA, the factors that affect it when they do and the resulting effects on flock fertility. Some of the controllable factors investigated elsewhere and which may be associated with embryo loss in the region will now be discussed.

High temperatures as cause of embryo mortality

That high temperatures can lead to the death of a large proportion of embryos in newly mated ewes is well established (Dutt et al., 1956; 1959; Alliston and Ulberg, 1961; Dutt, 1963; 1964; Boyd, 1965; Thwaites, 1967; 1971; Lindsay et. al., 1975; Sayer, 1979; Kelly, 1986). It is also established from field observations that embryonic deaths do occur in hot environments (Morley, 1954; Moule, 1954; Shelton, 1964; Moule, 1966; all cited in, Edey 1969). The timing of heat stress seems more critical than its duration. Alliston and Ulberg (1961) and Dutt (1963, 1964) supported by Thwaites (1967; 1971), Lindsay et al. (1975), and Sayer (1979) showed that the sheep embryo is highly susceptible to continuously applied material heat stress during early cleavage stages while it is in the fallopian tube, i.e. during the first three days after conception. There are indications that acclimatization and diurnal variations in temperature can modify the adverse effects of such a stress (Thwaites, 1967b) but all embryos will usually die when continuous exposure to high temperatures raises ewe rectal temperature by 0.76 to 1.13°C (Thwaites, 1967c). Thwaites (1971) working with a room temperature of 40.6°C suggested that short-term heat waves of the kind that occur in the field can increase embryo mortality rates only in ewes that have recently ovulated. A field study carried out under summer conditions where mean ambient temperatures were between 32 and 40°C showed negative correlations between these temperatures at the time of mating and lambing performance, a situation ascribed to embryo mortality (Lindsay et al., 1975). Since prolonged heat stress due to high ambient temperatures within or above the indicated range prevails during dry seasons in many areas of SSA where housing facilities are lacking, it is likely that embryo death may be more than a minor component of reproductive losses in the region.

Effect of genotype on embryo mortality

Animal genotype is the second possible factor affecting embryo loss. Many authors elsewhere have generally agreed that significant differences in embryo mortality exist between breeds and lines of sheep (Foote et al., 1959; Bellows et al., 1963; Cumming et al., 1975; Edey 1976 and Meyer et al., 1983). However, according to Hanrahan (quoted in Kelly, 1984) who found low repeatability estimates (0.11 ±0.04 and 0.06 ±0.07) for the trait in Merino ewes, the potential for direct selection for higher embryonic survival may be small. Undoubtedly, variations in the trait among individuals within and between breeds exist and do need to be explored in SSA. This may require an understanding of the relationship between the ability of native does and ewes to withstand SSA's stressful environment and the degree to which survival of their fertilized ova is sustained.

Effect of undernutrition on embryo mortality

The effect of undernourishment on early embryo death has also been the subject of many investigations. However, there is a considerable variation in published results on the issue. While a number of studies have shown a decrease in embryo survival due to nutritional restriction (Bennet et al., 1964; Edey, 1966; 1970a; Cumming, 1972a; 1972b; Blockey et al., 1974), others have reported no such effects (Killeen, 1967; Edey, 1970b; 1970c; Bennet et al., 1970; Parr et al., 1982; Smith et al., 1983). Blockey et al. (1974) investigating the suggestion of Van Niekerk et al. (1968) that a few days of fasting could kill embryos, found that three days of fasting killed up to 10 per cent of single embryos during the first ten days after mating but had no effect on twin embryos. The authors concluded that there would normally be little effect on lambing percentage since deaths occurred early and ewes returning to service could mate again. Edey (1976) reviewed the available literature and pointed out that:

1. "when detected, levels of induced mortality have usually been less than 15 per cent, so fairly sensitive experimental designs are required to decide if loss is occurring";
2. "with rare exceptions, positive results have been associated only with severe undernutrition for periods of 7 to 21 days during the first month of pregnancy".

The above observations together with the findings of Parr et al. (1982) and Smith et al. (1983), led Kelly (1984) to conclude that "under normal farming conditions, it is unlikely that such severe changes in nutrition will occur".

From what precedes, it may be doubtful that embryonic death due to undernutrition represents an important source of embryo mortality in small ruminants under the normal drought-free conditions of SSA although nutrition is one of the major constraints to increased ruminant productivity in the region. Selenium deficiency may, however, be a problem in the highlands of SSA in view of the fact that this deficiency has been found to result in deaths of embryos of about four weeks old elsewhere (Hartley, 1963; Mudd and Mackie, 1973 quoted in Egan, 1974; Kelly, 1986) and that blood selenium in sheep and goats have been shown to be below minimum required levels in Kenya (Mbwiria et al., 1984).

Foetal losses

Under normal conditions, loss of conceptus from the end of organogenesis (Day 30-40) through to parturition (foetal period), is small (i.e. less or equal to 6 per cent) (Robinson, 1951; Quinlivan et al., 1966; Edey, 1969; 1976; Kelly 1984; 1986). Foetal loss entails abortion and stillbirth. Abortion is the expulsion before full term of a conceptus unable to sustain independent life (Dennis, 1969, quoted in Osuagwuh, 1985) or death in utero prior to the start of normal birth process (Woolliams et al., 1983). Stillbirth is the expulsion of a dead conceptus which is fully developed and might normally be expected to survive outside the uterus if born alive (Woolliams et al., 1983).

Unlike embryo mortality for which no estimate is available in SSA, foetal death is quite documented though available data are limited. Oftentimes, however, published reports fail to distinguish abortions from stillbirths. Where possible, the two components of reproductive losses will be discussed separately in this review.

Estimates of foetal losses

Estimates of abortions found in the literature are collated in table 3.2. There is a considerable variation on the basis of their expression. Some authors expressed them rightly on the basis as percent of total breeding females (Bertaudière, 1977; Lefèvre et al., 1979; Berger and Ginisty, 1980; Bourzat, 1980; Dumas, 1980; Adesiyun et al., 1983; Okoh, 1986; Armbruster, 1988), others as percent of total lambs/kids born (Reynolds, 1979; Wilson and Traore, 1988), or as percent of parturitions (Haumesser and Poutrel, 1973; 1980; Murayi et al., 1985) or as percent of livebirths (Adesiyun et al., 1983). In one report, abortions and stillbirths were expressed as percent of all foetuses (Suleiman, 1976) while in another, they were estimated as percent of pregnancies (Akakpo, 1988). Many estimates have no declared specification basis (Sarr et al., 1988; Shavulimo et al., 1984; Branckaert, 1987; El-Naim, 1979; Rutagwenda et al., 1985). The paucity of data coupled with the above varying classification will not permit meaningful comparisons between breeds, species and management conditions within ecological zones. However, estimates expressed as percent of breeding females of Bertaudière (1977), Dumas (1980), Lefèvre et al. (1979), Bourzat (1980) which range from 13 to 40 per cent for goats appear very high compared with those ranging from 3.7 to 13.65 per cent reported for sheep by Okoh (1986), Dumas (1980), Armbruster (1988) and Bourzat (1980). The above ranges could be applicable in the semi-arid zone as well. In the humid and sub-humid zones, abortions have been estimated at 25 per cent of breeding does and 3.7 to 6.5 per cent of breeding ewes (Dumas, 1980; Armbruster, 1988). Overall, most abortion rates are higher than the estimate of 9 per cent of breeding females proposed by Charray et al. (1980) for the western and central African sheep and goats.

Available estimates on stillbirths are fewer than those on abortions in SSA (table 3.2) and offer no basis for comparisons. However, the values of 10.3, 14.9 and 10.64 per cent reported by Wilson and Traore (1988), Suleiman (1976) and Osuagwuh et al. (1980) are high when approximated to estimates of 3.8 and 4 per cent obtained for sheep in Cameroon and Mali (Branckaert, 1987; Wilson and Traore, 1988) and to those of 4 and 7.39 per cent reported in Sudan (El-Naim, 1979) and Nigeria, respectively (Osuagwuh and Akpokodje, 1981).

It appears that losses due to foetal death in general have rarely been investigated and that stillbirths have been neglected or generally recorded as abortions. Among ewes and does in SSA, abortion rates are likely to be high and considerably variable (3.7 to 40 per cent of breeding females). Goats are more prone to abortions than sheep. Except in a few cases, the rates are exceedingly high when compared with the tolerable level of 1-5 per cent proposed in earlier work by Watson (1952).

Causes of abortions and stillbirths

Published information on the causes of abortions is shown in Table 3.3. These causes can be partitioned in two groups of components which are of environmental (abortion-induced diseases, nutrition, season, dam age, litter size, management) and genetic origins. Such components interact within and between groups.

Abortifacient diseases

Reports on clinically diagnosed diseases responsible for abortions are rare in the literature. One of the few cases observed is concerned with enzootic abortion which was detected in most ecological zones (Lefèvre et al., 1979; Okoh, 1986; Armbruster, 1988). Two out of the three reports on this disease were under village management conditions. The highest abortion rate (26.5 per cent) was obtained under these same conditions where the introduction of controlled breeding as a management device was said to have been tested (Armbruster, 1988). In the semi-arid zone of Chad, incidence of chlamydial abortion was highest in the dry cool season (Lefèvre et al., 1979). Brucellosis, another abortifacient disease, was also clinically diagnosed. Losses due to Brucella ovis in sheep were estimated at 64.3 per cent of live births [3] in a rainy month on a state owned ranch in the sub-humid zone of Nigeria by Adesiyun et al. (1983). The authors suggested that inappropriate management played an important role contributing to these losses. Okoh (1980) observed a 'storm' of abortions due to Brucella abortus in sheep kept with cattle showing very high incidence of Brucellosis near Kano (Nigeria). The positive reactor rate was estimated at 14.5 per cent but the magnitude of the related abortion rate was not mentioned. Finally, the devastating growing effect of Rift Valley Fever (RVF) has been pointed out by Akakpo et al. (1988) in West Africa where they found that in the semi-arid zone of Burkina Faso, pregnancy rate interruptions due to RVF jumped from 29.62 per cent in sheep and 41.1 per cent in goats in 1985-86 to 78.3 and 52.1 per cent in 1987, respectively. High incidence of RVF was also reported in Mauritania, Senegal and The Gambia where cases of human death have occurred (Jouan, 1988 cited in OIE, 1988). Sarr et al. (1988) reported that abortions due to RVF virus are now common among small ruminants in the Senegal river valley following their occurrence in Mali, Madagascar, The Gambia, Sudan and Guinea Conakry. The latter authors indicated that abundant seasonal rains, swamps and a hot climate coupled with high concentration of animals and mosquitos, are responsible for the spread of the disease. Rats and migratory birds may have played an important role as vectors. It is worthwhile noting that RVF virus has existed in West Africa since its first presence was reported more than three decades ago (Ferguson, 1959). It is also worthwhile noting that many other disease conditions can cause abortions in small ruminants. Among these is PPR which was reported to have been associated with 41.2 per cent abortions in does raised under village management in the humid zone of Nigeria.

[3] This is the specification basis used by the authors.

Nutrition and season

Nutritionally induced abortions have long been acknowledged particularly in does in Southern Africa (Van Rensburg, 1971; Wentzel et al., 1974) and suspected under the semi-arid village conditions of Niger (Haumesser and Poutrel, 1973) and Burkina Faso (Bourzat, 1980). In Niger, 75 per cent of the reported abortions in goats occurred towards the end of the dry season. In Burkina Faso, 21.6 per cent of abortions took place in the rainy season, 29.9 per cent in the dry cool season and 48.5 per cent in dry hot season. It was estimated that 23.6 to 87.5 per cent of breeding ewes and 27.3 to 72.2 per cent of breeding does joined in the dry hot season lost their foetuses before term. Both the reports by Bourzat (1980), Haumesser and Poutrel (1973) incriminated the scarcity of feed resources during the dry season, agreeing with evidence presented by Rutagwenda et al., (1985) in the semi-arid zone of Kenya. The latter authors obtained 22 and 0 per cent abortion rates when females were mated at the end of long dry season and prior to the long rains, respectively. In the humid zone of Côte d'Ivoire, the detrimental effect of season seems to be more important in the first months of the long rainy season (April-May) where more than 50 per cent of breeding females lost their foetuses before term (Armbruster, 1988). In general, management practices found in crop producing areas of the humid and sub-humid zones are thought to be responsible for losses of this kind. In these zones, small ruminants are tethered during rainy seasons to prevent them from damaging crops (Lagemann, 1977; Mack et al., 1984). This leads to under-nourishment which results in weight losses and poor reproductive performance occurring ironically during the very period when feed resources are abundant.

The period of high vulnerability when nutritionally induced abortions occurred in goats was found to be between 90 to 110 days of foetal life (Wentzel et al., 1974; Shelton and Groft, 1974). This was confirmed by Osuagwuh and Akpokodje (1985) who found that abortions are the prominent response of WAD does to undernourishment and that most of these abortions occurred during the period of accelerated foetal growth i.e. 90-120 days of foetal life.

Dam age, litter size, parturition interval and genotype

Very high rates of abortion and stillbirth were found among twin or triplet bearers (Suleiman, 1976; Osuagwuh, 1984), females with short parturition intervals (Haumesser, 1975, Rombaut and van Vlaenderen, 1976) and when primiparous and immature females were bred (Rombaut and van Vlaenderen, 1976; Ojo, 1980). In the humid zone of Côte d'Ivoire, Rombaut and van Vlaenderen (1976) observed that ewe lambs bred between four and eight months of age not only suffered from higher abortions and stillbirths (55 per cent) than adult ewes (14.6 per cent), but also lost 89 per cent of their progenies before one year of age. They strongly recommended that immature females be protected in the traditional system where breeding is not controlled. Osuagwuh (1984) who reported 70.5 per cent abortion among does carrying two or three foetuses and 61.1 per cent among first kidders, suggested that the high abortion rates among young and/or multiple pregnancy bearing does may be due to inadequate nourishment of both the foetuses and the young growing dam.

Certainly, the overall level of decrease in productivity due to foetal deaths under the traditional production system of SSA will remain unknown for a long time. However, there is a risk that this decrease is high in some areas of the region. For example, more than 50 per cent of both sheep and goats usually abort before three years of age in many areas of the semi-arid zone of Chad (Dumas, 1980). Perhaps, one of the most urgent needs is to identify the least susceptible breeds or genotypes among sheep and goats found in every ecological zone. In this regard, the data presented by Bourzat (1980) for the semi-arid zone of Burkina Faso is quite interesting. Mossi type animals in this zone aborted more during the hot season than Peul type breeds. Mossi goats and sheep are southern types of small ruminants closely related to the WAD breeds (Charray et al., 1980). That these animals tend to have lower performance than Peul types due to the environmental challenge may be an indication of their lower degree of adaptation to that environment. Evidence that some genotypes of native breeds may do better than others in a given environment has also been presented by Osuagwuh et al. (1980). In a crossbreeding trial involving WAD, Yankasa and Uda sheep, the authors observed higher stillbirths for Yankasa x WAD (22 per cent) and Uda x WAD (23 per cent) than for pure breed WAD (0 per cent). Where breed or genotype differences and genotype by environment interactions are detected, possibilities for improvement exist and must be used to reduce prenatal losses.

