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Goat Meat Production in Asia

Proceedings of a workshop held in Tando Jam, Pakistan, 13–18 March 1988

Proceedings

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Goat Meat Production in Asia

Proceedings of a workshop held in Tando Jam, Pakistan, 13–18 March 1988

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IDRC-268e

Goat meat production in Asia : proceedings of a workshop held in Tando Jam, Pakistan, 13–18 March 1988. Ottawa, Ont. IDRC, 1988. xi + 262 pp. : ill. (Proceedings series / IDRC)

/Goats/, /meat/, /animal production/, /Asia/ – /animal breeding/, /reproduction/, /animal nutrition/, /animal health/, /agricultural management/, /meat processing/, /marketing/, /international trade/, /export potential/, /production functions/, /case studies/, /conference reports/, /lists of participants/.

UDC: 636.39(5) ISBN: 0-88936-525-3

Technical editor: W.M. Carman

A microfiche edition is available.

Abstract/Résumé/Resumen

Abstract: This publication presents the results of a workshop held in Tando Jam, Pakistan, 13–18 March 1988, that focused specifically on all aspects of goat meat production in Asia. The workshop addressed the factors affecting meat production (breeding, nutrition, reproduction, sex, management, animal health, and diseases), the nutritional value of goat meat, methods of slaughter, processing techniques, consumer preferences, and the national and international marketing of goats. The detailed discussions on these aspects were further highlighted by country case studies, prevailing situations, issues and policies, and potential for improving the prevailing patterns of production. An important session covered broader issues concerned with research and development, strategies for increasing production, and export potential, especially in Near East markets. These discussions enabled a definition of research and development priorities and the scope for increasing goat meat production.

Résumé: Cette publication fait le compte rendu d'un atelier tenu à Tando Jam, au Pakistan, du 13 au 18 mars 1988 et qui a porté sur tous les aspects de la production de la viande de chèvre en Asie. Il y a été question notamment des facteurs influant sur la production de la viande (sélection des espèces, nutrition, reproduction, sexe, gestion, santé animale et maladies), de la valeur nutritive de la viande de chèvre, des méthodes d'abattage, des techniques de transformation, des préférences des consommateurs et du marketing national et international des chèvres. En plus de discuter de ces questions en profondeur, les participants ont aussi abordé les points suivants : études de cas de certains pays, situations actuelles, enjeux et politiques, et possibilités d'améliorer les tendances actuelles de la production. Lors d'une séance importante, les participants se sont penchés sur des questions plus vastes concernant la recherche et le développement, les stratégies qui permettraient d'augmenter la production et les possibilités d'exportation, particulièrement vers les marchés du Proche-Orient. Ces discussions ont permis de définir des priorités en matière de recherche et de développement et de déterminer le potentiel de croissance de la production de la viande de chèvre.

Resumen: Esta publicación contiene los resultados de un taller celebrado en Tando Jam, Paquistán, del 13 al 18 de marzo de 1988, dedicado específicamente a todos los aspectos de la producción de carne de cabra en Asia. El taller estudió los factores que afectan la producción de carne de cabra (cruce, nutrición, reproducción, sexo, manejo, salud y enfermedades), el valor nutricional de la carne caprina, los métodos de sacrificio, las técnicas de procesamiento, las preferencias del consumidor y el mercado caprino nacional e internacional. Las discusiones detalladas sobre estos aspectos se vieron además enriquecidas con el potencial para mejorar los patrones prevalecientes de producción. Una de las sesiones importantes cubrió los aspectos más amplios de investigación y desarrollo, estrategias para el aumento de la producción, potencial de exportación, especialmente en los mercados del cercano oriente. Las discusiones permitieron determinar las prioridades de investigación y desarrollo así como las posibilidades para aumentar la producción de carne caprina.

