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ACTUAL AND POTENTIAL LEVELS OF PERFORMANCE OF INDONESIAN SHEEP AND GOATS UNDER TRADITIONAL MANAGEMENT SYSTEMS

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1. Aim of this review

The aim of this paper is to gather together results of breeding and management studies of sheep and goat production in West Java, in order to:

1. summarise scientific information prior to producing "technology packages" for extension workers.
2. identify areas requiring research attention.
3. help scientists to avoid unnecessary duplication of research.

In recent years there has been considerable research effort in sheep and goat production in Indonesia. Much of this work has been conducted from Bogor in West Java, especially by staff of the Research Institute for Animal Production (BPT) in collaboration with the Small Ruminant Collaborative Research Support Program (SR-CRSP).

2. Background information

In Indonesia there are about 4.2 million sheep and 7.9 million goats (Direktorat Jenderal Peternakan, 1983). These totals are higher than those for any South East Asian country. About 50% of the sheep in Indonesia and 17% of the goats are in West Java.

2.1 Sources of information

In the data that follow frequent reference is made to two research stations near Bogor (Cicadas, sheep; Cilebut, goats) and to three villages of West Java (Cirebon, 4 m; Ciburuy, 450 m; Garut, 650 m) where data have been collected by the SR-CRSP during

the period 1980-86.

2.2 Breeds

The sheep in West Java are small and have coarse wool and thin tails. They are known as Javanese Thin-tailed (Mason, 1978). For convenience in this report, the name of this breed will be abbreviated to JTT. The Priangan is a strain of JTT which was described by Merkens and Soemirat in 1926. It is found in the hills east of Bandung, and is larger than the normal JTT with a higher frequency of sheep having small or vestigial ears. Priangan rams are used for fighting. Priangan sheep are also called Garut sheep after the principal town for ram fighting.

In Central and East Java, the predominant breed is the East Java Fat-tailed (JFT). This breed has been studied at the Cicadas Experimental Station near Bogor. The Semarang strain is found in the hills in Central Java near the town of Semarang. It is white and is thought to be derived from crosses between the JTT and the JFT breeds, although in the sample of Semarang sheep studied by Bradford et al. (1986) tail size was very similar to that of the JTT.

There are two breeds of goats in Indonesia. The "indigenous" goat is small and is called the Kacang breed (Kacang means bean or peanut). Etawah goats are larger animals with long ears and big teats. Etawah goats are descended from the Jamnapari and related types of dairy goat in India, and they have been used extensively for crossing in Indonesia. Intermediate phenotypes between the Kacang and Etawah are found in Indonesian villages.

2.3 Body weight

The average weight of ewes at mating in the villages (near Cirebon, Ciburuy and Garut) is 22.6(+-0.51) kg, n=212 (Subandriyo, 1985b). This is considerably lower than the estimates made by Hardjosubroto and Astuti (1980):

	Body weight (kg)	
	Male	Female
JTT	40	30
Priangan sheep	60	35
East Java Fat-tailed sheep	40	35
Kacang goat	35	30
Grade Etawah goat	60	50

Although the above estimates are too high, they do show the relative sizes of the breeds. The apparently greater sex dimorphism in the Priangan breed is probably a reflection of the better food provided for the Priangan (Garut) fighting rams.

Ewes are considerably heavier in cooler uplands (e.g. Garut) than in the hot lowlands (e.g. Cirebon) as the data of Sabrani et al. (1982) show:

	Body weight (kg)		
Age(d)	Cirebon (4 m)	Ciburuy (250 m)	Garut (600-700 m)
< 1	15.0	13.7	21.7
1 - 2	16.5	17.6	24.1
2 - 3	16.5	18.4	26.0
3 - 4	16.2	20.4	27.1
> 4	15.5	20.1	28.0

In Cirebon ewes reach their maximum weight of about 16.5 kg at the age of 1 - 2 years, but in Garut ewes continue to gain weight reaching about 28.0 kg at 4 years of age.

Sabrani et al. (1982) also gave the body weights of goats in Cirebon and Bogor classified according to age:

Age (y)	Body weight (kg)	
	Cirebon	Bogor
< 1	14.1	12.8
1 - 2	18.4	17.3
2 - 3	21.4	18.4
> 3	23.0	19.8

They state that one reason why the average weights of goats is higher in Cirebon than in Bogor is because there is a larger proportion of Etawah blood in the goat population in Cirebon.

The overall mean weight of adult goats, obtained from the above data by weighting the values according to the number of individuals measured, was 18.4 kg.