It can be concluded that many sheep and goat flocks in SSA may not be free of abortifacient diseases. As indicated by Okoh (1986), infectious abortions are probably among the highest economic problems facing the small stock industry of the region. Their association with particular seasons and mismanagement may be real and warrants more investigation. Undoubtedly, Rift Valley Fever appears to be the most dangerous abortion causing disease of our time as evidenced by its rapid spread and growing destructive effect among flocks and human populations between and within countries of SSA. Foetal losses tend to be related to dry season undernourishment in both sheep and goats raised in the semi-arid zone while the start of rainy season seems to be a period of high vulnerability in humid and sub-humid zones. In most cases, losses are highest in multiple foetus bearers, primiparous and immature females, and when parturition intervals are exceedingly short. Underfed does will be expected to respond with high abortion rates. Overall, there are no guidelines for proper specification of published estimates; such a situation is misleading and prevents sound comparisons to be made.

Embryonic and foetal loss due to slaughter of pregnant females

Wastage of conceptus through the slaughter of pregnant females is probably one of the most destructive practices man has ever used against his own production endeavour. While early pregnancy diagnosis may not be possible in most production systems of SSA, there can be no doubt that slaughter of three to four months pregnant does/ewes has some motives other than ignorance. It may be that farmers sell pregnant females because they look heavier and consequently sell at better prices than others. It may also be that because of financial resource limitations, females are indiscriminately sold for slaughter in time of crisis. It may further be that farmers wait for well-known poor producing females to be pregnant and so acquire apparent good condition before they sell them. Whatever the reason, it is most likely that many pregnancies are diagnosed before females are put to death. As shown in Table 3.4, 20 to over 70 per cent of does and ewes slaughtered at various slaughter houses of SSA were pregnant females. Furthermore, there is some evidence to suggest that the proportion of slaughtered pregnant females is highest when these are in their third to fifth months of gestation. Mukasa-Mugerwa and Tekelye (1988) found that of the conceptuses killed, 9.7, 21, 33.3 and 31.9 were in their first, second, third and forth months of age, respectively. In Mali, the average ages of foetuses when their dams were slaughtered were 3.1 months in goats and 3.6 months in sheep (Wilson and Traore, 1988). In Senegal, out of the 138 pregnant foetuses collected at the slaughter house in Dakar, 7.19, 13.66 and 79.13 per cent were 1-2, 2-3 and 3-5 months old, respectively (Nsekanyarenze, 1988). In Nigeria's Enugu and Nsukka abattoirs, pregnancy losses that could be avoided (i.e., 12-20 weeks old pregnancy) were estimated at 31.0 per cent in does and 33.9 per cent in ewes (Wosu and Dibua, 1992). The above figures suggest that slaughter of pregnant does and ewes is one of the most important causes of prenatal losses in the region. It remains to be seen, however, if the overall profit accruing to the farmers who intentionally sell pregnant females, compensates for the above expected loss.

Table 3.1. Basal Embryo Loss

Author(s)	Type of Estimate	% Mortality	Size of Sample		Breed	Age	Location
			Ewes	Ova			
Dutt (1954)	Slaughter day 3-	32.7	180	264	Mixed	Yearling	U.S.A.

	lambing						
Quinlivan et. al. (1966)	Slaughter day 2, 18, 40, 140-lambing	22.1	676	1,017	Romney	2.5 yr	N.Z.
Averill (1955)	Slaughter day 3 and 18-24	22.5	131	262	Suffolk		U.K.
Laffey and Hart (1959)	Slaughter day 3-4	40	60	85	N.Z. Halfbred		N.Z.
Hasnain (1964)	Slaughter day 18	43.3	14	30			U.K.
Mattner and Braden (1967)	Slaughter day 2 and 20	20.8	100		Merino	5 yr	Aust.
Hulet et. al. (1956)	Slaughter and returns to service	28.6 9.9	603 ewe-years		Hampshire and Shropshire		U.S.A.
Edgar (1962)	Slaughter day 24 and returns to service	10.8 0	276 328		Romney Romney	1.5 yr 5 yr	N.Z.
Watson and Radford (1966)	Returns to service and slaughter on day 28	24	127	155	Merino	1.5 yr	Aust.
Dolling and Nicolson (1967)	Returns to service and slaughter on day 28	4.7-5.7 18.6-20.6	183 158	193 194	Merino Merino	1.5 yr 8.5-11.5 yr	Aust.
Morley (1954)	Indirect estimate	25-30	716		Merino		Aust.
Mullaney (1966)	Indirect estimate	22.8	7,304 ewe-years		Merino, Polwarth and Corriedal	4-9 yr	Aust.
Mullaney (1966)	Indirect estimate	24	2,451 ewe-years		Merino, Polwarth and Corriedal	2-3 yr	Aust.

Table 3.2. Some Estimates of Abortion/Stillbirth in Small Ruminants in Sub-Saharan Africa

Country	Breed/Species	Ecozone	Management Conditions	Type of Loss	Specification	% Loss	Author(s)
Malawi	Small East African goats	Highlands	Village	Abortion	As % of viable births	5.6	Karua, 1989
Nigeria	Balami & Yankasa sheep	Highlands	Station	Abortion	As % of breeding females	3	Okoh, 1986
Rwanda	African long-fat tailed sheep	Highlands	Station	Abortion	As % of parturitions	2.9	Murayi et al., 1985
Côte d'Ivoire	WAD goats	Humid	Village	Abortion	As % of breeding females	5.3	Armbruster, 1988
Cameroon	WAD sheep	Humid	Station	Stillbirth	No specification	3.8	Branckaert, 1987
Côte d'Ivoire	WAD sheep	Humid	Village	Abortion	As % of breeding females	3.7	Armbruster, 1988
Nigeria	WAD, Udah, Yankasa & Permer cross-breed sheep	Humid	Station	Stillbirth	As % of parturitions	10.64	Osuagwnh et. al., 1980
Burkina Faso	Mossi goats	Semi-arid	Village	Abortion	As % of breeding	30.5	Bourzat, 1980

					females		
Burkina Faso	Peul goats	Semi-arid	Village	Abortion	As % of breeding females	22.15	Bourzat, 1980
Chad	Sahel goats	Semi-arid	Village	Abortion	As % of breeding females	35	Bertaudière, 1977 cited in Lefèvre et al., 1979
Chad	Sahel goats	Semi-arid	Village	Abortion	As % of breeding females	17.92	Lefèvre et al., 1979
Chad	Sahel goats	Semi-arid	Village	Abortion	As % of parturitions	28	Lefèvre et. al., 1979
Mali	Sahel goats	Semi-arid	Village	Abortion	As % of total kids born	12.6	Wilson & Traore, 1988
Mali	Sahel goats	Semi-arid	Village	Stillbirth	As % of total kids born	10.3	Wilson & Traore, 1988
Niger	Sokoto goats	Semi-arid	Village	Abortion	As % of parturitions	6.5	Haumesser & Poutrel, 1973
Senegal	Sheep & goats	Semi-arid	Village	Abortion	No specification	12.5	Sarr et al., 1988
Chad	Sahel goats	Semi-arid	Village	Abortion	No specification	5	Dumas, 1980
Somalia	Somali goats	Semi-arid	Village	Abortion	As % of parturitions	1-7	Bouzat et al., 1992
Burkina Faso	Mossi sheep	Semi-arid	Village	Abortion	As % of breeding females	10.75	Bourzat, 1980
Burkina Faso	Peul sheep	Semi-arid	Village	Abortion	As % of breeding females	13.65	Bourzat, 1980
Chad	Sahel sheep	Semi-arid	Village	Abortion	No specification	4.6	Dumas, 1980
Mali	Sahel sheep	Semi-arid	Village	Abortion	As % of total lambs born	5.1	Wilson & Traore, 1988
Mali	Sahel sheep	Semi-arid	Village	Stillbirth	As % of total lambs	4	Wilson & Traore, 1988
Sudan	Sugor & Burog sheep	Semi-arid	Station	Abortion & Stillbirth	As % of all foetuses	14.9	Suleiman, 1976
Somalia	Black-headed Somali-sheep	Semi-arid	Village	Abortion	As % of parturitions	3-5	Bouzat et al., 1992
Chad	Kirdi goats	Sub-humid	Village	Abortion	No specification	10	Dumas, 1980
Kenya	East African x Exotic goats	Sub-humid	Village	Abortion	No specification	10	Shavulimo et. al., 1984
Malawi	Malawi goats	Sub-humid	Station	Abortion	As % of total kids born	11.76	Reynolds, 1979

Malawi	Small East African goats	Sub-humid	Ranch	Abortion	As % of viable births	9.5	Karua, 1989
Chad	Mayo-Kebbi & Kirdi sheep	Sub-humid	Village	Abortion	No specification	6.5	Dumas, 1980

Table 3.3. Causes of Abortion/Stillbirth in Small Ruminants in Sub-Saharan Africa

Country	Breed/Species	Ecozone	Management Conditions	Cause		Type of Loss	Specification	% Loss	Author(s)
				Main	Secondary				
Rwanda	Small East African goat	Highlands	Station		Station 1	Abortion	% of parturition	1.28	Murayi et. al., 1987
Rwanda	Small East African goat	Highlands	Station		Station 2	Abortion	% of parturitions	20.6	Murayi et. al., 1987
Nigeria	Balami & Yankasa sheep	Highlands	Station	Chlamydiosis		Abortion	% of breeding females	3	Okoh, 1986
Nigeria	WAD goat	Humid	Station		Multiple birth and dry season	Abortion	% of total abortions	70.5	Osuagwuh, 1984
Nigeria	WAD goat	Humid	Station		First kidders	Abortion	% of total abortions	61	Osuagwuh, 1984
Cote d'Ivoire	WAD sheep	Humid	Village		Part. Int < 7 months	Abortion & Stillbirth	% of total abortions	22	Rombaut & Van Vlaenderen, 1976
Cote d'Ivoire	WAD sheep	Humid	Village		Breeding females aged 4-8 months	Abortion & Stillbirth	% of total abortions	56	Rombaut & Van Vlaenderen, 1976
Cote d'Ivoire	WAD sheep	Humid	Village		Breeding adult females	Abortion & Stillbirth	% of total abortions	15	Rombaut & Van Vlaenderen, 1976
Cote d'Ivoire	WAD sheep	Humid	Station		Rainy season	Abortion	% of breeding females	50-52.6	Berger & Ginistry, 1980
Cote d'Ivoire	WAD sheep	Humid	Station		Dry season	Abortion	% of breeding females	3.12	Berger & Ginistry, 1980
Nigeria	WAD sheep	Humid	Station		Early rains	Stillbirth	% of total kids/lambs born	0	Osuagwuh et.al., 1980
Nigeria	Permer x WAD sheep	Humid	Station		Dry season	Stillbirth	% of total kids/lambs born	19.23	Osuagwuh et. al., 1980
Nigeria	Sahel x WAD sheep	Humid	Station		Dry season	Stillbirth	% of total kids/lambs born	22.22	Osuagwuh et. al., 1980
Nigeria	Permer x WAD sheep	Humid	Station		Early rains	Stillbirth	% of total lambs born	0	Osuagwuh et al., 1980
Nigeria	Uda x WAD sheep	Humid	Station		Early rains	Stillbirth	% of total lambs born	0	Osuagwuh et al., 1980

Nigeria	Yankasa X WAD sheep	Humid	Station		Early rains	Stillbirth	% of total lambs born	0	Osuagwuh et al., 1980
Nigeria	Sahel x WAD sheep	Humid	Station		Dry season	Stillbirth	% of total kids/lambs born	23.08	Osuagwuh et. al., 1980
Cote d'Ivoire	WAD sheep	Humid	Village	Chlamydiosis		Abortion	% of breeding females	26.5	Armbruster 1988
Niger	Sokotto goat	Semi-arid	Village	Malnutrition		Abortion	% of parturitions	6.5	Haumesser & Poutrel, 1973
Chad	Sahel goat	Semi-arid	Village	Chlamydiosis		Abortion	% of breeding females	17.92	Lefèvre et. al., 1979
Burkina Faso	Mossi goat	Semi-arid	Village		Rainy season	Abortion	% of breeding females	11.2	Bourzat, 1980
Burkina Faso	Mossi goat	Semi-arid	Village		Dry cool season	Abortion	% of breeding females	16.2	Bourzat, 1980
Burkina Faso	Mossi goat	Semi-arid	Village		Dry hot season	Abortion	% of breeding females	72.2	Bourzat, 1980
Burkina Faso	Peul goat	Semi-arid	Village		Rainy season	Abortion	% of breeding females	13.4-40.9	Bourzat, 1980
Burkina Faso	Peul goat	Semi-arid	Village		Dry cool season	Abortion	% of breeding females	20-31.8	Bourzat, 1980
Burkina Faso	Peul goat	Semi-arid	Village		Dry hot season	Abortion	% of breeding females	27.3-66.6	Bourzat, 1980
Kenya	Small East African goat	Semi-arid	Station		Kidding at the onset of long rains	Abortion	No specification	22	Rutagwenda et al., 1985
Kenya	Small East African goat	Semi-arid	Station		Mated prior to long rains	Abortion	No specification	0	Rutagwenda et al., 1985
Kenya	Small East African goat	Semi-arid	Station		Kidding prior to short rains	Abortion	No specification	0	Rutagwenda et al., 1985
Kenya	Small East African goat	Semi-arid	Station		Kidding during short dry season	Abortion	No specification	11	Rutagwenda et al., 1985
Burkina Faso	Sahel type goat	Semi-arid	Village	Rift Valley Fever	1985-86	Abortion	% of pregnancies	41.17	Akakpo et. al., 1988
Burkina Faso	Sahel type goat	Semi-arid	Village	Rift Valley Fever	1987	Abortion	% of pregnancies	52.1	Akakpo et. al., 1988
Sudan	Sugor & Burog sheep	Semi-arid	Station		Single	Abortion + Stillbirth	% of all foetus	11.3	Suleiman, 1976
Sudan	Sugor & Burog	Semi-arid	Station		Twins	Abortion	% of all	16.36	Suleiman,

	sheep					+ Stillbirth	foetus		1976
Sudan	Sugor & Burog sheep	Semi-arid	Station		Triplet	Abortion + Stillbirth	% of all foetus	100	Suleiman, 1976
Burkina Faso	Mossi sheep	Semi-arid	Village		Rainy season	Abortion	% of breeding females	33.3	Bourzat, 1980
Burkina Faso	Mossi sheep	Semi-arid	Village		Dry cool season	Abortion	% of breeding females	12.5-33.3	Bourzat, 1980
Burkina Faso	Mossi sheep	Semi-arid	Village		Dry hot season	Abortion	% of breeding females	33.3-87.5	Bourzat, 1980
Burkina Faso	Peul sheep	Semi-arid	Village		Rainy season	Abortion	% of breeding females	17.6-25	Bourzat, 1980
Burkina Faso	Peul sheep	Semi-arid	Village		Dry cool season	Abortion	% of breeding females	25-58.8	Bourzat, 1980
Burkina Faso	Peul sheep	Semi-arid	Village		Dry hot season	Abortion	% of breeding females	23.6-50	Bourzat, 1980
Niger	Uda sheep	Semi-arid	Village		Peul Nomad	Abortion	% of Parturitions	2.45	Haumesser & Gerbaldi, 1980
Niger	Uda sheep	Semi-arid	Village		Hausa sedentary	Abortion	% of Parturitions	0.3	Haumesser & Gerbaldi, 1980
Burkina Faso	Sahel sheep	Semi-arid	Village	Rift Valley Fever	1985-86	Abortion	% of pregnancies	29.62	Akakpo et. al., 1988
Burkina Faso	Sahel sheep	Semi-arid	Village	Rift Valley Fever	1987	Abortion	% of pregnancies	78.3	Akskpo et. al., 1988
Nigeria	Uda, Balami & Yankasa crosses	Sub-humid	Station	Brucellosis		Abortion	% of breeding females	1.0	Adesiyun et al., 1983
Nigeria	Uda, Balami & Yankasa crosses	Sub-humid	Station	Brucellosis		Abortion	% of breeding females	1.9	Adesiyun et al., 1983