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The influence of sex on goat meat production

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Abstract: *Goats have a number of characteristics, such as high reproductive potential, ability to thrive on shrubs, bushes, and tree leaves, and less susceptibility to infectious diseases, that make them suitable as meat-producing livestock in developing countries. Males grew faster than females and, generally, the progeny of large breeds grew faster than the progeny of small breeds. Cross-breeding larger with smaller breeds achieved faster growth rates in the progeny. Castrates grow faster than entire males, irrespective of the method of castration (open or emasculation). Limited work suggests that 1-month castrates grew significantly faster ($P < 0.05$) compared with intact animals. The dressing percentage is generally lower in females than in males and increases with increased body weight. Higher planes of nutrition improved weight gains and dressing percentage. One-month castrates yielded significantly higher carcass weights ($P < 0.05$) compared with intact animals under identical conditions of feeding and management. In yearlings, lean meat and fat contents in the carcass varied from 62 to 65% and from 6.9 to 17.4%, respectively. Lean meat to bone ratios varied from 2.7:1 to 3.6:1. The area of eye muscle increased with increased body weight and this was accompanied by a decrease in bone content.*

Résumé: *Les chèvres présentent certaines caractéristiques – fort potentiel reproductif, aptitude à se nourrir d'arbustes, de buissons et de feuilles d'arbres, plus grande résistance aux maladies infectieuses – qui en font de bons animaux à boucherie dans les pays en développement. La croissance des mâles est plus rapide que celle des femelles et, en général, la croissance de la progéniture des races de grande taille, plus rapide que chez celles de petite taille. L'hybridation de races de grande de taille et de races de petite taille hâte la croissance de la progéniture, tout comme la castration accélère passablement celle des mâles, quelle que soit la méthode utilisée (castration ouverte ou émasculation). Malgré leur portée limitée, certains travaux suggèrent que chez les chèvres châtrées à un mois la croissance est plus rapide ($P < 0,05$) comparativement aux bêtes non castrées. Le rendement à l'abattage est généralement inférieur chez les femelles et proportionnel à l'augmentation du poids. Des niveaux de nutrition plus élevés ont permis des gains de poids et un rendement à l'abattage supérieurs. Les chèvres châtrées à un mois ont présenté des carcasses d'un poids supérieur ($P < 0,05$) comparativement aux bêtes non castrées qui ont reçu une alimentation et des soins identiques. Chez les chèvres âgées d'un an, la quantité de viande maigre et de gras des carcasses est de 62 à 65 % et de 6,9 à 17,4 % respectivement. Quant au rapport entre la quantité de viande maigre et d'os, il s'échelonne entre 2,7 pour 1 et 3,6 pour 1. L'étendue des muscles oculaires augmente avec le poids du corps et est accompagnée d'une diminution du contenu en os.*

Resumen: *Las cabras poseen unas características como alto potencial reproductor, habilidad para sobrevivir alimentándose de arbustos, malezas y hojas de árboles y son menos susceptibles de contraer enfermedades infecciosas, características que las hacen más apropiadas como ganado productor de carne en países en desarrollo. Los machos crecieron con más rapidez que las hembras y, generalmente, la prole de razas grandes creció con mayor rapidez que la de razas pequeñas. El cruzamiento de razas grandes con pequeñas logró índices de crecimiento más rápidos en la prole. Los machos castrados crecieron con mayor rapidez que los machos enteros, independientemente del método de casración (abierto o de emasculación). Un trabajo limitado sugiere que los animales castrados de un mes crecieron significativamente con mayor rapidez ($P < 0,05$) comparado con los animales que no fueron castrados. Los rendimientos de la canal son generalmente más bajos en las hembras que en los machos y aumenta con el peso. Una nutrición superior mejoró las ganancias de peso y los rendimientos de la canal. Los animales castrados de un mes arrojaron pesos de la canal significativamente más altos*

(P < 0,05) comparados con animales no castrados bajo condiciones idénticas de alimentación y explotación. En los corderos, la carne magra y los contenidos de grasa en la canal variaron de 62 a 65% y de 6,9 a 17,4% respectivamente. Las relaciones entre la carne magra y los huesos variaron de 2,7:1 a 3,6:1. El área del músculo motor aumentó con el incremento del peso y esto estuvo acompañado por una disminución en el contenido del hueso.