2.4 Management

In the lowlands of West Java farmers usually own either sheep or goats. Mixed species flocks are rare. In the lowlands there are roughly equal numbers of sheep flocks and goats herds, but in the uplands there are almost no goats.

All the sheep and goats in West Java are confined in small platform houses during the night (Gatenby et al., 1985) and are stall-fed. In the lowland areas the sheep may graze in the afternoons, herded by children. Mawi and Sabrani (1982) reported that in the lowlands near Cirebon, 73% of sheep flocks sometimes graze, whereas in the upland area near Garut this proportion is

only 4%. Goats are never allowed to graze in the villages because they are too destructive.

The figures of Mawi and Sabrani are similar to those of Djajanegara et al. (1982) who reported that the proportions of flocks and herds which grazed in the lowland and upland areas of West Java were:

	Lowland	Upland
Sheep	74%	1%
Goats	0%	-

2.5 Flock and herd size

Flocks and herds are usually small. Djajanegara et al. (1982) found that the flock or herd size varied with location and species, but nowhere was the mean number of adults greater than 5. In Garut, Soedjana and Knipscheer (1983) reported an average flock size of 4.0 sheep. In their survey 55% of the sheep were adult ewes. Van Eys et al. (1984) estimated average flock and herd size in Cirebon, Ciburuy and Garut to be between 4.7 and 8.3 animals.

2.6 Socio-economic role

Sheep and goats are kept primarily as a means of storing capital which can be liquidated easily when required. Manure production is a secondary role. Achieving maximum income from a flock or herd is not the primary objective.

The inputs into the production system are minimal: labour, unimproved grass and crop by-products, a small area of land, and a

house constructed from local materials.

3. Reproductive performance

3.1 Seasonality

A slaughter house study conducted in Bogor showed that ovulation in village ewes occurs throughout the year, but that ovulation rate is lowest at the end of the dry season (Obst et al., 1980). More general observations (e.g. by Hardjosubroto and Astuti, 1980) indicate that there is little seasonal variation in either oestrus or births.

3.2 Litter size

The mean litter size reported by Subandriyo (1985b) for JTT sheep in villages was 1.4 (+-0.06), n=306. Mason (1980) gave a mean litter size of 1.3 for JTT and 1.8 for Priangan sheep. Bradford et al. (1986) reported values of 1.98 and 1.73 for mature JTT and JFT with corresponding values of 1.54, 1.55 and 1.20 for JTT, JFT and Semarang ewes under 2 years. At Cilebut Experiment Station, the mean litter sizes of both Kacang and Etawah goats were about 1.3 (Setiadi and Sitorus, 1984). For both sheep and goats in Cirebon and Ciburuy, Van Eys et al. (1984) found mean litter size was between 1.1 and 1.3, but for sheep in Garut it was 1.9.

3.3 Lambing interval

Bell et al. (1983) in a study in villages found that lambing interval had a mean of 520 days (i.e 17 months), but was very variable. At Cicadas Experimental Station, a mean lambing interval of 298 days (i.e. 10 months) was achieved (Subandriyo et al., 1981). (see also section 5.8).

3.4 Milk yield

Atmadilaga (1958) measured the milk yield of eleven Priangan ewes by weighing their lambs before and after suckling. He found that mean milk yield reached a peak of 0.55 kg/day in the third week of lactation and subsequently fell to 0.19 kg/day in the twelth week.

For ewes at Cicadas Experimental Station, Sitorus et al. (1985b) reported mean milk yields over 12 weeks of between 0.27 and 0.38 kg/day depending on feeding level and litter size.

3.5 Mating ability of rams

George (1982) reported that JTT rams were unable to serve Fat-tailed ewes because of the presence of the fat tail. Obst et al. (1980) reported a much lower fertility for fat-tailed ewes than for JTT ewes maintained on a high plane of nutrition, when each were mated to rams of their own breed.

3.6 Puberty

Age at first lambing in villages is about 450 to 550 days, i.e. 15 to 18 months (Hardjosubroto and Astuti, 1980). Sitorus et al. (1982) state that for female goats the age at first mating is 9.0 months in the experimental station and 10.2 months in villages. The ages of first parturition corresponding to these matings would be about 14 to 15 months, respectively. Puberty in JTT and JTT x JFT crossbred ewes at the Cicadas Station ranged from 5 to 15 months with a mean age of about 11 months (Tiesnamurti, 1987).

3.7 Longevity

No estimates of the longevity of ewes or does in villages have been published.