Table 3.4. Examples of losses due to slaughter of pregnant does and ewes - Slaughter house data

Country	Location	Month/year	Number of females slaughtered			Number of pregnant females slaughtered			% pregnant females slaughtered			Authors
			Sheep	Goats	Sheep + Goats	Sheep	Goats	Sheep + Goats	Sheep	Goats	Sheep + Goats	
Ethiopia	Addis Ababa	July 1985 June 1986	608	-	-	426	-	-	70	-	-	Mukasa-Mugerwa and Tekelye, 1988
Mali	Niono	1983-86	469	3,166	-	94	1,004	-	20	32	-	Wilson

												and Traore, 1988
Senegal	Dakar	1987	-	-	79,805	-	-	21,301	-	-	27	Abassa and Tine, 1987
Chad	Bokoto	July & August 1988	16	215	-	7	154	-	44	72	-	Gongnet and Abassa, 1988
Togo	Lome	1982-85	17,847	14,631	-	7,139	5,755	-	40	39	-	Kombate and Abassa, 1987

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Chapter IV. Post-natal losses

One of the key indicators of the efficiency of a small ruminant production system is the degree to which lambs and kids survive to a marketable age and/or to a sustainable reproductive life. Low survival rates may be signs of serious problems in such a system; they may be, as Osuagwuh (1985) put it, indications of a very low standard of husbandry. They may also be among the major causes of a reduced rate of multiplication of animals and poor return to capital invested. Thus, knowledge of postnatal losses is a prerequisite for a good understanding of the production system of interest and to the adequate diagnosis of the related constraints.

While researchers in SSA are unanimous about the need to study and reduce postnatal losses in small ruminants, they fail to express these losses in standardized ways, which are necessary for proper understanding and comparisons. In the literature reviewed, mortality rates were expressed either on the basis of percentage of total animals born, total death, total death in the class and rarely as percentage of animals born alive. Information reported this way is incomplete, confusing and of little use, particularly in many cases when it does not allow the reader to calculate indicators of interest that are not presented by the author (also see footnote 5). Further, it is likely that, in many instances, stillbirths are included in postnatal death components. In this review, postnatal reproductive losses will refer to losses occurring from birth to 12 months of age and will entail neonatal death, preweaning and post-weaning mortalities. These losses will now be examined.

Neonatal mortality

Neonatal mortality refers to death occurring within the first four weeks of the life of kids or lambs born alive (Dennis, 1970). It is the postnatal component of the perinatal death which also includes stillbirths. In this review, the term "neonatal period" specifically means first 30 days after birth and where possible, age specific mortalities within this period will be presented.

Lamb neonatal mortality

Estimates of neonatal lamb deaths in SSA are few. Under station management conditions in the humid zone of Nigeria, rates of 14.70 per cent of lambs born alive and 16.50 per cent of all lamb deaths were reported, respectively, by Otesile and Oduye (1983) and Otesile et al. (1983). Reports from other on-station studies indicated an estimates of 16.60 per cent in Ghana (Tuah et al., 1987) and a high contribution (63 per cent) of neonatal death to overall kid mortality in Cameroon (Ndamukong, 1985). At the village level, kid losses occurring within the first month of life accounted for 15.25 per cent of all lambs born alive in the semi-arid zone of Sudan (Wilson, 1976) and for 67.8 per cent of all deaths in the 0 to 5 month-age class in the highlands of Ethiopia (Wilson et al., 1985). The latter authors also estimated that of the mortality recorded between 0 and 5 months, 35.6 per cent occurred during the first day and 22 per cent from the second to the seventh days after birth.

Neonatal lamb death may be of either non-infectious or infectious origin. Hartley and Boyes (1955) and Alexander et al. (1959) cited by Tuah et al. (1987) recognized three categories of causes. These are starvation, dystocia and undiagnosed. Wiener et al. (1983), working in Scotland, recorded as many as 175 factors that they recognized as first, second and/or third causes of neonatal death. The authors (Wiener et al., 1983) also arranged these factors into eight broad groups of causes among which was a condition they termed "weakly lamb". Such a condition involves weak lamb at birth, underdevelopment, exposure, starvation in general and starvation due to maternal agalactia in particular. Whatever the causes, the incidence of neonatal death may be affected by predisposing (or secondary) factors such as birth weight, dam age, birth type, parity, sex of neonates, season of the year and parturition interval. After examining the main and secondary factors responsible for lamb neonatal deaths in the humid zone of Ghana, Tuah et al. (1987), concluded that starvation was the most important cause followed by pneumonia. The work of these authors (Tuah et al., 1987) is probably the best that can be found in published literature on lamb and kid neonatal mortality in SSA. Unfortunately, the number of observations presented was too small and the fate of lambs in the 3 to 30 day age class was not examined. In the semiarid zone of Mali, Traore (1985) found that lambs which died in the first week of life in agropastoral systems did so from "immaturity and subvitality", conditions which can reasonably fit into the "weakly lamb complex" since, as Wiener et al. (1983) put it, they converge in their effect of weakening the lamb and precipitating death. Under station management in the sub-humid zone of Togo, type of birth was found to account for 85.12 per cent of total variability in lamb mortality between birth and 5 days. More than 25 per cent of twins compared with 14.55 per cent of singles died within the above period (Abassa and Adeshola-Ishola, 1988). Under similar managerial conditions in the humid zone of Senegal, neonatal mortality was reported to be 75.5 per cent higher among twins than among singles (Fall et al., 1983). Certainly, poor survival of twin lambs is linked to their birth weights which are generally lower than those of singles. In general, however, whenever birth weights fall far below the average of the breed, both single and twin lambs suffer from higher than average mortality during the neonatal period. This agrees with the findings of Tuah et al. (1987) in Ghana, Abassa and Adeshola (1988) in Togo, Rombaut and Vlaenderen (1976) in Côte d'Ivoire. The study in Togo showed that 37.1 per cent of lambs weighing less than 1 kg died within the first five days of life while only 11.31 per cent mortality were recorded for the same period among those weighing between 1 and 1.5 kg. In the Côte d'Ivoire study, neonatal death toll under traditional management conditions was estimated at 57 and 12 per cent among lambs weighing respectively less than 1 kg and from 1 to 1.5 kg. This study also showed the adverse effect of shorter than average parturition intervals on survival of neonate lambs: 30 per cent of the lambs died when interval between births was less than 7 months compared with 20 per cent when this interval was greater than 7 months. The study, further, referred to the cause of this poor performance as "fatigue of the dams" and highlighted the negative effects of premature matings of young females on the birth weight and survival of their progenies. Finally, the study blamed the lack of basic herd management and particularly the notorious uncontrolled breeding which favours indiscriminate matings and related undesirable effects. In Ghana, Tuah et al. (1987) established that the highest mortality rates were in lambs born to 2 and 7 year old ewes and blamed inadequate management for the decreased survival. In Togo, the lowest death rates were recorded in lambs associated with second to fourth parities. Management can also contribute to higher than "normal" neonatal mortality rates when it allows lambs to be born during unfavourable seasons as shown by most studies quoted above. The above studies showed a tendency for lower than average survival rates in animals born during dry seasons in the semi-arid areas and wet seasons in the humid zones.

Kid neonatal mortality

As for lambs, little is published on kid neonatal mortality in SSA though there are some indications that early death may account for a substantial proportion of postnatal losses. On-station studies by El-Naim (1979) in the semi-arid zone of Sudan showed that up to 74.4 per cent of preweaning casualties corresponding to 66.7 per cent of total post-natal death occurred during the first week of life in Sudan Nubian kids born alive. In the humid zone of Nigeria, 56.1 per cent of the mortality observed from 0 to 3 months of age happened during the first day of life in station-managed WAD kids (Osuagwuh and Akpokodje, 1981). The proportion of WAD kids which died was not revealed nor was the specific neonatal loss reported. Conversely, it was disclosed that 89.8 per cent of total deaths of Sudan Nubian kids born alive were neonatal and that 32 per cent of these kids died during the first week of life. Of all deaths under humid zone and village management conditions, 61 per cent were reported to have occurred in less than one-month old WAD kids and lambs in Nigeria (Mack, 1983) and 16.6 per cent in one week old Landim kids in Mozambique (Makinnon, 1985). Under these same conditions, 76.42 per cent of kids which died from birth to 4 months of age were reported to be in the 0-30 day age group (Ndamukong, 1985).

From the preceding, it can be seen that most published data on kid neonatal death were calculated on the basis of percentage of total deaths. The number and proportion of kids born alive which died during the neonatal period were generally not revealed [4]. Chances are that high proportions of total preweaning deaths occur during this period. Perhaps, one of the greatest constraints to the adequate assessment of the potentially high neonatal death is the paucity of data coupled with the improper reporting of the available information.

> [4] The reason why this is needed is specified in the introductory notes of this chapter. Also, see footnote 5.

The main causes of kid neonatal death worldwide are similar to those listed earlier for lamb neonatal mortality. The condition involving weak kids at birth, underdevelopment, exposure and starvation will be referred to as "weakly kid syndrome or complex". In SSA, most causes of early deaths, particularly in the village flocks, are unknown. Further, most reports failed to address age specific causes of death within the preweaning period. Such a situation limits the clear assessment of the specific reasons for neonatal kid death.

A number of reports have placed emphasis on secondary factors which trigger the pathologies and/or cause death tolls to increase. Among these factors are birth weight-birth type combinations, parity and season of birth. That birth weight is by far the most critical of all in view of its adverse effect on kid survival is overwhelmingly recognized in SSA (Sacker and Trail, 1966; Kyomo, 1978; Nwody, 1979; Osuagwuh and Akpokodje, 1981; Murayi et al., 1987). El-Naim (1979) reported that low birth weights due to large litter sizes were the cause of 64.4 per cent of deaths occurring during the first month of life in kids raised under station management and semi-arid zone conditions in Sudan. In the humid zone, Osuagwuh and Akpokodje (1981) in Nigeria, observed that, of station managed kids which died the first day of their life, 50.7 per cent, 29.0 per cent and 20.3 per cent were among triplets, twins and singles, respectively. Under similar management conditions in the sub-humid zone of Malawi, 35.7 per cent of twins were reported to have died within the first week of life while death of only 4.34 per cent of singles was recorded during the same period (Reynolds, 1979). As stated earlier for lambs, the lighter weight of twin kids as compared with singles makes them more vulnerable. There are, however, instances where single kids may be highly susceptible as well. Though such instances may be rare in SSA, earlier studies by Sacker and Trail (1966) revealed that mortalities in heavier single East African kids were high, particularly when these kids were from first kidder dams. In general, first kidders and/or multiple births are the most important sources of low birth weights which in turn cause general weakness and starvation that lead to death.

Weak kids are also more prone to infections and predator attacks than stronger ones.

Season of birth, a generally uncontrolled factor in SSA, is another very important contributing cause of early death in the prevailing traditional production systems of the region. El-Naim (1979) in the semi-arid zone of Sudan showed that neonatal mortality rates were variable between seasons and that higher rates were obtained during the rainy seasons where high incidence of low birth weights and coccidiosis prevailed. Oppong and Yebuah (1981), working in the sub-humid zone of Ghana, pointed out that frequency of kid mortality was affected by rainfall and that during the rainy season the weak and young kids abandoned by their dams may die either from starvation or pneumonia. More details on the seasonal effects on kid death will be given in the preweaning mortality section.

Of paramount importance is that causes of death also tend to be age specific. Traore (1985) identified two vulnerable "periods of pathological crisis" in the early life of kids raised under village conditions in the semi-arid zone of Mali. From 1 to 7 days of life "weakly kid syndrome" was the major cause of death. During the second period which was from 8 to 30 days after birth, deaths were due to afflictions with complex and non-specified etiology (eg., pneumopathies, diarrhoea, subvitality). Specific and easily identifiable pathologies such as pasteurellosis and PPR could only be sorted out during the second period which was known to extend from 3 to 5 months of age.

Overall, it can be concluded that deaths of neonate kids and lambs have not been extensively investigated in SSA. Most studies were carried out in the humid zones. Due to lack of data presented, it is difficult to draw patterns by management system and species and make comparisons within and between ecozones. Most estimates were on percentage of total deaths basis. Thus, the number [5] and proportion of kids and lambs born which died during the neonatal period were generally unknown. Judged from the available albeit limited information, neonatal mortality rate (i.e. from 0-30 days) may generally be considered above 20 per cent (probably 20-30 per cent) of kids and lambs born alive and may account for more than 70 to 80 per cent of preweaning deaths. The proportion of neonatal death occurring within the first week of kid and lamb life in SSA may be substantial as well. This is expected since such mortality is generally reported to be relatively high elsewhere even under better management conditions (Hight and Jury, 1970 cited in Meyer and Clarke, 1978). In this connection, it is interesting to note that Blood et al. (1981) quoted in Tuah et al. (1987) estimated the proportion of preweaning mortality that is found in the first few days of life at 70 to 80 per cent agreeing with Willingham et al. (1986) who found that in Texas (USA), 73 per cent of lamb preweaning losses were in the first few weeks of life. Most causes of these losses are generally either unknown, not investigated or not reported. However, "weakly lamb/kid syndrome,, seems to be the single most important cause of death. Pneumonia, mentioned on a few occasions, may be the next cause. The most important predisposing factor is birth weight or birth weight-litter size complex followed by dam age, season of birth and parturition interval. Survival seems to be higher in neonates born during rainy seasons in the semi-arid area and dry seasons in the humid zones.

> [5] The need to have the number of lambs and kids dying is consistent with the fact that without it, the proportions of age-specific deaths of interest which are missing in most published documents cannot be calculated.

Preweaning mortality

Preweaning mortality refers to death occurring between birth and weaning of kids or lambs born alive. It includes neonatal deaths. Studies carried out in SSA indicate that man induced weaning as a management device is not practiced in the traditional systems of production. Kids and lambs run with their dams until after the milk production of the latter has come to an end. Further, because most local breeds are poor milk producers, expectations are that the maternal milk provision will stop before or at the time the suckling kids/lambs are 5 months old. This situation is not specific for traditionally managed flocks; it is also found under station management conditions where the research objective is to maintain animals under conditions which are as close as possible to those characterizing on-farm traditional management. While the reason for the lack of imposed weaning of kids and lambs whose dams provide no milk for household consumption and sale is not quite understood, literature reveals that where weaning takes place as a management device, it generally does so when lambs and kids are 3 or 4 months of age. In this section, therefore, age at weaning will be from 3 to 5 months both at station and village levels and no attempt will be made to separate preweaning death rates by ages. The question as to wether stillbirths are included in preweaning mortalities found in published reports will remain unanswered in the section as these reports generally do not specify the life/death status at birth of the animals.