The majority of goats in Asia are found on the Indian subcontinent (Bangladesh, Bhutan, India, Nepal, Pakistan, and Sikkim). In terms of meat production, of the 1.9×10^6 t of goat meat produced per year worldwide, approximately 74% comes from tropical countries with 34% from India (Devendra and Owen 1983). In Asia, where landholdings are small and the purchasing power of the farmer is limited, goats are the animal of choice for meat and milk, especially for small, marginal farmer communities because the goat maintains itself on tree leaves or shrubs, thrives in a wide range of ambient temperatures, is less susceptible to infectious diseases like tuberculosis, and produces highly palatable lean meat; it is also highly productive compared with other ruminants, being a prolific breeder. There is considerable potential for increasing goat meat production, especially because the demand for animal protein far exceeds supply in many Asian countries.

Growth rates

One of the major influences on the growth of goats is the mature size of the sire and the dam. The mature size of goats varies from 15 kg for small Bengal breeds to over 75 kg for Jamunapari goats. Generally, the progeny of large breeds are heavier at birth and grow faster than the progeny of small breeds (Table 1). Because one of the means of increasing the contribution of meat from goats is the greater exploitation of available genetic resources (Devendra 1987), especially meat breeds in Asia, large breeds of goats have been crossed with smaller breeds

Table 1. Birth weight of common breeds of goats and their growth rates.

Breed	Sex[a]	Birth weight (kg)	Mature weight (kg)	Growth rate (g/day)[b]	Source
Jamunapari	M	3.57	75.90	93	Senger (1978)
	F	2.78	60.70	64	
Bengal	M	1.10	19.30	31	Senger (1978)
	F	0.98	13.22	20	
Katjang	M±F	1.50	25.30	56	Devendra (1966)
Beetal	M	3.04	60.75	90	Joshi (1979)
	F	2.96	45.50	49	
Barbari	M	1.83	30.40	40	Joshi (1979)
	F	1.61	25.35	33	
Malabari	M	1.61	25.35	41	Nair (1979)
	F	1.59		35	
Alpine x Beetal	M	3.20	-	124	Mishra (1979)
	F	3.14	-	59	
Saanen x Beetal	M	3.56	-	112	Mishra (1979)
	F	3.18	-	58	
Alpine x Malabari	M	1.84	-	52	Nair (1979)
	F	1.68	-	38	
Saanen x Malabari	M	2.05	-	49	Nair (1979)
	F	1.89	-	42	

aM, male; F, female.
bBirth to 12 months.

to achieve faster growths. Cross-breeding of Beetal with Alpine and Saanen revealed a nearly twofold improvement in growth rates over a 12-month period in Alpine × Beetal and Saanen × Beetal males (Table 1). Likewise, Alpine × Malabari and Saanen × Malabari showed improved growth rates, although to a lesser degree. These improved growth rates are a consequence of hybrid vigour. The combining ability of indigenous breeds must be studied carefully if heterosis traits in meat production are to be exploited.

Effects of sex and growth

Males grow faster than females from birth to 12 months of age and these differences essentially reflect differences in size at maturity, with males being heavier at maturity than females (Table 1). In certain areas of the Indian subcontinent, male kids intended for slaughter are castrated. In Muslim areas of Asia, the market demand favours intact male goats for slaughter (Devendra and Owen 1983). Recently, many researchers (Louca et al. 1977; Senger 1978; Chawla and Iqbal Nath 1980; Kumar et al. 1980; Devendra and Owen 1983) have studied the effect of castration on growth. Generally, castrates grow faster than intact males (Table 2). Senger (1978) observed that under identical conditions of housing, feeding, and management, castrates (open) grew better than intact males. These differences reflect differences in mature size of the breed.