4. Performance of lambs and kids

4.1 Lamb and kid survival

Subandriyo (1985b) estimated that in villages, mean lamb survival to 90 days averaged 74 (+-5.4)%, n=282. This value is considerably higher than the figure reported by Tiesnamurti et al. (1984) who found that survival rate depended on location and litter size, and ranged from 77% for single lambs in Garut to only 18% for twins in Cirebon.

At Cilebut Experimental Station the survival rates to 90 days were 86% for Kacang kids and 80% for Etawah kids (Setiadi and Sitorus, 1984).

4.2 Growth rate

For Kacang and Etawah kids at Cilebut Station (Setiadi and Sitorus, 1984), the following mean weights were recorded:

	Kacang	Etawah
Birth weight (kg)	2.0	3.1
Weaning weight (kg) (90d)	9.2	10.8
Pre-weaning growth rate (g/d)	80	81

Least squares means of weights of JTT lambs at birth, weaning and 180 days were given by Subandriyo et al. (1985). These means and the growth rates calculated from them are:

	Villages		Cicadas Station	
	n	mean +-SE	n	mean +-SE
Birth weight (kg)	427	2.0+-0.06	349	1.9+-0.07
Weaning weight (kg)	284	8.3+-0.31	187	9.6+-0.36
Weight at 180 d (kg)	157	13.1+-0.67	116	14.8+-0.30
Pre-weaning growth rate (g/day)		69		85
Post-weaning growth rate (g/day)		53		57

The following pre-weaning growth rates (g/day) were recorded by Van Eys et al. (1984):

	Sheep	Goats
Cirebon	62	64
Ciburuy	54	41
Garut	74	-

Post-weaning growth rates recorded in the same study were all considerably lower (overall mean of 29g/day), with the exception of male sheep in Garut which had a mean post-weaning growth rate of 54 g/day.

By fitting linear regressions to the weights of individual lambs recorded at monthly intervals to the age of 10 months, Waldron et al. (1985) obtained mean growth rates of 32, 50 and 72 g/day in Cirebon, Ciburuy and Garut, respectively. The overall mean growth rate was 58 g/day.

Under a traditional village system near Bogor, Chaniago et al. (1984) measured growth rates of 54 g/day for single lambs and 44

g/day for twins.

4.3 Weaning rate

Weaning rate (WR) is calculated as the product of litter size (L) and survival rate (S) divided by lambing interval (I). Assuming L is 1.4, S is 0.74 and I is 520 days, then WR is 0.73 per year.

4.4 Litter weight at weaning

Subandriyo (1985a) estimated the average litter weight at weaning to be 10.3(+-0.81) kg, n=264 for JTT in villages, and 12.6(+-1.23) kg, n=137 at Cicadas Experimental Station.

4.5 Productivity index

A productivity index can be calculated as the product of weaning rate (WR) and weight of lamb or kid at weaning (WW), divided by the weight of the ewe or doe (W). This gives a measure of the total weight of lamb or kid weaned per unit weight of ewe or doe per year. Assuming that WR is 0.73 per year, WW is 8.3 kg and W is 22.6 kg, the productivity index is 0.27 per year.

This calculated value of the productivity index is lower than the values obtained for sheep in tropical Africa and tropical America, which range from 0.38 to 0.60 per year (Gatenby, 1986). One reason why the West Javan value is low is that weaning was assumed to take place at 3 months whereas in the other studies weaning weight was measured at 6 months. Nevertheless, the productivity index in West Java is probably low because the maximisation of output is not usually a primary objective. This suggests that if achieving a higher output was to become socio-

economically attractive, then it would be technically possible to raise the productivity.

5. Factors affecting performance

5.1 Genetics

The highly variable litter size is explained by high variation in ovulation rate between individual ewes (Bradford et al.,1986). Ovulation rate is highly repeatable for individuals, and is thought to be controlled by a major gene.

5.2 Breed

For lambs in an experiment in Ciawi, the growth rate to 3 months of age was 151 g/day for purebred JTT, and 173, 174 and 178 g/day for Suffolk, Poll Dorset and Wiltshire Horn crosses (Hetzel et al., 1982). These values for JTT are more than double that cited in section 4.2 reflecting a much higher plane of nutrition for the sheep involved in the Hetzel report (which documents a good growth potential for the JTT sheep if nutrition is not limiting).