Estimates of kid preweaning mortality

Table 4.1 shows available estimates for kid preweaning death in SSA. Overall, they vary from 14.9 to 55 per cent under station management conditions and 19.6 to 43.5 per cent at village level. In the humid and sub-humid zones, the lowest estimate at the station level (23 per cent) was obtained for Tanzanian kids in Tanzania (Kyomo, 1978) and the highest (55 per cent) for WAD in Ghana (Oppong and Yebuah, 1981). At the village level in these zones, extreme values are 19.6 per cent for WAD in Nigeria (Mosi et al., 1982) and 43.5 per cent for Newala kids in Tanzania (Hendy, 1980).

In the semi-arid area, estimates vary from 14.9 per cent for Boer x Indigenous crosses in Zimbabwe (Khombe, 1985) to more than 40 per cent for Nubian kids in Sudan (El-Naim, 1979). No other estimate is available for the highlands apart from the 26.3 per cent reported in Rwanda by Murayi et al. (1987).

Information on the contribution of preweaning mortality to total death is limited (table 4). Available records indicate, however, that in the humid and sub-humid zones, this contribution may be substantial as it was estimated at 72.10 per cent in Ghana (Oppong and Yebuah, 1981), 50 per cent in Senegal (Faugère et al., 1988), and 75.8 and 78 per cent in Ghana (Yebuah, 1975 cited in Dankwa, 1976 and Dankwa, 1976, respectively).

It appears that preweaning mortality among kids in SSA is variable, that published observations are limited in the humid, sub-humid and semi-arid zones, virtually inexistent in the highlands. It can be concluded that at least 20-40 per cent of kids may be expected to die before weaning under station conditions of SSA. Under these same conditions, it is possible that the death toll amounts to 30-50 per cent in humid and sub-humid zones and 20-40 per cent in the semi-arid area. Lower preweaning rates were published for kids under village management than under station conditions. This however, except perhaps in some state or parastatal farms, does not seem to be conceivable in the face of lack of general management and data recording scheme characterizing the production systems in the family sector. Mortality rates reported for the sector may have been underestimated as research under traditional systems faces more constraints and requires longer investigations and larger sample sizes for the results to be meaningful than investigations on station. Further, it is not clear whether the on-station death rates examined here should be considered as indicative of decreased viability of native goat breeds known as "freedom seekers" when they are moved from their natural production system where a high degree of freedom is allowed to the restricted station management environment where such a freedom is limited. Nevertheless, until the interactive effects of goat behaviour and managerial conditions on kid mortality are clearly determined, it is conceivable to consider that the true estimate of preweaning kid loss in traditionally managed flocks is higher than that found under station management conditions. The contribution of preweaning death to total mortality in the humid and sub-humid zones could be expected to be high, perhaps 50 to 80 per cent.

Estimates of lamb preweaning mortality

Available estimates for lamb preweaning mortality in SSA are collated in table 4.2. Overall, they range from 10 per cent for WAD lambs in the humid zone of Côte d'Ivoire (Ginisty, 1977) to 44 per cent for Uda lambs in the sub-humid zone of Nigeria (Adu and Brinckan, 1978 cited in Osuagwuh, 1985). In the semi-arid zone most rates are between 19.6 per cent for Peul lambs in Senegal (Sow et al., 1988) and 32.10 per cent for Masai lambs in Kenya (Wilson et al., 1985). An extreme paucity of information is observed both at station and village levels of the highlands and at village level of humid, sub-humid and semi-arid areas.

As for the contribution of preweaning mortality to total death, it may be quite variable. For WAD lamb in humid zone, Oppong (1973), Dankwa (1976) and Otesile et al. (1982) estimated it at 32.1, 47.8 and 18.8 per cent, respectively. Ndiaye (1992) also reported that more than 40 per cent of the deaths recorded between birth and 12 months of age in traditionally managed lambs (and also in kids) in the humid zone of Senegal, occurred during the 0-3 month age period. In the semi-arid zone of Mali, Traore (1985) found that more than 60 per cent of lamb and kid deaths were from birth to weaning.

It could be concluded that under station conditions, at least 20-30 per cent of lambs may die between birth and weaning in humid, sub-humid and semi-arid zones of SSA. As stated earlier, casualties are expected to be substantially higher at the family sector level than at the research stations. From the limited data presented, it is difficult to assess the magnitude of the contribution of preweaning mortality to the total lamb death. The review of the overall available estimates tends to indicate a lower preweaning fatality in lambs than in kids. To this end, chances are that the above contribution is lower than that found for kid preweaning death.

Causes of kid preweaning mortality

Available published data on the causes of kid preweaning mortality are collated in table 4.3. Overall, the most common cause of death is pneumonia (of various origins) whose contribution to the preweaning mortality ranges from 11.9 to 51.8 per cent with the lowest value obtained for WAD kids under station management conditions in Nigeria (Osuagwuh and Akpokodje, 1981) and the highest for Sahel kids in Mali (Traore, 1985). "Weakly kid syndrome" seems to be the second most reported cause followed by parasitic infestation and unknown causes. The syndrome's contribution to the preweaning death may be very variable as it goes from 3 per cent for station managed kids in Nigeria (Osuagwuh and Akpokodje, 1981) to 64.8 per cent for Tanzanian kids also station managed in Tanzania (Kyomo, 1978). The unknown (i.e., mortality of unknown etiology) found in only a few reports may have contributed highly as substantiated in Oppong and Yebuah (1981), Wilson et al. (1984), Traore (1985). A proportion as high as 44.4 per cent of preweaning mortality was ascribed to unknown causes in traditionally managed East African kids of Kenya (Wilson et al., 1984).

Due to lack of available data, it is difficult to make comparisons between and within ecozones. It is also difficult to rank the major causes according to the magnitude of their contribution to the total loss. However, pneumonia, the most commonly reported condition, also appears to be the first kid killer during the preweaning period in view of the evidence presented for the semi-arid zone by Traore (1985) and Wilson et al. (1984) in Mali, Madjit (1980) in Chad and for the humid or sub-humid zone in Ghana by Vohradsky (1966 cited in Oppong and Yebuah, 1981), Oppong and Yebuah (1981), Dankwa (1976), in Nigeria by Osuagwuh and Akpokodje (1981), Bayer (1982), Otesile et al. (1983), Osuagwuh (1984 cited in Osuagwuh, 1985), and in Kenya by Angwenyi and Bebe (1989). Traore (1985) found that PPR, pasteurellosis and other pneumopathies induced afflications accounted for more than 50 per cent of preweaning mortality in the semi-arid zone of Mali. The condition may occur in the form of broncho-pneumonia, suppurative pneumonia and/or fibrinous pneumonia (Otesile et al., 1983) and can be, among other things, of PPR and/or pasteurellosis origins. Related death is recorded during rainy seasons in humid and sub-humid zones (Wilson et al., 1984; Oppong and Yebuah, 1981; Osuagwuh, 1985; Opasina, 1985), both rainy and dry seasons in semi-arid zone (Traore, 1985) and in humid areas (Otesile et al., 1983; Faugère et al., 1988). Reports generally agree, however, that the death toll is highest during the rainy or cool season of the humid and sub-humid zones and during the cool dry season of the semi-arid zone. Traore (1985) reported that the fear of devastating pasteurellosis during this cool dry season creates a "real psychosis" among small stockholders in the semi-arid zone of Mali.

While pneumopathies seem to emerge easily as the number one kid killer, it is not quite clear in the literature which of the two remaining major conditions, helminthiasis and "weakly kid", should be ranked as the second most important cause of death. Kyomo (1978) found general weakness to be the main reason for Tanzanian kid death, Faugère et al. (1988) ranked underdevelopment as the first WAD kid killer, Traore (1985) and Oppong and Yebuah (1981) showed that weak neonate/starvation complex ranked second after pneumonia in causing death in Sahel type and WAD kids, respectively. Therefore, it is likely that the "weakly kid syndrome" is the second most important cause of preweaning mortality among kids in SSA. It may well be that in many cases, this syndrome represents the first most important hazard as evidenced by on-station investigations in sub-humid zone of Tanzania where nearly 65 per cent of preweaning mortality were due to general weakness (Kyomo, 1978) and on-farm research in the humid zone of Senegal, where underdevelopment was by far the most important cause of death during the first 3 months of the kid's life and was responsible for 2/3 of death occurring within the first month after birth Faugère et al., 1988). It is suggested that maternal agalactia, ascribed to poor nutrition of the dams, a consequence of poor rainfall, might have been one of the major predisposing factors in the semi-arid area as well as in the humid zones. Not surprisingly, Oppong and Yebuah (1981) have observed that starvation of kids in sub-humid zone of Ghana occurs when the rain fails.

Among other predisposing factors is the birth type which has a tremendous influence on kid survival through its effect on birth weight. Mayer and Clark (1978) observed that twins of the same birth weight as singles are more susceptible to mismothering and hence to starvation losses than the latter. However, it is overwhelmingly recognized that in SSA, multiple birth is generally accompanied by low birth weight which, in turn, results in higher mortalities in twins and triplets than in singles (Oppong and Yebuah, 1981; Osuagwuh, 1985; Traore, 1985). Oppong and Yebuah (1981) suggested that since the WAD goat is not a dairy animal, does are unlikely to be able to raise more than one kid successfully under poor nutrition conditions. It is probably in the semi-arid area that increasing litter size leads to more problems as substantiated by Traore (1985), who found that most conditions of preweaning death in Mali were in twins and triplets and that multiple birth contributed a great deal to high prevalence of infectious diseases.

Birth weight is not only affected by birth type; it may also be largely influenced by sex, breed and parity/dam age. Osuagwuh and Akpokodje (1981) in the humid zone, and Oppong and Yebuah (1981) in the sub-humid zone agreed on the prevalence of higher death rates among female than male kids raised under station management conditions. However, it was found that viability of traditionally managed kids in the sub-humid zone of Tanzania (Hendy, 1980), humid zone of Nigeria (Opasina, 1985) and semi-arid zone of Kenya, Mali and Sudan (Wilson, 1984) was either unaffected by sex or was lower in the male than in the female kids. While the reasons for this variation are yet to be documented, Oppong and Yebuah (1981), after observing that 55 per cent of the kids which died were females, lamented that such a situation is a setback to the rapid multiplication of the flock. It Could be that breed and management interactions play an important role in the variation of mortality rate through birth weight.

The existing positive correlation between birth weight of the progeny and weight of the dam is also an important factor to consider together with dam age or parity. Does are lighter at their first kidding than at their subsequent parturitions, a situation which along with their inexperience, invariably causes high mortality among their kids (Nwodi, 1979). Wilson et al. (1984), working in the semi-arid zone, found that the most important single secondary variable influencing kid preweaning death was parity; they estimated the preweaning death rates among first, second and third parity kids to be 47.9, 38.8, 31.4 per cent, respectively, in Mali and 43.7 per cent, 21.6 per cent, 12.3 per cent, respectively, in Sudan.

It would appear that available data on causes of kid preweaning mortality in SSA are limited, that most investigations were limited to research stations and that little or nothing is known for the highlands. Pneumopathies appear to be the first cause of kid preweaning death in semi-arid, humid and sub-humid zones. They may occur in any season but are more devastating in the cool dry season of semi-arid zone and rainy season of humid and sub-humid zones. The second most important cause of preweaning death may be the "weakly kid complex" followed by helminthiasis. The former may be more important during the dry season particularly in the hot dry season of semi-arid zone and the latter in the rainy season. Birth type/birth weight combinations, parity and sex seem to be the most important contributing secondary factors in that order.

Causes of lamb preweaning mortality

The main causes found in the literature for preweaning mortality in sheep of SSA are shown in Table 4.4. Of the available information, 82.6 per cent were published from research stations, 17.4 per cent from the family sector, 43.5 per cent from humid zone, 30.4 per cent from the sub-humid zone, 21.7 per cent from the semi-arid zone and 4.4 per cent from the highland areas. The main causes can be partitioned into four groups. These are "weakly lamb syndrome", pneumopathies and parasitic infestations and others. Pneumopathies encompass pneumonia of all origins including Peste des Petits Ruminants (PPR) while parasitic infestations are essentially made up of haemonchosis, coccidiosis and tapeworm infestation. Others in this section includes diarrhoea of various origins and pox. From the limited data available, indications are that "weakly lamb complex" may have accounted for 2 to 35 per cent of preweaning death, pneumopathies for 2.8 to 60 per cent and parasitic infections for 0.6 to 10.1 per cent.

Studies in the humid and sub-humid zones indicate that substantial proportions of deaths occurring from 0 to 12 months, were in the preweaning period. These proportions amounted to 53.3, 41.2 and 41.2 per cent for pneumopathies, tapeworms and enteritis due to other parasites, respectively, at Nungua research station in Ghana (Oppong, 1973). At the agricultural research station of Legon also in Ghana (Dankwa, 1976) 91.5, 73.5, 38.4, 60.3 per cent were accounted for by starvation, pneumopathies, tapeworms and other parasitic infections, respectively. Otesile et al. (1982) recorded 44.4 per cent pneumopathies and 34.5 per cent parasitic infections at the University of Ibadan teaching and research station in Nigeria. The data presented by the latter authors also showed that 50 per cent of the mortality due to parasitic infections in the 0-3 month age group were from haemonchosis while 32.1 per cent of those ascribed to pneumopathies were due to PPR. Reports, however, indicate that in traditionally managed flocks in the humid zone of Senegal, PPR has not brought about any casualty in the 0-3 month group and that the most critical condition in that group was diarrhoea which accounted for 50 per cent of all deaths occurring in the preweaning period Faugère et al., 1988). In the semi-arid zone of Senegal, diarrhoea induced deaths in village flocks also seemed to concentrate in the 0-3 month old age group as 5.2 per cent mortality was found between 0 and 3 months, 2.1 per cent between 4 and 12 months and 0.1 per cent between 1 and 7 years of age Faugère et al., 1989). In these flocks deaths ascribed to pneumopathies in general and PPR in particular were said to be negligible but those due to sheep pox in the O. to 3 month old age class amounted to 18.2 per cent. Elsewhere, in the semi-arid zone of Mali, traditionally managed lambs were also reported to have suffered substantial casualties due to pox (Traore, 1985). The author found that 36.7 per cent of preweaning deaths were due to pox while 23.3, 10 and 8.3 per cent were ascribed to "weakly lamb", pneumopathies and diarrhoea, respectively.

Perhaps, one of the most important aspects of the studies related to causes of lamb and kid deaths in SSA is the high frequency of undiagnosed cases categorized in what is termed as unknown. Losses due to this factor may stand high as shown by Peacock (1982) in Kenya, Traore (1985) in Mali, Faugère et al. (1988) in Senegal.