The age at which castration should be done to get maximum returns is still open to speculation. Castration at 2 months was superior to castration at both 1 and 3 months (Table 2). Of the unilateral and bilateral methods used (Senger

Table 2. Effects of timing and method of castration on growth of goat breeds.

Breed	Time after birth	Method[a]	Weight range (kg)	Growth rate (g/day)	Source
Beetal					
Intact	4 days	-	10-15	44	Chawla and
Castrated	5 days	O	10-15	44	Iqbal Nath
	3 months	O	10-15	47	(1980)
	6 months	O	10-15	51	
Bengal					
Intact	-	-	10-15	41	Singh et al.
Castrated	2 months	E	10-15	44	(1985)
Jamunapari x Bengal					
Intact	-	-	10-15	50	
Castrated	2 months	E	10-15	64	
Barbari					
Intact	-	-	5-10	22	Sengar (1978)
Castrated	1 month	O	5-10	25	
	2 months	O	5-10	27	
	3 months	O	5-10	25	
Barbari					
Intact	-	-	15-20	25	Kumar et al.
Castrated	15 days	O	15-20	26	(1980)
		E	15-20	27	
	1 month	O	15-20	40	
		E	15-20	39	
	2 months	O	15-20	35	
		E	15-20	36	
	3 months	O	15-20	31	
		E	15-20	33	

[a]O, open; E, emasculator.

1978), the bilateral method was more effective; Sidhar et al. (1978) found that open castration at 1 and 2 months of age had a significant ($P < 0.05$) effect on live weight gain, whereas length, height, and paunch girth remained unaffected. They concluded that castration at 1 month of age was more economical in terms of improved body weight gain. The effect of castration at different intervals of age (5 days, 3 months, and 6 months) on live weight at 9 months in Beetal goats suggests that maximum growth was obtained with castration at 6 months followed by castration at 3 months (Table 2). Early castration (5 days) had no effect.

Kumar et al. (1980) observed no significant differences in weight gains and preslaughter weights in open or emasculator methods of castration at different age intervals, i.e., 15 days, 1 month, 2 months, and 3 months (Table 2). Among castrated animals, however, 1-month castrates gained significantly ($P < 0.05$) more weight (23.50 kg) than their intact counterparts (15.66 kg) slaughtered at 18 months.

Carcass yield

The dressing percentage (D%) has long been used to estimate the food value of meat and relates carcass weight to live weight. This parameter is rarely used as an indicator of carcass yield, unless it is quoted on an empty body weight basis (Devendra and Owen 1983) to eliminate the variation caused by gut contents; this can be as much as 29% of the live weight (Owen et al. 1977). Generally, a D% of 45–50% (live weight basis) for males is common and this increases with a concomitant increase in live weight in almost all goat breeds (Table 3). A higher plane of nutrition generally yields a higher D%; this was demonstrated by Gaili et al. (1972) with Sudan Desert goats and by Devendra (1966) with Katjang goats. To maximize the growth of kids between weaning (3 months) and slaughter

Table 3. Effect of live body weight on dressing percentage in goats.