5.3 Age of sheep

The reproductive capability of a ewe increases with age, reaching a maximum at about 4 years. This increase in reproduction is associated with an increase in body weight of the dam, as is demonstrated by the following data obtained in villages (Subandriyo, 1985b):

Age of ewe (y)	Mating weight (kg) n	Mating weight (kg) mean (SE)	Litter size n	Litter size mean (SE)
1	31	19.3(+-0.81)	56	1.3(+-0.09)
2	102	21.7(+-0.55)	145	1.4(+-0.07)
3	45	23.8(+-0.75)	65	1.5(+-0.09)
4	34	25.3(+-0.77)	40	1.6(+-0.11)

5.4 Nutrition

At Cicadas Experimental Station, increasing the level of nutrition before mating had a positive effect on ovulation rate (Inounu et al. 1985), but ovulation rate was more influenced by previous lambing performance than by level of nutrition. Pitono et al. (1986) subsequently confirmed at Bogor that ovulation rate was positively related to nutritional level. It is clear that these sheep have good potential to respond to improved nutrition, in terms of both reproduction and growth (section 5.2).

5.5 Wool cover

At Cicadas Experimental Station, the wool cover of ewes (i.e. the proportion of body covered with wool) showed a negative correlation with litter weight at weaning (Inounu and Sitorus, 1984), suggesting that ewes with less wool are more productive than those with more complete wool cover. The picture is not entirely clear because in this study wool density (which is related to the quantity of wool per unit area) was positively related to productivity. A negative correlation between the wool cover of ewes and the weaning weight of their lambs has been observed for Dorper sheep in Kenya (Odenya, 1982). However, in an experiment at

Bogor, shearing failed to significantly increase the growth rate of lambs (Martawidjaja et al., 1986).

5.6 Environment

The performance of sheep and goats is affected by location. In upland areas of West Java (e.g. Garut) sheep weights and productivity are higher than in the lowland areas (e.g. Cirebon) as the data of Subandriyo (1985b) show:

	Body weight (kg)		Litter size		Lamb survival (%)	
	n	mean (SE)	n	mean (SE)	n	mean (SE)
Cirebon	28	22.0(+-0.83)	51	1.2(+-0.10)	47	62(+-8.4)
Ciburuy	139	20.9(+-0.44)	198	1.5(+-0.05)	186	75(+-4.7)
Garut	45	24.8(+-0.82)	57	1.7(+-0.10)	49	85(+-8.6)

There must be many reasons why performance varies with location. Some of these are management system, health of animals and climate, with quantity and quality of forage received by the animals probably being the most important difference between locations, although other factors do apply.

5.7 Health

The warm humid climate of West Java is well suited to the free-living stages of gastro-intestinal parasites, and worm infections are one of the most serious disease problems of sheep and goats. Darmono (1982) reported that 82% of sheep slaughtered in Bogor slaughter house were infected with Haemonchus contortus, and Beriajaya and Stevenson (1986) demonstrated that in villages near Cirebon, Bogor and Garut, nematode infections sufficient to depress growth rates and probably increase mortality rates were

commonly encountered in village sheep and goats.

Commercial anthelmintics are not often used, yet can significantly reduce the worm burden of sheep and improve their weight gain and lower their mortality rate (Soetedjo et al., 1980; Beriajaya and Stevenson, 1985; Handayani and Gatenby, 1988). An alternative approach to control internal parasites is to allow the animals to eat only forage which has not been contaminated with parasites. For this method to work satisfactorily, either ALL sheep and goats in the locality must be confined, or else areas for forage production must be fenced against roaming sheep and goats.

Personal observation suggests that mange caused by the mite Sarcoptes scabei is also a serious problem specifically in goats. There do not appear to be scientific studies of goat mange in West Java, but in lowland North Sumatra, Handayani et al. (1986) found that mange was the most serious factor limiting the post-weaning growth and survival of goats.

5.8 General management

Comparing village and improved management systems, Chaniago et al. (1984) concluded that management has a substantial effect on the liveweight of ewes and the growth rate of lambs. One of the main aspects of management that limits the reproductive rate of sheep in Garut, and probably also in other locations, appears to be the poor utilization of rams for breeding, resulting in long lambing intervals (Bell and Inounu, 1982; Bell et al., 1983). In the villages near Garut there appears to be little incentive to achieve high reproductive rates, and this is presumably because the

use of sheep and goats as a readily saleable asset is much more important to the farmers than the monetary income *per se*.

6. Past and present attempts to improve productivity

There are many possible approaches to the improvement of the productivity of sheep and goats in villages. Improvement of nutrition and health are important, but will not be discussed in this review.