Among the predisposing factors of preweaning death are premature and indiscriminate mating of replacement females, season, type of birth, birth weight, age at first parturition, parturition interval, and particularly its role in the occurrence of dam's fatigue, and parity. Some of these have been focused on in the earlier discussions in relation to their effects on neonatal mortality. While these discussions still hold valid in the present section, evidence was presented which suggests that in the semi-arid zone, losses due to pneumopathies, pox and malnutrition prevailed in the dry cool and hot seasons in Mali (Traore, 1985), while the main cause of death in the dry cool season in Burkina Faso was found to be pneumopathies (Bourzat, 1980). In the humid zone of Senegal, Faugère et al. (1988) found that deaths due to pneumonia conditions in traditionally managed WAD lambs were limited to dry seasons with the maximum toll occurring in the cool dry season. Oppong (1973), however, found that most WAD lambs which died from these conditions in the sub-humid zone of Ghana, did so during the rainy season which was also referred to as the period of highest total mortality. The latter author acknowledged that death from pneumonia "was usually within 24 hours of the animal been caught in the rain". This is in agreement with the observation of van Vlaenderen, (1985) working with village flocks in Togo, who observed the very high mortality recorded during the wet season "was due to the rain which can cause pneumonia". Similar findings were highlighted by Fall et al. (1983) in Senegal and Abassa and Adeshola-Ishola (1988) in Togo who both observed that lambs under station management conditions and born in the rainy season suffered heavier casualties than those born in dry season. Fall et al. (1983) estimated the increase in mortality at 1.3 per cent from 3 days of age up to weaning for each additional 100 mm of rainfall and Van Vlaenderen (1985) found that more than 80 per cent of lamb casualties took place in the second half of the rainy season. It is during such a season that challenge from infective agents is highest and that death from parasitic gastroenteritis, mainly haemonchosis, occurs. Certainly, the decades old observation by Beal (1929) cited in Oppong (1973) that Haemonchus cortortus is "the curse of sheep and goat breeding" in Ghana still remains true in the humid zones of SSA. In connection with this, the suggestion by Otesile and et al. (1982) could not be more accurate when they pointed out that "in part of the humid tropic such as in southern Nigeria where the acquisition of large areas of land for farming is difficult and the environment favours rapid build up of the parasite, the cost of an efficient prophylaxis regime will be prohibitive".

It would appear that during the preweaning period, the main causes of lamb death in SSA are pneumopathies, "weakly lamb syndrome" and parasitic infections. The most important of these infections was haemonchosis. Here again available information is limited, making it difficult to produce useful comparisons between and within ecozones. Most data were published for the humid and sub-humid zones and were from research stations. In these zones, pneumonia appears to be the most important killer in the preweaning period followed by parasitic infestations and "weakly lamb syndrome". In the semi-arid zone, available information suggested that either weakly lamb syndrome" or pox prevail as first deadly condition, followed by diarrhoea of various origins and pneumopathies. The latter can occur during any season of the year but the cool dry season in the semi-arid zone and the rainy season in the humid and sub-humid areas are periods when the lambs are most vulnerable. Death from parasitism particularly haemonchosis is highest during rainy seasons in the humid and sub-humid zones. Though little was provided in the literature regarding the seasonality of "weakly lamb-syndrome", chances are that this condition occurs all year round throughout SSA with the predisposing factors being dry season (particularly in the semi-arid zone), premature and indiscriminate mating of the replacement females, fatigue of dam due to short parturition intervals, lower than average birth weight and multiple birth.

Post-weaning mortality

In the second chapter of this review, female progenies are assumed to be bred for the first time at an age that is less than or equal to 12 months. This implies that post-weaning mortality, in relation to reproductive losses in SSA's small ruminants is to refer, here, to death occurring between weaning and 12 months of age of kids or lambs. Published data on such death are generally scanty, a situation which will limit the scope of the discussions in this section.

Estimates of post-weaning mortality

Expressed on percentage of total animal basis, post-weaning mortality was 19.4 per cent for WAD lambs raised under station management conditions in the humid zone of Senegal (Fall et al., 1983) and 15 per cent for traditionally managed Newala kids in the Tanzanian sub-humid zone (Hendy, 1980). Their contribution to total death is not negligible as it was estimated at 30.2 per cent (Mosi et al., 1982) and 41.5 per cent (Opasina, 1983) for on-farm WAD kids in Nigeria, 16.2 per cent for station-managed WAD kids at Legon in Ghana (Oppong and Yebuah, 1981) and 43.9 per cent for WAD lambs also station managed in Nigeria (Otesile et al., 1983). Faugère et al. (1988) found that most village kid deaths in the humid zone of Senegal were in the period following weaning and that 50 per cent of these were between 3 and 7 months. Earlier investigations at the Legon university research station in Ghana (Dankwa, 1976) indicated that 24 per cent of the total deaths were occurred during the post-weaning period for WAD lambs and 11.1 per cent for WAD kids. These investigations also indicated that of the total mortality from birth to 12 months of age, 34.1 per cent were in the post-weaning period for lambs and 12.8 per cent for kids. Studies in Nigeria (Otesile et al., 1983) showed that up to 54.1 per cent of casualties recorded during the first 12 months in the life of kids were between 4 and 12 months. It has also been shown that of the total deaths recorded from birth to 11 months of age in WAD lambs, 66.1 per cent in Nigeria (Otesile et al., 1982) and 57.4 per cent in Ghana (Oppong, 1973) occurred between 4 and 11 months.

Causes of post-weaning mortality

Causes of post-weaning kid mortality found in published reports are mainly pneumopathies, particularly Peste des Petits Ruminants (PPR) origin, parasitic infections and bacterial enteritis. Pneumonia was reported to have been responsible for 32.9 per cent of deaths occurring between 3 and 12 months of age in station managed kids in the sub-humid zone of Ghana, parasitic gastro-enteritis (PGE) for 15.2 per cent and starvation for 1.3 per cent (Oppong and Yebuah, 1981). At the University of Ibadan farm located in the humid zone of Nigeria, pneumonia, helminthiasis and bacterial enteritis accounted for 41.0, 38.5 and 15.4 per cent respectively, of the deaths occurring from 4 to 12 months in the WAD kids (Otesile et al., 1983). Pneumonia was also found to be the most important cause of post-weaning death in WAD kids of 4 to 12 months of age at the University of Legon Research Station in the sub-humid zone of Ghana (Dankwa, 1976). It contributed 28.9 per cent of such deaths and was followed by PGE (17.8 per cent), heartwater (8.9 per cent) and starvation (2.2 per cent).

Among the major causes of pneumonia, PPR is by far the most important hazard in view of its related heavy economic losses limiting caprine production in West-Africa (Nduaka and Ihemelandu, 1973; Bourdin and Doutre, 1973; Abegunde et al., 1980 all cited in Opasina, 1979; and Akerejola et al., 1979). In Nigeria, Opasina (1983) found that the proportions of traditionally managed kids lost to PPR in the 4 to 8 month age group were highest 61.9 per cent in the humid forest and 56.1 per cent in the derived savanna when compared to those recorded in the 8 to 12 month age group (39.1 per cent in the humid forest and 33.3 per cent in the derived savanna). This may be an indication that goats are more vulnerable to PPR challenge at 4 to 8 months of age than during subsequent months. However, Faugère et al. (1988) suggested that most PPR induced death which occurred in village managed kids in the humid zone of Senegal did so between 3 and 24 months of age and that immunity to the condition probably takes long time to become established in goats. The above findings together with the observation of Opasina (1985) that PPR, known to be common in the rainy season, can now occur in the form of outbreaks in any season, demonstrate that the disease is probably one of the most alarming sources of risk associated with goat production at least in the humid and sub-humid areas of SSA.

Helminthiasis, and particularly haemonchosis which appears in most of the above humid/sub-humid zone data as the second kid killer after the pneumopathies has been the subject of many investigations (FAO, 1966; Fayibi, 1973; Kuil, 1973 all cited in Ndamukong et al., 1987; and Akerejola et al., 1979). Schillhorn van Veen (1982) cited in Ndamukong et al. (1987) referred to the humid zone goat as "a walking zoo" for its multitude of parasites. This statement was further substantiated by the latter authors, who found in a single goat, at autopsy in Bamenda (Cameroon), a haemonchus burden of more than 5,000 adult worms, when it was thought that sheep did not tolerate more than 2,500.

The major reasons for lamb mortality during the post weaning period have some degree of similarities with those reported for kids during the same period. At Nungua research station in the sub-humid zone of Ghana, pneumonia was found to be responsible for 28.4 per cent of total WAD lamb death occurring from 4 to 11 months of age thus competing with tapeworms (29.3 per cent) and followed by chemical poisoning (11.0 per cent) and other parasitic infections particularly of haemonchosis origin (10.0 per cent) (Oppong, 1973). Dankwa (1976), at Legon Research Station in Ghana, found that 20.9, 19.2 and 10.7 per cent of WAD lamb death between 4 and 12 months of age were ascribed to pneumonia, tapeworm infestation and heartwater respectively. Under humid conditions in Nigeria, 29.9, 17.9, 12.8 and 8.5 per cent of deaths occurring between 4 and 12 month of age in station managed lambs were said to be due to pneumonia, haemonchosis bacterial enteritis and starvation (Otesile et al., 1982) respectively. PPR, as source of pneumopathies, was said to have caused most deaths in the 3 to 12 month age group, the associated casualty rate being half of that found in kids Faugère et al., 1988). The latter authors indicated that lambs not only were protected by colostrum antibodies (e.g. no death was recorded from 0 to 3 months of age) but immunity was also developed earlier in sheep than goats. They also indicated that the diarrhoea which killed nearly half of the lambs before weaning (0-4 months) was less devastating during the post-weaning period and had no effect on adults over 3 years of age.

Sheep seem to have a lower tolerance of helminths than goats (Ndamukong, 1987). Their nutritional behaviour, e.g. sheep are less inclined to browse than goats, increases their risks of acquiring more pasture transmitted parasite infestations than goats (Anderson and Christofferson, 1973 cited in Ndamukong et al., 1987). Fascioliasis which is now believed to cause high mortalities among small ruminants in many areas of SSA, particularly in the highlands of Ethiopia, appears to be more harmful in sheep than in goats. Unfortunately, estimates of death rates by specific age of interest (e.g. preweaning, post-weaning, after 12 months of age) due to the condition are lacking. It was estimated that 45.7 per cent of Ethiopian Menz type sheep which died between 7 and 50 months of age did so from this condition (Njau et al., 1988). Heavy mortalities due to liver flukes were also observed occasionally in sheep and goats grazing swampy or temporarily flooded areas in Nigeria (Akerejola et al., 1979). This agrees with earlier reports on goat death along the Yobe river (Henderson, 1937) cited in Akerejola et al., 1979) and on the prevalence of sheep infestations in Zaria (Kuil, 1972). In the agropastoral irrigated rice production area of the semi-arid zone of Mali, Soumaila (1984) reported that, in general, fascioliasis which had little effect on goat survival, was the first sheep killer. The infestation rate was said to vary from 26.7 per cent at the end of the dry season to 42.1 per cent at the end of the rainy season in sheep, 8.3 to 12.3 per cent in goats and 32.6 to 66.7 per cent in cattle. In northern Nigeria, the prevalence rate of Fasciola gigantica infection was estimated at 64.4 per cent in cattle, 40.8 per cent in sheep and 17.6 per cent in goats with the highest incidence occurring during and directly after the rainy season, and with no significant difference between young and old animals (Schillhorn van Veen et al., 1980).

It appears that lamb/kid post-weaning mortality has not been under abundant investigations in SSA. The available published reports were mostly concerned with the humid and sub-humid zones. Losses found in these zones are high for both goats and sheep and chances are that they account for at least 20 to 40 per cent of total death occurring from birth to 12 months of age in kids and lambs of SSA in view of the high contribution of post-weaning mortality to the total death shown above and that of preweaning loss presented earlier. There can be no doubt that the highest kid/lamb post-natal mortality occurs in the 0 to 12 months age group of small ruminants in SSA. This is also in agreement with many authors such as Dumas and Raymond (1975), Dumas et al. (1977), Gerbaldi (1978), Vallerand and Branckaert (1975), Dumas, 1975, Jooste, 1974; Faugère et al., 1989; Faugère et al., 1988; Dankwa, 1976; Oppong and Yebuah, 1981). Pneumopathies of various origins are the undisputed first killer of kids and lambs. Among these origins is PPR, which was found to be one of the key constraints to goat and sheep production. It can occur any time of the year, causes heavier casualties in kids than in lambs with the former being critically vulnerable for a longer period of time than the latter. The second major killer disease was parasitic infestation with haemonchosis representing the prime hazard. Sheep seem to be less tolerant to Haemonchus sp. and more prone to tapeworm infestations than goats. As expected, starvation, a component of "Weakly kid/lamb complex" was found to have a negligible effect on survival at the post-weaning stage of life. Fascioliasis in humid, swampy, flooded or irrigated areas and in the highlands may be considered as a great threat to sheep production in SSA, mostly on the accounts of its heavy casualties. The possibility that Fasiola sp could be associated with Clostridium oedematiens and cause a serious havoc in the flocks in SSA just as it is already established elsewhere (Turner, 1930 cited in Ogunrinade and Adegoke, 1982) makes this threat much greater.