Breed	Sex[b]	8-15 kg	15-20 kg	20-30 kg	30-40 kg	Source
Jamunapari	M	48.10	49.65	52.15	-	Pant et al.
	F	44.45	43.85	43.03	-	(1974)
Osmanabadi	M	44.41	44.73	45.20	-	Reddy and
		(50.30)	(51.40)	(52.10)	-	Raghavan
	F	41.37	43.10	42.40	-	(1984)
		(51.00)	(52.40)	(51.10)		
Katjang	M	-	44.21	51.39	-	Devendra and
			(50.61)	(58.32)		Owen (1983)
Angora x local	M	38.56	36.65	43.62	-	Ghaneker et al.
		(49.29)	(47.93)	(53.07)		(1973)
Sudan Desert	M	34.5	-	-	-	Ibrahim and
		(49.2)				Gali (1985)
Sirohi	M	44.3	44.5	50.6	52.1	Prasad (1985)
		(55.2)	(56.5)	(58.8)	(59.9)	
Beetal	M	44.5	45.7	49.6	50.3	Prasad (1985)
		(50.2)	(52.3)	(58.2)	(58.1)	
Jhakrana	M	42.6	46.7	49.6	-	Prasad (1985)
		(56.1)	(56.9)	(58.7)		
Kutchi	M	43.5	44.5	50.5	-	Prasad (1985)
		(54.4)	(55.8)	(58.3)		
Marwadi	M	45.74	50.18	49.71	-	Prasad (1985)
		(52.38)	(56.81)	(57.22)		

Note: Values in parentheses are dressing percentages based on empty body weight; all others are based on live weight.
[a]M, male (all males are entire); F, female.

(9 months), the weaner kids were subjected to two feeding regimes (8-h browsing and browsing + ad lib. concentrate supplementation) to assess the effect of D%. Concentrate supplementation in addition to browsing resulted in a 2–3% increase in D% in Sirohi and Beetal × Sirohi (Table 4), suggesting that heavier goats dressed higher than lighter goats by 2–4% on a higher plane of nutrition. Parthasarathy et al. (1984) observed an increase of 5% in D% when kids were supplemented with ad lib. concentrate in addition to browsing. Reddy and Raghavan (1984) observed that increasing the concentrate component of the ration from 30 to 70% increased the D% by about 2.5% and reduced the time taken to attain a slaughter weight of 24 kg by 1.5 months.

Effects of sex and castration

At a given live weight, males are generally heavier than females (Wilson 1958; Louca et al. 1977; Owen et al. 1978). Pant et al. (1974) observed that D% was lower in female Jamunapari goats than in males (Table 3). Likewise, in Osmanabadi goats, D% is always lower in females than in males (Reddy and Raghavan 1984). Pant et al. (1974) observed, however, that D% in Jamunapari goats was highest in females of 10–15 kg live weight and in males of 25–30 kg live weight.

Castration of male goats eliminates odours in the meat, rendering it more palatable (Devendra and Owen 1983). Castration has a range of effects on D%; the time of castration is important in this respect. Castration at 5 days (Chawla and Iqbal Nath 1980) and 15 days (Kumar et al. 1980) did not result in any significant improvement of D% (Table 5); however, castration at 7 days in Damascus goats produced carcasses with a slightly higher D% (56.4) than those of intact males (55.7%), whereas late castration (7.5 months) yielded a lower D% of 54.9% (Louca et al. 1977). Castration at 6 months in Barbari (Srivastava et al. 1968) and Alpine × Beetal goats (Chawla and Iqbal Nath 1980) improved D% by 0.8 and 1.5%, respectively (Table 5). In Alpine × Beetal, castration at 3 months improved D% by 2.2%.

Khumar et al. (1980) observed the effects of method (open or emasculator) and timing (15 days, 1 month, 2 months, or 3 months) of castration on D% under identical conditions of feeding, management, and slaughtering (18 months). The improvement as D% or a result of castration was significant ($P < 0.05$); the difference in improvement between emasculator and open methods was insignificant. Kids castrated at 1 month yielded higher carcass weights when compared with 15-day, 3-month, and 6-month castrates, irrespective of the method of castration.

Table 4. Effect of the plane of nutrition on dressing percentage (empty body weight) of intact, male goats.

Feeding regime	Breed	8–15 kg	15–20 kg	20–30 kg	30–40 kg
8-h browsing	Sirohi	55.5	56.0	-	-
	Beetal x Sirohi	-	56.1	56.9	-
Browsing + concentrate	Sirohi	-	57.4	58.1	59.9
	Beetal x Sirohi	-	57.3	57.9	59.6

Source: Bhatia (1985).