6.1 Crossing with temperate breeds

There have been many attempts to introduce temperate breeds of sheep in Indonesia. In 1926, Merkens and Soemirat reported that temperate sheep have been imported since about 1750. These authors reported specific introductions of Merino sheep in 1864, and of Romney Marsh sheep in 1912. They commented that many of the imported sheep died. More recently, the Government of Indonesia has imported Merino, Suffolk, Sufmer (i.e. Suffolk x Merino) and Dormer (i.e. Dorset x Merino) sheep for crossing with local breeds (Hardjosubroto and Astuti, 1980). Information about the outcome of these programmes is scarce. This, together with personal observation of the remnants of the importations, leads one to conclude that the mortality of the imported animals is high and their fertility low.

Mason (1978) reported that the Texel breed was imported by the Dutch and that in experiments at IPB (the Agricultural University at Bogor), Texel x Priangan lambs had good growth rates. Again no mortality or fertility data are available. Mason stated that to thrive and reproduce satisfactorily the imported breeds and their

crosses must be maintained at an altitude of at least 800 m and be well-fed, clipped frequently and dosed against helminths.

A scientific comparison of the productivity of JTT ewes and first crosses between JTT and Suffolk, Wiltshire Horn and Poll Dorset was carried out at Ciawi by Fletcher et al. (1985). The lambs from the crossbred ewes were substantially heavier than the JTT lambs at weaning, but the JTT ewes ate less and produced more lambs over the two-and-a-half year period. The average weight of food consumed per weight of lamb produced was 16 for the JTT and 22, 24 and 33 for the crossbreds.

There is little scientific literature relating to the importation of temperate breeds of goats into Indonesia. This probably reflects the emphasis placed by the Dutch and later development personnel on sheep with which they were more familiar than goats. Importations of Cashmere and Angora goats at the beginning of the 20th century were briefly reported by Merkens and Anwar (1932) who stated that the results were disappointing as most of the animals died.

In conclusion, although imported temperate breeds of sheep, and goats and their crosses may give high growth rates or high milk yields, they do not give as good survival, reproductive rates nor growth per unit food input as the local breeds. This conclusion is strongly stated by Obst (1985) in his recommendations for research at BPT Ciawi.

6.2 Crossing with tropical breeds

Until recently breeds of sheep in the tropics were not well-documented, so that it was almost impossible for animal scientists and development workers in Indonesia to know what tropical breeds were available. In the last 10 years there have been two introductions of tropical breeds of sheep into Indonesia. These are the Barbados Blackbelly and the Virgin Island. These are both breeds which developed in the Caribbean, although their ancestral home is in West Africa. Both are hair breeds so that, unlike the indigenous sheep in Indonesia, they have little or no wool (although some individuals may have partial wool covering which is subsequently shed).

Barbados Blackbelly sheep were imported into Central Java by Heifer Project International. The descendents of these animals were distributed to farmers in a lowland area in Demak District. A preliminary survey (Gatenby et al. 1986a) indicated that the farmers liked to use the Barbados Blackbelly rams as terminal sires, but did not like the purebred Barbados Blackbelly ewes as these were poor mothers and produced little milk. At the time of the survey there were not yet any crossbred parents. It should be noted that the Barbados Blackbelly sheep observed in Central Java were physiologically different from Barbados Blackbelly sheep in the Caribbean, presumably because during their sojourn in the USA before reaching Indonesia some exotic blood was introduced (Shelton, 1983).

Virgin Island sheep are a white hair breed which were imported into Indonesia in 1985 and are currently being evaluated in a crossbreeding programme at the BPT Sungai Putih Experimental Station in North Sumatra. First results of an environmental physiology comparison show that the hair coat gives a considerable advantage over the wool coat of the local sheep because it reduces the amount of sunshine absorbed (Gatenby et al., 1986b).

According to many authors (e.g. Merkens and Anwar, 1932) goats were brought from India to Indonesia by Arab traders. These goats were larger than the native Kacang goat and had higher milk yields. Of the 316 Etawah goats imported by the Dutch in 1913, about half died. Further importations in 1918, 1920, 1928 and 1931 also suffered heavy mortality. The individuals that survived were used for crossbreeding in villages. Their descendents form the Etawah breed of Indonesia.

6.3 Selection within existing breeds

A selection programme using JTT and East Java Fat-tailed sheep is underway at Cicadas Experimental Station. The objectives of this programme are to confirm the mechanism of inheritance of prolificacy, and to develop high and moderate prolificacy strains of sheep. The high prolificacy strain has a relatively high frequency of triplets and a mean litter size between 2.0 and 3.0. Ewes of the moderate prolificacy strain produce only singles and twins, with a mean litter size around 1.5. This approach is based on the assumption of a major gene controlling prolificacy (Bradford et al., 1986).