Table 4.1. Some estimates of Preweaning mortality in goats

Ecozone	Country	Breed	Management	Age class	Mortality*		Author(s)
					% ANB	% TDTH	
Highlands	Rwanda	Rwandan	Station	0-5 m	26.30	--	Murayi et al., 1987
Humid	Ghana	WAD	Station	0-3 m	--	75.8	Dankwa, 1976
Humid	Ghana	WAD	Station	Preweaning		78	Yebuah, 1975 cited in Dankwa,
Humid	Nigeria	French Alpin WAD	Station	0-3 m	28.57	--	Nwodi, 1979

Humid	Nigeria	French Alpin WAD	Station	0-5 m	52.38	--	Nwodi, 1979
Humid	Nigeria	WAD	Station	0-3 m	38.6	--	Osuagwuh & Akpokodje, 1981
Humid	Nigeria	WAD	Station	Preweaning	32.5	--	Ngere et al., 1984
Humid	Nigeria	WAD	Station	Preweaning	39.6	--	Osuagwuh, 1985
Humid	Nigeria	WAD	Village	0-3 m	33	--	Mack, 1983
Humid	Nigeria	WAD	Village	0-3 m	19.6	27.79	Mosi et al., 1982
Humid	Nigeria	WAD	Village	0-3 m	25.6	--	Opasina, 1985
Humid	Nigeria	WAD	Village	0-5 m	23	--	Wilson, 1984
Sub-humid	Tanzania	Newala	Village	0-3 m	43.5	--	Hendy, 1980
Sub-humid	Tanzania	Tanzanian	Station	0-4 m	23	--	Kyomo, 1978
Sub-humid	Nigeria	Maradi	Station	Preweaning	41.5	--	Ngere et al., 1984
Sub-humid	Ghana	WAD	Station	0-3 m	55	72.10	Oppong & Yebuah, 1981
Sub-humid	Nigeria	Maradi	Station	0-3 m	30.80	--	Adu et al., 1979
Sub-humid	Nigeria	Maradi	Village	Preweaning	32.80	--	Otchere et al., 1987
Sub-humid	Nigeria	WAD	Village	0-3 m	35	--	Bayer, 1982
Sub-humid	Kenya	Boer x East Africa	Station		18.6	--	Angwenyi and Bebe, 1989
Semi-arid	Kenya	Small East African	Village	0-5 m	22.3	--	Wilson, 1984
Semi-arid	Kenya	Small East African	Village	0-5 m	31.30	--	Wilson et al., 1984
Semi-arid	Mali	Sahel	Village	0-5 m	35	--	Wilson et al., 1984
Semi-arid	Mali	Sahel	Village	0-5 m	34.6	--	Wilson, 1984
Semi-arid	Sudan	Nubian	Station	0-4 m	43	--	El-Naim, 1979
Semi-arid	Sudan	Sudan Desert	Village	0-5 m	24.8	--	Wilson, 1984
Semi-arid	Zimbabwe	Boer x Indigenous	Station	0-5 m	14.90	--	Khombe, 1985
Semi-arid	Niger	Maradi	Station	0-4 m	29.5	--	Djibrillou, 1987
Semi-arid	Chad	Sahel	Village	Preweaning	15	--	Charray et al., 1980
Semi-arid	Somalia	White Somali	Village	0-4 m	24	--	Bouzat et al., 1992

* ANB = Animal born
* TDTH = Total death

Table 4.2. Some estimates of preweaning mortality in sheep

Ecozone	Country	Breed	Management	Age class	Mortality (%)		Authors
					ANB	TDTH	
Highlands	Rwanda	East African long-fat-tailed	Station	0-5 m	17.5	--	Murayi et al., 1985

Highlands	Rwanda	East African long-fat-tailed	Station	0-5 m	13.6	--	Murayi et al, 1985
Humid	Côte d'Ivoire	WAD	Station	Preweaning	10	--	Ginistry, 1977
Humid	Ghana	WAD	Station	0-3 m	--	47.89	Dankwa, 1976
Humid	Ghana	WAD	Station	0-3 m	--	32.1-1	Oppong, 1973
Humid	Ghana	WAD	Station	0-4 m	--	20.95	Tuah & Baah, 1985
Humid	Nigeria	WAD	Station	0-3 m	20	--	Dettmers et al., 1976
Humid	Nigeria	WAD	Station	0-3 m	--	18.81	Otesile et al., 1982
Humid	Nigeria	WAD	Station	0-3 m		18	Taiwo et al., 1982
Humid	Nigeria	WAD	Village	0-3 m	16	--	Mack, 1983
Humid	Nigeria	WAD	Station	0-3 m	--	20	Dettmers and Loosli, 1974
Humid	Nigeria	WAD	Station	0-3 m	--	21.30	Dettmers et al., 1976
Humid	Senegal	WAD	Station	0-4 m	33.09	--	Fall et al., 1983
Humid	Senegal	WAD	Village	0-3 m	16	--	Faugère et al., 1988
Humid	Senegal	WAD	Station	0-4 m	33	--	Mbaye, 1983
Semi-arid	Mali	Sahel type	Village	0-5 m	30.29	--	Wilson, 1983
Semi-arid	Sudan	Sugor & Burog	Station	0-4 m	--	46.6	Suleiman, 1976
Semi-arid	Zimbabwe	Indigenous x Merino	Station	0-5 m	13.1	--	Khombe, 1985
Semi-arid	Kenya	Masai	Village	0-5 m	32.1	--	Wilson et al., 1985
Semi-arid	Senegal	Peul	Station	0-4 m	27.85	--	Sow et al., 1988
Semi-arid	Senegal	Warale	Station	0-4 m	14.15	--	Sow et al., 1988
Semi-arid	Chad	Mayo Kebbi & Kirdi	Station	0-3 m	25.1	--	Guérin, 1979
Semi-arid	Senegal	Peul	Station	0-4 m	19.6	--	Sow et al., 1988
Semi-arid	Somali	Black-headed Somali	Village	0-4 m	26	--	Bouzat et al., 1992
Sub-humid	Nigeria	Uda	Station	Preweaning	44	--	Adu & Brinckman, 1978 cited in Osuagwuh, 1985
Sub-humid	Nigeria	Yankassa	Station	Preweaning	28	--	Adu & Buvanendra, 1978 cited in Osuagwuh, 1985
Sub-humid	Nigeria	Yankassa	Village	Preweaning	32.7	--	Otchere et al., 1987
Sub-humid	Togo	WAD	Station	0-4 m	29.76	--	Abassa & Adeshola-Ishola, 1988
Sub-humid	Zimbabwe	Merico & Dorper	Station	0-4 m	15.42	--	McKenzie & Grant, 1976
Sub-humid	Nigeria	Native	Station	0-3 m	24	--	Adu & Buvanendra, 1982

Table 4.3: Cause of preweaning mortality in goats

Ecozone	Country	Breed	Management	Age class	Cause		Author	Mortality	
					Secondary	Main		PCTDTH	PCTANMCL

Humid	Cameroon	Native	Village	0-4 m	Died* 0-1 m		Ndamukong, 1985	4.5	
Humid	Cameroon	Native	Village	0-4 m	Died* 1-2 m		Ndamukong, 1985	31.78	
Humid	Cameroon	Native	Village	0-4 m	Died* 2-3 m		Ndamukong, 1985	45.43	
Humid	Cameroon	Native	Village	0-4 m	Died* 3-4 m		Ndamukong, 1985	18.14	
Humid	Nigeria	French Alpine x WAD	Station	0-5 m	Female		Nwodi, 1979		19.04
Humid	Nigeria	French Alpine x WAD	Station	0-5 m	Male		Nwodi, 1979		33.33
Humid	Nigeria	WAD	Station	0-4 m		Coccidiosis	Otesile et al., 1983	3.4	
Humid	Nigeria	WAD	Station	0-4 m		Pneumonia	Otesile et al., 1983	15.9	
Humid	Nigeria	WAD	Station	0-4 m		Helminthiasis	Otesile et al., 1983	6.24	
Humid	Nigeria	WAD	Station	0-4 m		Bacterial Enteritis	Otesile et al., 1983	10.22	
Humid	Nigeria	WAD	Station	0-3 m	RS	Coccidiosis	Osuagwuh & Akpokodje, 1981	1.5	
Humid	Nigeria	WAD	Station	0-3 m	DS	Disease	Osuagwnh & Akpokodje, 1981	17.8	
Humid	Nigeria	WAD	Station	0-3 m -	RS	Disease	Osuagwuh & Akpokodje, 1981	82.1	
Humid	Nigeria	WAD	Station	0-3 m		Enteritis	Osuagwuh & Akpokodje, 1981	6	
Humid	Nigeria	WAD	Station	0-3 m	Female		Osuagwuh & Akpokodje, 1981	32.8	
Humid	Nigeria	WAD	Station	0-3 m	Male		Osuagwuh & Akpokodje, 1981	20.6	
Humid	Nigeria	WAD	Station	0-3 m		Helminthiasis	Osuagwuh & Akpokodje, 1981	14.9	
Humid	Nigeria	WAD	Station	0-3 m		PPR	Osuagwuh & Akpokodje, 1981	34.4	

Humid	Nigeria	WAD	Station	0-3 m	DS	PPR	Osuagwuh & Akpokodje, 1981	3	
Humid	Nigeria	WAD	Station	0-3 m	RS	PPR	Osuagwuh & Akpokodje, 1981	31.3	
Humid	Nigeria	WAD	Station	0-3 m	Parity 1		Osuagwuh & Akpokodje, 1981		31.6
Humid	Nigeria	WAD	Station	0-3 m	Parity 2		Osuagwuh & Akpokodje, 1981		25
Humid	Nigeria	WAD	Station	0-3 m	Parity 3		Osuagwuh & Akpokodje, 1981		35.2
Humid	Nigeria	WAD	Station	0-3 m	Parity 4		Osuagwuh & Akpokodje, 1981		38.9
Humid	Nigeria	WAD	Station	0-3 m	Parity 5		Osuagwuh & Akpokodje, 1981		42.9
Humid	Nigeria	WAD	Station	0-3 m	Parity 6		Osuagwuh & Akpokodje, 1981		43.3
Humid	Nigeria	WAD	Station	0-3 m	Parity 7		Osuagwuh & Akpokodje, 1981		50
Humid	Nigeria	WAD	Station	0-3 m	Parity 8		Osuagwuh & Akpokodje, 1981		52.6
Humid	Nigeria	WAD	Station	0-3 m		Pneumonia	Osuagwuh & Akpokodje, 1981	31.3	
Humid	Nigeria	WAD	Station	0-3 m	DS	Pneumonia	Osuagwuh & Akpokodje, 1981	11.9	
Humid	Nigeria	WAD	Station	0-3 m	RS	Pneumonia	Osuagwuh & Akpokodje, 1981	19.4	
Humid	Nigeria	WAD	Station	0-3 m	Single		Osuagwuh & Akpokodje, 1981	19.51	

Humid	Nigeria	WAD	Station	0-3 m		Starvation Malnutrition	Osuagwuh & Akpokodje, 1981	12	
Humid	Nigeria	WAD	Station	0-3 m	DS	Starvation Malnutrition	Osuagwuh & Akpokodje, 1981	3	
Humid	Nigeria	WAD	Station	0-3 m	RS	Starvation Malnutrition	Osuagwuh & Akpokodje, 1981	9	
Humid	Nigeria	WAD	Station	0-3 m	Triplet		Osuagwuh & Akpokodje, 1981	27.64	
Humid	Nigeria	WAD	Station	0-3 m	Twin		Osuagwuh & Akpokodje, 1981	52.84	
Humid	Nigeria	WAD	Village	0-3 m	Female		Opasina, 1985		16.7
Humid	Nigeria	WAD	Village	0-3 m	Male		Opasina, 1985		33.3
Humid	Nigeria	WAD	Village	0-4 m	PPR		Opasina, 1983		5
Semi-arid	Kenya	Small EA	Station	Preweaning	Single & kidding beginning long DS		Rutagwenda et al., 1985		54
Semi-arid	Kenya	Small EA	Station	Preweaning	Single & kidding prior to SR		Rutagwenda et al., 1985		30
Semi-arid	Kenya	Small EA	Station	Preweaning	Single & kidding at the onset of the LR		Rutagwenda et al., 1985		0
Semi-arid	Kenya	Small EA	Station	Preweaning	Twin & kidding beginning long DS		Rutagwenda et al., 1985		80
Semi-arid	Kenya	Small EA	Station	Preweaning	Twin & kidding during short DS		Rutagwenda et al., 1985		64
Semi-arid	Kenya	Small EA	Station	Preweaning	Twin & kidding at the onset of LR		Rutagwenda et al., 1985		0
Semi-arid	Kenya	Small EA	Station	Preweaning	Twin & kidding prior to SR		Rutagwenda et al., 1985		62
Semi-arid	Kenya	Small EA	Village	0-5 m		Disease	Peacock, 1982	31	
Semi-	Kenya	Small EA	Village	0-5 m		Disease	Wilson et	31.3	

arid							al., 1984		
Semi-arid	Kenya	Small EA	Village	0-5 m	Female		Wilson et al., 1984		23
Semi-arid	Kenya	Small EA	Village	0-5 m	Flock 1		Wilson et al., 1985		24.8
Semi-arid	Kenya	Small EA	Village	0-5 m	Flock 2		Wilson et al., 1985		19.4
Semi-arid	Kenya	Small EA	Village	0-5 m	Flock 3		Wilson et al., 1985		48.4
Semi-arid	Kenya	Small EA	Village	0-5 m	Flock 4		Wilson et al., 1985		45
Semi-arid	Kenya	Small EA	Village	0-5 m	Flock 5		Wilson et al., 1985		32.4
Semi-arid	Kenya	Small EA	Village	0-5 m	Flock 6		Wilson et al., 1985		20.2
Semi-arid	Kenya	Small EA	Village	0-5 m	Flock 7		Wilson et al., 1985		17.4
Semi-arid	Kenya	Small EA	Village	0-5 m	Long DS		Peacock, 1982		31.4
Semi-arid	Kenya	Small EA	Village	0-5 m	Long DS		Wilson et al., 1984		31.4
Semi-arid	Kenya	Small EA	Village	0-5 m	Long DS		Wilson et al., 1985		40.6
Semi-arid	Kenya	Small EA	Village	0-5 m	Long RS		Peacock, 1982		14.6
Semi-arid	Kenya	Small EA	Village	0-5 m	Long RS		Wilson et al., 1984		14.6
Semi-arid	Kenya	Small EA	Village	0-5 m	Long RS		Wilson et al., 1985		17.5
Semi-arid	Kenya	Small EA	Village	0-5 m		Lost	Peacock, 1982	9	
Semi-arid	Kenya	Small EA	Village	0-5 m	Male		Wilson et al., 1984		21.7
Semi-arid	Kenya	Small EA	Village	0-5 m		Malnutrition	Peacock, 1982	6.9	
Semi-arid	Kenya	Small EA	Village	0-5 m		Malnutrition	Wilson et al., 1984	7	
Semi-arid	Kenya	Small EA	Village	0-5 m	Parity 1		Wilson et al., 1984		23.6
Semi-arid	Kenya	Small EA	Village	0-5 m	Parity 2		Wilson et al., 1984		20
Semi-arid	Kenya	Small EA	Village	0-5 m	Parity 3		Wilson et al., 1984		13
Semi-arid	Kenya	Small EA	Village	0-5 m		Predator	Peacock, 1982	8.3	
Semi-arid	Kenya	Small EA	Village	0-5 m		Predator	Wilson et al., 1984	8	
Semi-arid	Kenya	Small EA	Village	0-5 m	Short DS		Peacock, 1982		23.8
Semi-arid	Kenya	Small EA	Village	0-5 m	Short DS		Wilson et al., 1984		23.8

Semi-arid	Kenya	Small EA	Village	0-5 m	Short DS		Wilson et al., 1985		25.5
Semi-arid	Kenya	Small EA	Village	0-5 m	Short DS		Peacock, 1982		19.3
Semi-arid	Kenya	Small EA	Village	0-5 m	Short RS		Wilson et al., 1984		19.3
Semi-arid	Kenya	Small EA	Village	0-5 m	Short RS		Wilson et al., 1985		34.4
Semi-arid	Kenya	Small EA	Village	0-5 m	Single		Peacock, 1982		18.8
Semi-arid	Kenya	Small EA	Village	0-5 m	Single		Wilson et al., 1984		18.8
Semi-arid	Kenya	Small EA	Village	0-5 m	Single		Wilson et al., 1985		21.3
Semi-arid	Kenya	Small EA	Village	0-5 m	Twin		Wilson et al., 1984		25.8
Semi-arid	Kenya	Small EA	Village	0-5 m	Twin		Wilson et al., 1985		37.7
Semi-arid	Kenya	Small EA	Village	0-5 m		Unknown	Wilson et al., 1984	44.4	
Semi-arid	Mali	Sahel	Village	0-5 m	Cold DS		Wilson et al., 1984		39.5
Semi-arid	Mali	Sahel	Village	0-5 m		Diarrhoea	Traore, 1985	11.67	
Semi-arid	Mali	Sahel	Village	0-5 m	Dry cool SB		Wilson, 1983		35.66
Semi-arid	Mali	Sahel	Village	0-5 m	Dry hot SB		Wilson, 1983		27.8
Semi-arid	Mali	Sahel	Village	0-5 m	Male		Wilson et al., 1984		32.9
Semi-arid	Mali	Sahel	Village	0-5 m	Female		Wilson et al., 1984		37
Semi-arid	Mali	Sahel	Village	0-5 m	Hot DS		Wilson et al., 1984		36.7
Semi-arid	Mali	Sahel	Village	0-5 m	RS		Wilson et al., 1984		32.5
Semi-arid	Mali	Sahel	Village	0-5 m	Millet field		Wilson, 1983		39.11
Semi-arid	Mali	Sahel	Village	0-5 m		Others	Traore, 1985	18.33	
Semi-arid	Mali	Sahel	Village	0-5 m	Parity 1		Wilson et al., 1984		47.9
Semi-arid	Mali	Sahel	Village	0-5 m	Parity 2		Wilson et al., 1984		38.8
Semi-arid	Mali	Sahel	Village	0-5 m	Parity 3		Wilson et al., 1984		31.4
Semi-arid	Mali	Sahel	Village	0-5 m		Pneumopathies	Traore, 1985	51.8	
Semi-arid	Mali	Sahel	Village	0-5 m	Post RSB		Wilson, 1983		36.63
Semi-	Mali	Sahel	Village	0-5 m	Post RS		Wilson et		30.9

arid							al., 1984		
Semi-arid	Mali	Sahel	Village	0-5 m	RS		Wilson et al., 1984		32.5
Semi-arid	Mali	Sahel	Village	0-5 m	RSB		Wilson, 1983		38.27
Semi-arid	Mali	Sahel	Village	0-5 m	Rice field		Wilson, 1983		30.07
Semi-arid	Mali	Sahel	Village	0-5 m	Single		Wilson et al., 1984		33.3
Semi-arid	Mali	Sahel	Village	0-5 m	Single		Wilson, 1983		23.54
Semi-arid	Mali	Sahel	Village	0-5 m	Triplet		Wilson, 1983		48.47
Semi-arid	Mali	Sahel	Village	0-5 m	Twin		Wilson et al., 1984		36.6
Semi-arid	Mali	Sahel	Village	0-5 m	Twin		Wilson, 1983	.	31.76
Semi-arid	Mali	Sahel	Village	0-5 m		Unknown	Traore, 1985	18.33	
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Cold DS		Wilson et al., 1984		21.3
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Female		Wilson et al., 1984		21.9
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Hot DS		Wilson et al., 1984		34
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Male		Wilson et al., 1984		27.7
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Migratory		Wilson et al., 1984		25.5
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Parity 1		Wilson et al., 1984		43.7
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Parity 2		Wilson et al., 1984		21.6
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Parity 3		Wilson et al., 1984		12.3
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Post RS		Wilson et al., 1984		27
Semi-arid	Sudan	Sudan desert	Village	0-5 m	RS		Wilson et al., 1984		16.9
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Sedentary		Wilson et al., 1984		24.1
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Single		Wilson et al., 1984		26
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Triplet		Wilson et al., 1984		26.3
Semi-arid	Sudan	Sudan desert	Village	0-5 m	Twin		Wilson et al., 1984		22.1
Sub-humid	Ghana	WAD	Station	0-3 m		Monieziasis	Oppong & Yebuah, 1981	9.24	
Sub-	Ghana	WAD	Station	0-3 m		Others	Oppong &	11.5	

humid							Yebuah, 1981		
Sub-humid	Ghana	WAD	Station	0-3 m		PGE	Oppong & Yebuah, 1981	2.05	
Sub-humid	Ghana	WAD	Station	0-3 m		Pneumonia	Oppong & Yebuah, 1981	27.92	
Sub-humid	Ghana	WAD	Station	0-3 m		Starvation	Oppong & Yebuah, 1981	16.02	
Sub-humid	Ghana	WAD	Station	0-3 m		Unknown	Oppong & Yebuah, 1981	5.33	
Sub-humid	Tanzania	Newala	Village	0-3 m	Female		Hendy, 1980		44
Sub-humid	Tanzania	Newala	Village	0-3 m	Male		Hendy, 1980		43
Sub-humid	Tanzania	Tanzanian	Station	0-4 m		Accident	Kyomo, 1978	8	
Sub-humid	Tanzania	Tanzanian	Station	0-4 m		Enteritis	Kyomo, 1978	3.5	
Sub-humid	Tanzania	Tanzanian	Station	0-4 m		General weakness	Kyomo, 1978	64.8	
Sub-humid	Tanzania	Tanzanian	Station	0-4 m		Plant poisonning	Kyomo, 1978	2	
Sub-humid	Tanzania	Tanzanian	Station	0-4 m		Pneumonia	Kyomo, 1978	19.1	
Sub-humid	Tanzania	Tanzanian	Station	0-4 m		Septicaemia	Kyomo, 1978	0.5	

* Specified period in which a given proportion of preweaning death occurred. Such a period can be a predisposing factor that influences the effect of the main cause of death.

DS Dry Season
RS Rainy Season
SR Short Rains
LR Long Rains
SB Season of Birth
RSB Born in Rainy Season
PCTDTH Per cent Total Death
PCTANCL Per cent Animals in the Class

Table 4.4. Causes of preweaning mortality in sheep

Ecozone	Country	Breed	Management	Age class	Cause		Author	Mortality	
					Secondary	Main		PCTDTHCL	PCTANMCL
Humid	Cameroon	Native	Village	0-4 m	Died 0-1 m*		Ndamukong, 1985	76.42	
Humid	Cameroon	Native	Village	0-4 m	Died 1-2 m*		Ndamukong, 1985	5.92	

Humid	Cameroon	Native	Village	0-4 m	Died 2-3 m*		Ndamukong, 1985	8.83	
Humid	Cameroon	Native	Village	0-4 m	Died 3-4 m		Ndamukong, 1985	8.83	
Humid	Cote d'Ivoire	WAD	Village	0-5 m	BW 1-1.5 kg		Rombaut & Vlaenderen 1976		80
Humid	Cote d'Ivoire	WAD	Village	0-5 m	BW < 1 kg		Rombaut & Vlaenderen 1976		100
Humid	Ethiopia	Menz	Village	0-5 m	Died 0-1 d*		Wilson et al., 1985	35.6	
Humid	Ethiopia	Menz	Village	0-5 m	Died 0-1 m*		Wilson et al., 1985	67.8	
Humid	Ethiopia	Menz	Village	0-5 m	Died 1-7 d*		Wilson et al., 1985	22	
Humid	Ethiopia	Menz	Village	0-5 m	Died 2-3 m*		Wilson et al., 1985	18.6	
Humid	Ethiopia	Menz	Village	0-5 m	Died 3-5 m*		Wilson et al., 1985	13.6	
Humid	Ethiopia	Menz	Village	0-5 m	Died 7-30 d*		Wilson et al., 1985	10.2	
Humid	Ghana	WAD	Station	0-4 m	DS		Tuah & Baah, 1985		22.6
Humid	Ghana	WAD	Station	0-3 m		Entero-toxemia	Dankwa, 1976	2.20	
Humid	Ghana	WAD	Station	0-3 m		Haemonchosis	Dankwa, 1976	1.32	
Humid	Ghana	WAD	Station	0-3 m		Heartwater	Dankwa, 1976	3.53	
Humid	Ghana	WAD	Station	0-4 m	Major rains		Tuah & Baah, 1985		27.1
Humid	Ghana	WAD	Station	0-4 m	Minor rains		Tuah & Baah, 1985		21.8
Humid	Ghana	WAD	Station	0-3 m		PGE	Dankwa, 1976	15.45	
Humid	Ghana	WAD	Station	0-3 m		Plant poisoning	Dankwa, 1976	5.74	
Humid	Ghana	WAD	Station	0-3 m		Pneumopathies	Dankwa, 1976	30.02	
Humid	Ghana	WAD	Station	0-4 m	Single		Tuah & Baah, 1985		7.48
Humid	Ghana	WAD	Station	0-3 m		Snake bite	Dankwa, 1976	1.10	
Humid	Ghana	WAD	Station	0-3 m		Starvation	Dankwa, 1976	9.5	
Humid	Ghana	WAD	Station	0-3 m		Tapeworms	Dankwa, 1976	6.18	
Humid	Ghana	WAD	Station	0-4 m	Twin		Tuah & Baah, 1985		13.47
Humid	Nigeria	Uda x WAD	Station	0-3 m	Early DS		Taiwo et al., 1982		50

Humid	Nigeria	Uda x WAD	Station	0-3 m	Early RS		Taiwo et al., 1982		0
Humid	Nigeria	WAD	Station	0-3 m		Coccidiosis	Otesile et al., 1982	1.56	
Humid	Nigeria	WAD	Station	0-3 m	Early DS		Taiwo et al., 1982		35
Humid	Nigeria	WAD	Station	0-3 m	Early RS		Taiwo et al., 1982		5
Humid	Nigeria	WAD	Station	0-3 m		Enterotoxemia	Otesile et al, 1982	0.6	
Humid	Nigeria	WAD	Station	0-3 m	Female		Dettmers et al., 1976		21.05
Humid	Nigeria	WAD	Station	0-3 m		Haemonchosis	Otesile et al., 1982	3.13	
Humid	Nigeria	WAD	Station	0-3 m	Male		Dettmers et al., 1976		17.72
Humid	Nigeria	WAD	Station	0-3 m		PPR	Otesile et al., 1982	2.82	
Humid	Nigeria	WAD	Station	0-3 m		Pneumonia	Otesile et al., 1982	6	
Humid	Nigeria	WAD	Station	0-3 m		Septicaemia	Otesile et al., 1982	0.6	
Humid	Nigeria	WAD	Station	0-3 m	Single		Dettmers et al., 1976		14.75
Humid	Nigeria	WAD	Station	0-3 m		Starvation	Otesile et al., 1982	0.6	
Humid	Nigeria	WAD	Station	0-3 m		Taeniasis	Otesile et al., 1982	1.56	
Humid	Nigeria	WAD	Station	0-3 m	Triplet		Dettmers et al., 1976		40.75
Humid	Nigeria	WAD	Station	0-3 m	Twin		Dettmers et al., 1976		18.92
Humid	Nigeria	Yankasa x WAD	Station	0-3 m	Early DS		Taiwo et al., 1982		40
Humid	Nigeria	Yankasa x WAD	Station	0-3 m	Early RS		Taiwo et al., 1982		0
Humid	Senegal	WAD	Station	0-4 m	Female		Fall et al., 1983		33.22
Humid	Senegal	WAD	Station	0-4 m	Male		Fall et al., 1983		32.96
Humid	Senegal	WAD	Station	0-4 m	Parity 1		Fall et al., 1983		54.48
Humid	Senegal	WAD	Station	0-4 m	Parity 2		Fall et al., 1983		34.05
Humid	Senegal	WAD	Station	0-4 m	Parity 3		Fall et al., 1983		19.34
Humid	Senegal	WAD	Station	0-4 m	Single		Fall et al., 1983		27.67
Humid	Senegal	WAD	Station	0-4 m	Twin		Fall et al., 1983		38.51
Semi-	Kenya	Masai	Village	0-5		Disease	Peacock,	17	

arid				m			1982		
Semi-arid	Kenya	Masai	Village	0-5 m	Flock 1		Wilson et al., 1985		36.7
Semi-arid	Kenya	Masai	Village	0-5 m	Flock 2		Wilson et al., 1985		36.8
Semi-arid	Kenya	Masai	Village	0-5 m	Flock 3		Wilson et al., 1985		31.5
Semi-arid	Kenya	Masai	Village	0-5 m	Flock 4		Wilson et al., 1985		33
Semi-arid	Kenya	Masai	Village	0-5 m	Flock 5		Wilson et al., 1985		40.9
Semi-arid	Kenya	Masai	Village	0-5 m	Flock 6		Wilson et al., 1985		26 4
Semi-arid	Kenya	Masai	Village	0-5 m	Flock 7		Wilson et al. 1985		32.4
Semi-arid	Kenya	Masai	Village	0-5 m	Flock 8		Wilson et al., 1985		25.1
Semi-arid	Kenya	Masai	Village	0-5 m	Long DS		Peacock, 1982		22.4
Semi-arid	Kenya	Masai	Village	0-5 m	Long DS		Wilson et al., 1985		38.1
Semi-arid	Kenya	Masai	Village	0-5 m	Long RS		Peacock, 1982		13.9
Semi-arid	Kenya	Masai	Village	0-5 m	Long RS		Wilson et al., 1985		27.3
Semi-arid	Kenya	Masai	Village	0-5 m		Lost	Peacock, 1982	15	
Semi-arid	Kenya	Masai	Village	0-5 m		Malnutrition	Peacock, 1982	2	
Semi-arid	Kenya	Masai	Village	0-5 m		Predator	Peacock, 1982	25	
Semi-arid	Kenya	Masai	Village	0-5 m	Short DS		Peacock, 1982		17.2
Semi-arid	Kenya	Masai	Village	0-5 m	Short DS		Wilson et al., 1985		27.3
Semi-arid	Kenya	Masai	Village	0-5 m	Short RS		Peacock, 1982		22.6
Semi-arid	Kenya	Masai	Village	0-5 m	Short RS		Wilson et al., 1985		35.7
Semi-arid	Kenya	Masai	Village	0-5 m	Single		Peacock, 1982		7.7
Semi-arid	Kenya	Masai	Village	0-5 m	Single		Wilson et al., 1985		14.4
Semi-arid	Kenya	Masai	Village	0-5 m	Twin		Peacock, 1982		31.4
Semi-arid	Kenya	Masai	Village	0-5 m	Twin		Wilson et al., 1985		49.8
Semi-arid	Kenya	Sahel	Village	0-5 m	Dry cool SB		Wilson, 1983		31.36
Semi-arid	Kenya	Sahel	Village	0-5 m	Dry hot SB		Wilson, 1983		23.50