At Margawati Multiplication Centre, Garut sheep are being selected for lines of high and low lamb survival (Obst, 1985).

6.4 Improvement of the environment

Common sense dictates that in a hot, humid climate, sheep and goats should be kept clean, dry and cool. The effects of temperature and humidity on the performance of sheep and goats in West Java were demonstrated by Martawidjaja et al. (1985). These authors found that litter sizes of ewes or does and livewight gains of lambs or kids were negatively related to air temperature and relative humidity.

Traditional houses ("kandangs") in West Java have evolved to provide the optimum environment for sheep and goats (Gatenby et al., 1987). The kandangs are raised up off the ground, have slatted floors and walls, and thick roofs with large overhangs. Inside these kandangs the temperature and humidity are barely higher than outside, air movement is encouraged, and the animals are always shaded from direct solar radiation. Thus farmers have already achieved very good environments for their animals, and there seems to be little scope for improvement by scientists.

6.5 Testing improved technology in the villages

Testing new technology in the villages in a scientific manner is not easy, and this is no doubt the main reason why there are so few reports in the literature. There is little documentation even of the rather non-scientific "look-see" approach in which a small number of farmers are given a new technology and their response observed.

In a project known as OPP ("Outreach Pilot Project"), scientists from BPT Bogor and BPPV (The Institute of Veterinary Research) in collaboration with SR-CRSP have been attempting to test new technologies in Bogor District. This project began in 1984 with 10 farmer groups. The total has risen to 25. Two of the new tecnologies concern nutrition and health which will not be discussed here.

The breeding sub-programme of BPT is involved in the distribution of animals of known prolificacy to farmers, and the subsequent monitoring of their productivity. These animals are sheep from Cicadas Experimental Station where their prolificacy has already been evaluated. A farmer group is given ewes and a ram of either high, moderate or low prolificacy potential, as estimated at Cicadas Experimental Station. First results show that in general the highly prolfic animals are not preferred by producers because the newborn lambs are very small and lamb mortality is very high.

In an attempt to reduce the lambing interval by timely mating, a comparison is being made of either (a) discussing with the farmers the importance of keeping the rams with the non-pregnant ewes, or of watching the ewes to observe oestrus and then introducing the ram, or (b) not discussing these with the farmers.

7. <u>Identification of traits which can be improved</u>

The performance traits which have the greatest potential for improvement are those which have either:

1. a low mean compared with accepted standards.
2. a high coefficient of variation (i.e. ratio of standard

deviation to mean).

The mean and standard deviations from sections 3 and 4 of this report are summarised in the following table. The potential means were estimated from data obtained on experimental stations in Indonesia or from other parts of the humid tropics.

Values of some performance traits for sheep reared in villages. Act is actual mean, Pot is potential mean, CV is coefficient of variation.

Parameters	Mean			Variation	
	Act	Pot	Ratio	sd	CV
Litter size	1.4	1.8	0.78	0.8	0.57
Lambing interval (d)	520	240	0.46	110	0.21
Age first lambing (d)	500	420	0.84	90	0.18
Lamb survival to 90 d (%)	74	85	0.87	25	0.34
Preweaning growth (g/d)	67	100	0.67	6.7	0.10
Weaning weight (kg)	8.3	12.0	0.69	1.8	0.22
Weaning rate (per y)	0.73	2.32	0.31		
Productivity (per y)	0.27	1.10	0.29		

7.1 Litter size

Litter size has a high coefficient of variation, 30-60% in different populations. The variation between individual observations is due largely to variation between individual ewes, so that it should be possible to develop strains of sheep with high, moderate or low litter sizes (as described in section 6), and thus considerably lower coefficients of variation within strains.

High litter sizes, however, may not give high productivity i village flocks because there are strong negative correlations between litter size and other productive parameters such as survival, growth rate and lambing interval, as shown in the following tables.

Effect of litter size on lamb and kid mortality to 90 days

Litter size	JTT villages a	JTT Station b	Kacang Station c	Etawah Station c
1	22	17	16	22
2	21	18	35	33
3	35	36		33
4		43		
5		60		

Sources: a, Subandriyo (1985); b, Inounu et al. (1984) and c, Setiadi and Sitorus (1984).

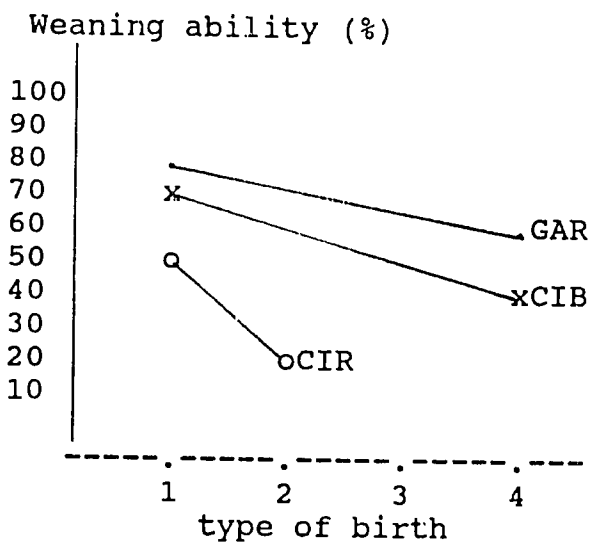
Effect of litter size on weights of lambs at birth and weaning. Data from Cicadas Experimental Station (Sitorus et al., 1986).

Litter size	Birth weight (kg)	Weaning weight (kg)
1	2.4	8.7
2	1.8	6.9
3	1.6	6.0

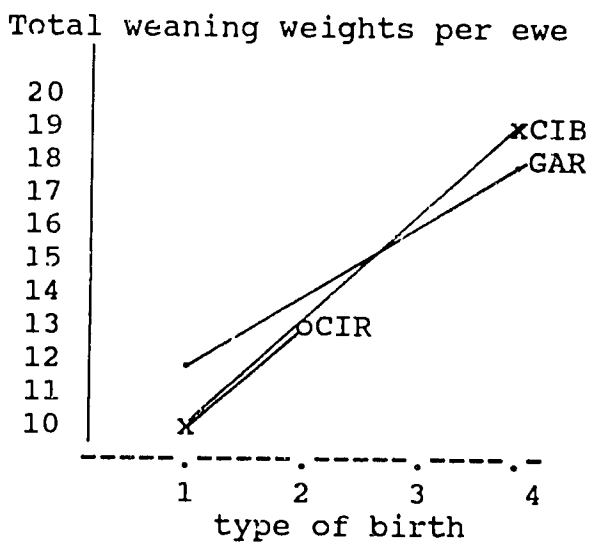
Lambing interval of ewes at Cicadas Experimental Station according to previous litter size (Sitorus et al., 1985a).

previous litter size	n	mean (d)	SE
1	18	261	+-14.6
> 1	27	270	+-10.6

The magnitude of the interaction between litter size and other performance traits depends on the environment. Tiesnamurti et al.(1984) fitted linear regressions to lamb survival in three villages and obtained the following picture, showing an interaction between litter size and location.



Weaning ability associated with the type of birth in West Java villages



Total weaning weights per ewe associated with the type of birth in West Java villages

Thus optimum litter size depends on the environment. In villages near Cirebon, Ciburuy and Garut, the optimum litter size

is about 2 (see following table), but under good experimental station conditions, litter weight at weaning increases with litter size at least until 3. Obst (1985) went so far as to state that selection within Indonesian genotypes for high ovulation rates (3 or more) is of low importance due to the high level of mortality of multiple births in current management systems. Probably a litter size of 2 is the optimum for the average farmer in Indonesia, but where management is good, there is enough food for the ewe in late pregnancy and early lactation, and there is adequate supervision of the young lambs, then a litter size of 3 may be recommended.

If the potential prolificacy of ewes is known, it is possible to advocate sheep according to the requirements of the farmer. Sheep with low to moderate prolificacy are suitable for farmers who have only minimal resources, where raising more than one lamb may not be feasible, and triplets are clearly disadvantageous. On the other hand, farmers with good management and adequate resources should benefit from highly prolific sheep.

Effect of litter size on litter weight at weaning (kg) (Subandriyo, 1985a)

Litter size	Litter weight at weaning			
	villages		Cicadas Station	
1	n=158	7.8+-0.74	n= 63	9.5+-1.25
2	n= 92	12.1+-0.81	n= 49	11.9+-1.30
3	n= 14	11.1+-1.66	n= 8	15.1+-2.72

7.2 Lambing interval

There is a large difference between the actual and potential lambing interval (section 7) showing that there is much scope for improvement in lambing interval. Some ewes and does in the villages lamb or kid only every 2 years. The reasons for this are many, but flock management is important and it seems that some ewes fail to conceive simply because they are not exposed to the ram (Bell et al., 1983). In the lowlands of West Java, many of the sheep are allowed to graze during part of the day, and during grazing the rams can detect and serve the ewes in oestrus; sheep in the uplands and almost all goats are never allowed to graze so that unless the rams are kept in the same pen as the ewes, or unless the farmer notices when a ewe is in oestrus and takes appropriate action, mating does not take place. An additional difficulty arises where there is no ram in the housed flock. In this case the farmer must borrow from his neighbour.