Semi-arid	Kenya	Sahel	Village	0-5 m		Gastroenteritis	Traore, 1985	8.3	
Semi-arid	Mali	Sahel	Village	0-5 m		General weakness	Traore, 1985	23.33	
Semi-arid	Mali	Sahel	Village	0-5 m	Millet field		Wilson, 1983		34.81
Semi-arid	Mali	Sahel	Village	0-5 m		POX	Traore, 1985	34	
Semi-arid	Mali	Sahel	Village	0-5 m		Pneumopathies	Traore, 1985	10	
Semi-arid	Mali	Sahel	Village	0-5 m	Post RSB		Wilson, 1983		32.33
Semi-arid	Mali	Sahel	Village	0-5 m	RSB		Wilson, 1983		33.97
Semi-arid	I Mali	Sahel	Village	0-5 m	Rice field		Wilson 1983		25.77
Semi-arid	Mali	Sahel	Village	0-5 m	Single		Wilson, 1983		19.24
Semi-arid	Mali	Sahel	Village	0-5 m	Triplet		Wilson, 1983		44.17
Semi-arid	Mali	Sahel	Village	0-5 m	Twin		Wilson, 1983		27.46
Semi-arid	Mali	Sahel	Village	0-5 m		Unknown	Traore, 1985	20	
Semi-arid	Sudan	Sugor & Burog	Station	0-4 m	BW =1.8-2.7 kg		Suleiman, 1976	49.16	
Semi-arid	Sudan	Sugor & Burog	Station	0-4 m	BW = 2.8-3.6 kg		Suleiman, 1976	27.5	
Semi-arid	Sudan	Sugor & Burog	Station	0-4 m	BW = 3.7-4.5 kg		Suleiman, 1976	20.83	
Semi-arid	Sudan	Sugor & Burog	Station	0-4 m	BW = >4.6 kg		Suleiman, 1976	2.5	
Semi-arid	Sudan	Sugor & Burog	Station	0-4 m		General weakness	Suleiman, 1976	35	
Semi-arid	Sudan	Sugor & Burog	Station	0-4 m	Others		Suleiman, 1976	5	
Semi-arid	Sudan	Sugor & Burog	Station	04 m		Pneumonia	Suleiman, 1976	60	
Semi-arid	Ghana	WAD	Station	0-3 m		Chemical poisoning	Oppong, 1973	0.8	
Sub-humid	Ghana	WAD	Station	0-3 m		Enterotoxemia	Oppong, 1973	0.64	
Sub-humid	Ghana	WAD	Station	0-3 m		Heartwater	Oppong, 1973	0.43	
Sub-humid	Ghana	WAD	Station	0-3 m		PGE	Oppong, 1973	3.01	
Sub-humid	Ghana	WAD	Station	0-3 m		Pneumonia	Oppong, 1973	14	
Sub-humid	Ghana	WAD	Station	0-3 m		Tapeworms	Oppong, 1973	10.12	
Sub-	Zimbabwe	Merino	Station	0-4		Mis-	McKenzie &	11.6	

humid		& Dorper		m		mothering/starvation	Grant, 1976		
Sub-humid	Zimbabwe	Merino & Dorper	Station	0-4 m		Complicated exposure	McKenzie & Grant, 1976	21.6	
Sub-humid	Zimbabwe	Merino & Dorper	Station	0-4 m	Twin	Malnutrition	McKenzie & Grant,	13.3	
Sub-humid	Zimbabwe	Merino & Dorper	Station	0-4 m		Pneumopathies (ID)	McKenzie & Grant, 1976	6.6	
Sub-humid	Zimbabwe	Merino & Dorper	Station	0-4 m		Disease - general	McKenzie & Grant, 1976	20	
Sub-humid	Zimbabwe	Merino & Dorper	Station	0-4 m	Management		McKenzie & Grant,	70	
Sub-humid	Zimbabwe	Merino & Dorper	Station	0-4 m	Twin		McKenzie & Grant, 1976	89	
Sub-humid	Mali	Sahel	Village	0-5 m	Part.Int. > 215 d		Wilson, 1983		25

* Specified period in which a given proportion of preweaning death occurred. Such a period can be a predisposing factor that influences the effect of the main cause of death.

SB Season of Birth
RSB Born in Rainy Season
ID Infectious Disease.
PCTDTH Per cent Total Death
PCTANCL Per cent Animals in the Class

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Chapter V. Conclusions and recommendations

The vast majority of people in SSA practice subsistence agriculture. In the region, these are the people who suffer the most from mass poverty and the well known "African food crisis". These are also the people who raise the bulk of SSA's small ruminants which they use for animal food security, income generation, acquisition of various agricultural inputs and large animals, family relation and social link strengthening. Unfortunately, because of the long-standing neglect of these animals by development programmes, the many flaws in the traditional production techniques and the lack of relevant human development schemes, output from the small ruminant subsector is low and the contribution of the sub-sector to the welfare of the poor rural producers is still below all expectations. The following is a summary of the major findings of the review of the reproductive losses in small ruminants in sub-Saharan Africa (SSA). Areas of needed interventions and possible solutions will be pointed out, without an in-depth analysis, with the hope that detailed follow-up research programmes and policies will be formulated, which can generate a positive and sustained impact at the rural family sector level.

Major findings

Small ruminant growth and "production efficiency"

- Except in Latin America, small ruminant population growth in SSA was the world's poorest over 1977-1992 and 1982-1992. It was also an unsteady growth with an annual average rate of 0.4 per cent which, over 1987-1992, was 0.5, 2.2, 1.5 and 0.5 per cent below that of Africa, Asia, all developing countries and the world, respectively. Such poor performance must have worsened the food crisis situation in SSA.
- Average meat production per head in SSA was the poorest in the world in 1975 and 1989. Then 1992 saw a production per livestock unit of 21, 31.5, 39.6, 31.3 and 39.5 kg below the average of Africa, Asia, Latin America, all developing countries and the world, respectively.
- Thus, the small ruminant sub-sector in SSA was not only suffering from a depressed population growth but also from a depressed meat output which may be due, among other things, to a lack of effort to increase production per unit of animal.

Reproductive performance

- Available information is generally limited, particularly in the highland zone.
- Tremendous variations exist between breeds within and between ecozones offering a good potential for improvement.
- Definitions of components of reproductive performance are oftentimes misleading and this may generate inaccurate estimates or misinterpretation of these estimates.
- Most does and ewes in traditional systems reproduce at intervals greater than 8 months, making it thus far impossible to reach the well accepted target of three lamb/kid crops in two years.
- Breeds with ability for three parturitions in two years in the unimproved traditional

production systems are the Sudan Desert, Mayo-kebbi, Kirdi and WAD. There is no doubt that WAD sheep and goats are among the most fertile small ruminants breeds in the tropics.

- Ewes in the semi-arid zone have low prolificacy and can generally be considered as single pregnancy bearers. Does in that zone are generally more prolific than ewes. However, only the Red Sokoto of Niger and Nigeria, the Lamdim in Mozambique and the Sudan Desert of Sudan can be considered as prolific goat breeds in the zone. WAD sheep and goats in the humid zones stand up well among the prolific tropical breeds. The twining rate in WAD goats may be over 60 per cent.
- Ewes are generally have lower fecundity than does. Fecundity tend to be higher for sheep in the humid zones than those in the semi-arid zone. The Mayo-Kebbi and the Kirdi in the sub-humid zone, the Red Sokoto and the Massakory in the semi-arid zone are probably the ones with the second highest fecundity among sheep breeds after WAD in the humid zones.
- Goats tend to have their first progenies at earlier ages (10-18.5 months) than sheep (11-24 months). In general, most female sheep and goats conceive prior to or at 12 months of age.

<u>Prenatal wastage</u>

- Virtually no information is available on fertilization failure and embryo mortality in SSA. However, weight losses due to high ambient temperatures and lack of quality stud males, among other factors, do prevail in the region.
- Under drought-free conditions of SSA, under-nutrition may not be an important source of embryo mortality.

- There are many confusing ways in which abortion rates are expressed, resulting in a considerable variation and misleading specification bases.
- Stillbirths have been neglected or recorded as abortions.

- Abortions in ewes and does are variable (3.7 to 40 per cent of breeding females) and are likely to be high. Ewes are less prone to abortions than does.

- Infectious abortions may be among the most important economic problems in small ruminant production in SSA. Chlamydiosis, Brucellosis and particularly Rift Valley Fever are reported as major sources of abortion.

- The dry season (with related undernourishment) in the semiarid zone and the start of rainy season in the humid and sub-humid zones are the periods of highest vulnerability to abortion in both sheep and goats.

- Abortions are most frequent in multiple foetus bearers, primiparous and immature females and also when the parturition intervals are too short.

- Slaughter of pregnant sheep and goat females is one of the most important causes of prenatal wastage in SSA.

<u>Postnatal wastage</u>

- There has only been a limited number of investigations of sheep and goat neonatal mortality in SSA and most studies were in the humid and sub-humid zones.

- The number and proportion of kids and lambs born alive which died during the neonatal period are generally unknown as most estimates were based on percentage of total deaths.

Neonatal mortality is likely to be above 20 per cent (probably between 20 and 30 per cent) of kids and lambs born alive and may represent 70 to 80 per cent of preweaning death.

- Major causes of neonatal mortality are weakly lamb/kid syndrome and pneumonia in that order. The most important predisposing factors are low birth weight or a birth weight-litter size combination followed by dam age, season of birth and parturition interval.
- Highest survival of neonates are obtained for animals born during the rainy seasons in the semi-arid zone and the dry seasons in humid and sub-humid areas.
- Data on preweaning mortality are limited and most investigations tend to concentrate on research stations and in the humid zones.
- Preweaning death may account for 30 to 50 per cent of deaths among kids born alive in the humid zones and 20 to 40 per cent in the semi-arid zone.
- Higher preweaning deaths are obtained for kids than for lambs. In kids these deaths are expected to be at least 20-30 per cent of animals born alive.
- In kids, causes of preweaning mortality tend to be pneumonia, weakly kid syndrome and helminthiasis in that order.
- Pneumopathies in kids are more devastating during the cool dry season in the semi-arid zone and the rainy season in the humid zones than any other time. Weakly Kid syndrome tends to be more important in the dry hot season in the semi-arid zone and helminthiasis in rainy season in the humid zones.
- Pneumopathies, weakly lamb syndrome and helminthiasis seem to be very important causes of lamb preweaning death in the humid zones, whilst weakly lamb syndrome and Pneumopathies are more important than helminthiasis in the semi-arid zone.
- Weakly lamb complex may occur all year round in SSA with dry season particularly in the semi-arid zone, premature and indiscriminate matings, lower than average birth weight and multiple birth being the predisposing factors.
- Haemonchosis and PPR are the most important sources of helminthiasis and pneumopathies, respectively.
- Investigations on lamb/kid post-weaning mortality are limited and most estimates are obtained in the humid zone.
- Losses due to post-weaning death may not be negligible and may account for at least 20 to 40 per cent of the total death recorded from birth to 12 months.
- Pneumopathies are the first cause of kid and lamb post-weaning mortality. Pneumonia of PPR origin can occur any time of the year and is more deadly in kids than in lambs.
- Helminthiasis, particularly haemonchosis is the second killer after pneumopathies. Sheep are less vulnerable to Haemonchus sp. than goats. Haemonchosis is a more limiting factor in the humid zones than in the semi-arid areas.
- Fascioliasis in humid, swampy, flooded or irrigated areas is a great threat to sheep production in SSA.

Some possible interventions

· There is a need for more investigations on every component of reproductive losses, particularly on fertilization failure, embryo mortality, stillbirth and neonatal mortalities. Meanwhile, the perinatal stage being the most critical of all periods in relation to kid and lamb survival is an area where interventions are immediately needed. Research should be extended to all ecozones and particularly to the highland area.

- A guideline is needed which could help researchers to fully and accurately report their findings on reproduction performance and losses in a standardized way.

- Investigations on reproductive potential of sheep and goat breeds in their native environment along with characterization of these breeds must be done.

- Research on breeds which are more productive than others in a given ecozone should be encouraged and efforts must aim at their spread in that specific zone of adaptation. For this, the existing great variations between and within breeds in the same ecozone must be exploited.

- In the health management area, again, a serious consideration should be given to the identification and selection of breeds, strains or individuals which, in the traditionally unimproved environment, tend to tolerate or better resist the most important pathologies or conditions. Genetic improvement of small ruminants using both conventional and the most advanced technologies (i.e., biotechnologies) must be highly encouraged.

- The necessary provision to the small ruminant producers (i.e., the poor rural households) of animals that show high fitness in their native environment and are less vulnerable to the stressful conditions of such environments should be among goals of paramount importance. The view that natural selection alone is taking care of this is not progressive.

- Extensive research on the use of monoclonal antibodies for disease diagnosis should be encouraged in small ruminant development in SSA. Investigations on the Major Histocompatibility Complex (MHC) should be extended to small ruminants and their major diseases as well.

- Simple and cost-effective breeding management schemes must be made available to help avoid indiscriminate matings and permit births to take place when survival and growth of kids and lambs are highest.

- Cost-effective health packages for PPR control are immediately needed and must be appealing to the producers. Here, it should be noted that the cool dry season in the semi-arid zone and the rainy season in the humid zone are periods of highest vulnerability. It should also be noted that immunity is established earlier and lasts longer in sheep than in goats and that preweaning and post-weaning periods are critical.

- Genetic research coupled with sustainable and cost effective control packages are needed to counteract the negative impact of haemonchosis particularly in the humid zones. Such research should be extended to weakly lamb/kid syndrome and measures to prevent or eliminate its lethal effects taken. Genetic research should also help increase the growth rate of breeds which tend to show high ages at first parturition, where quality stud males are available, as growth is positively correlated with age at puberty. In particular, research for the improvement of the trait (i.e., age at first parturition) in the Kirdi, the Mayo-and the highland breeds must be given undivided and deserved attention. Finally, WAD breeds which are highly prolific but poor milk producers should benefit from genetic studies aimed at increasing their milk production capability which, in turn, could increase the survival of their progenies.

• Studies into why pregnant females are sold and slaughtered must be undertaken and losses due to the process prevented. In the meantime, it is essential that pregnancy diagnosis be performed at the various abattoirs found in SSA prior to the slaughter of small ruminant females. Training must also be provided to farmers on simple methods of pregnancy detection. The issue is one of national or regional policy adequacy and governments' determination to make such a policy work.

• In nutrition management areas, simple techniques for feed conservation and strategic supplementation schemes should be sought and made available to producers in all ecozones as no poorly fed primiparous female or multiple pregnancy bearer can be expected to realize its production potential or exhibit high reproductive performances. In connection with this, efforts must be directed at the promotion and development of locally sustained animal feed industries.

• High production per head should be encouraged. This cannot be achieved without a good nutrition management that recognizes the critical importance of the notion of quality rations and that of production targets and the corresponding feeding strategies.

• Producers must be trained in areas of basic animal husbandry and be encouraged to use the simple and cost-effective nutrition, health and breeding packages which are made available to them. This is important because high neonatal mortality due to weakly lamb/kid syndrome and lack of basic management (including housing devices) are related.

• Quality breeding males must be made available in a required number and birth must take place when survival of the young is highest. This requires breeding to occur during appropriate periods of the year.

• High rates of loss and high incidence of serious managerial problems in a production system are highly correlated, indicating that losses are merely an aggregate response to inadequacies in such a system. Issues of small ruminant losses in SSA are not simple and should not be overlooked. In other words, for SSA to reduce to a tolerable level its sheep and goat reproductive losses, production systems and related managerial practices in the region must be improved drastically or changed all together. This in itself must be subject to an overall development package involving, among other things, rural infrastructure building, market and marketing development, inter-African trade, education and training of producers, incentive to produce and to sell, provision of adequate extension research and services. Certainly, what is needed is an active and proper government interventionist role which recognizes that the planning of any successful livestock strategy is not only technological or economical but also and essentially political, and that "development will occur only when the people most directly affected are enlisted in its support" (Herrick and Kindleberger (1988)[6]) through their full and active participation.

[6] Henrrick, B. and C. P. Kindleberger. 1988 Economics Development. Fourth Edition. McGraw-Hill International Editions. London.

Acronyms and abbreviations

FAO - Food and Agriculture Organization of the United Nations
ILCA - International Livestock Centre for Africa
MHC - Major Histocompatibility Complex
PGE - Parasitic Gastroenteritis
PPR - Peste des Petits Ruminants
SSA - Sub-Saharan Africa
UN - United Nations
UNECA - United Nations Economic Commission for Africa
WAD - West African Dwarf