7.3 Age at first lambing

Age at first lambing shows relatively less variation than litter size and lambing interval. It is a function primarily of growth rate and nutrition; puberty is attained when a critical body weight is reached. Improvements in nutrition and health leading to improved growth rates would have an additional effect on improved productivity through earlier age at first lambing.

7.4 Longevity of ewes

As ewes become older, heavier and more experienced, they produce more and heavier lambs (section 5.3). Even though the

maintenance requirements of ewes increase slightly with age, the overall output per unit food input of older ewes is higher than that of primiparous animals.

In addition, a long reproductive life increases the proportion of productive adult females in the flock and dilutes the proportion of resources given to rearing ewe replacements. Thus, although longevity does not enter directly into the calculation of productivity index (kg lamb weaned per kg ewe weight per year), it is nevertheless a very important factor affecting the overall productivity of the flock. Until now, longevity has received almost no scientific attention and is a topic which needs research. In the Indonesian production environment, optimum age structure of the ewe flock is complicated by (a) the use of the animals as a cash reserve and therefore the tendency to sell the largest animals in the flock, and (b) the fact that some ewes become too prolific at older ages.

7.5 Lamb survival

There is relatively little difference between the actual and estimated potential mean values of lamb survival (only 11%), yet the coefficient of variation is high, making lamb mortality a key trait affecting flock performance. Lamb mortality to weaning is affected by many factors including litter size, nutrition of ewes (which acts through the birth weight of the lamb and the milk yield of the ewe) and general management. One of the most effective steps which can be taken to improve average survival rates is to set litter size born (through genetics and nutrition) at a level

compatible with nutrition and management at lambing so that the very high mortalities associated with triplets, quadruplets, etc. are avoided.

7.6 Preweaning growth and weaning weight

Some changes in preweaning growth rate may be the passive consequence of improvement in other performance components. For instance, preweaning growth is negatively correlated with litter size, and positively correlated with lamb survival, so that if emphasis is put on increasing litter size, growth rate is likely to fall, but if emphasis is put on improving lamb survival then growth rate is likely to be increased. Improved nutrition and health have the potential to increase growth rates significantly and selection for growth rate, concurrent with selection for desired levels of reproduction, should also contribute to increased growth.

7.7 Productivity

If the potential performance parameters were all reached, the data presented in section 7 show that the weaning rate of the village flocks would be increased by 200% and the productivity index (weight of weaned lamb produce per unit weight of ewe per year) by 300%. These figures show the enormous potential for the improvement of productivity, yet achieving this is difficult. Firstly the individual performance components are negatively correlated, and secondly, this analysis has not taken into account socioeconomic limitations.

This examination of performance traits has identified two key parameters which have critical impact on flock productivity. These

are lambing interval and lamb survival. Neither is strongly negatively correlated with other performance parameters. Both lambing interval and lamb survival are highly dependent on management factors, and so are relatively easy targets for improvement in the villages. Improving the management of the poor flocks should raise their productivity towards the level of the more successful flocks.

Longevity also appears to be a key parameter deserving attention, but at present little is known about the duration of the reproductive life of ewes in Indonesia and the factors affecting it. Therefore longevity should be a target for research attention rather than for immediate improvement in the villages.

8. Areas requiring research attention

(a). Practical methods of reducing lambing interval and increasing lamb survival in villages, particularly in flocks with low productivity.

(b). Longevity of ewes, its magnitude, variation, factors affecting it, and its response to attempts to improve it.

(c). Economic response to improvements (based on interventions in these and other areas).

9. Recommendations for extension workers to put forward to the farmers

Most farmers have a positive attitude towards agricultural extension (Suradisastra, 1983), so that if suitable technological improvements are available some farmers are willing to try them. On the other hand achieving maximum income from the flock or herd

is not the primary objective of farmers, and any increase in inputs above the present minimal level may make the potential improvement unacceptable. The problem is to find improvements which are both technologically and economically suitable, and to put them into suitable forms for distribution to the farmers.

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