Carcass composition

Allometric growth equations relating the differential growth rates of lean meat, bone, and fat indicate that as the body weight increases, the rate of bone growth decreases, the growth rate of lean meat remains constant or increases slightly (Tulloh 1963), and the fat tissue has a greater differential growth rate. This was demonstrated in male Botswana castrates, where the growth coefficients of lean meat, bone, and fat were 1.1697, 0.7756, and 1.9947, respectively (Owen et al. 1978), indicating that goats appear to be relatively late in maturing, with fat tissue not reaching an appreciable proportion of body weight until a heavy live weight is achieved. Generally, the lean meat composition of goat carcasses is about 60% (Devendra and Owen 1963); values are as high as 66% in intact Malawi goats (Owen 1975) and 68% in intact Alpine goats (Fehr et al. 1976) and as low as 53.9% in male and female Philippine goats (Argañosa et al. 1977) have been reported.

The percent lean meat in the carcass has been found to be strongly related to transverse surface area of the longissimus dorsi muscle, usually cut between the 12th and 13th rib in sheep and goats (Devendra and Owen 1983). Singh and Senger (1970) found this to be true in male Barbari and Jamunapari goats. In goats of approximately 20 kg live weight, the area of longissimus dorsi varied from 4.12 cm^2 in New Zealand feral males and females (Kirton 1970) to 16.12 cm^2 in Philippine entire males and females (Argañosa et al. 1977). The longissimus muscle developed significantly with increases in live weight (Ghanekar et al. 1973). This is true for several indigenous goat breeds of the Indian subcontinent (Table 6).

It is generally accepted that goat meat is leaner than mutton (Devendra and Burns 1983) and that goats deposit less subcutaneous fat and more visceral fat

Table 5. Effect of timing and castration method on dressing percentage (D%) of goats.

Breed	Time after birth	Method[a]	Live weight (kg)	D%	Source
Alpine x Beetal					
Intact	-	-	19.38	50.00	Chawla and
Castrated	5 days	O	18.38	50.35	Iqbal Nath
Intact	-	-	18.00	48.50	(1980)
Castrated	3 months	O	18.33	50.68	
Intact	-	-	18.40	51.68	
Castrated	6 months	O	17.08	52.98	
Barbari					
Intact	-	-	21.05	49.81	Srivastava
Castrated	6 months	E	21.20	49.93	et al. (1968)
Barbari					
Intact	-	-	15.66	43.79	Kumar et al.
Castrated	15 days	O	18.00	49.86	(1980)
		E	18.70	50.86	
	1 month	O	23.50	51.26	
		E	23.60	51.26	
		E	23.60	51.90	
	2 months	O	21.60	50.80	
		E	21.50	50.70	
	3 months	O	20.30	49.21	
		E	20.45	48.13	

[a]O, open; E, emasculator.

Table 6. Area (cm^2) of eye muscle (longissimus dorsi) in various breeds of male goats at different live weights.

Breed	Live weight range (kg)			
	8-15	15-20	20-25	25-30
Sirohi	-	6.20	9.94	10.82
Beetal	-	7.25	7.35	11.20
Beetal x Sirohi	4.45	-	9.78	10.30
Jhakrana	-	-	7.65	9.88
Kutchi	-	6.20	7.30	8.43

Source: Prasad (1985).

(Ladipo 1973; Owen et al. 1977; Owen et al. 1978). The amount of abdominal and renal fat was significantly ($P < 0.05$) higher in castrates than in intact goats (Chawla and Iqbal Nath 1980; Kumar et al. 1980). Fat levels are highly variable and depend on weight, breed, plane of nutrition, and sex (Owen et al. 1978). These aspects have been excellently reviewed by Devendra and Owen (1983).

Lean meat to bone ratios have been used to compare breeds and carcass meat yields. Generally, this ratio increases as empty body weight increases. Lean meat to bone ratios ranged from 2.7:1 for dairy goats (Ladipo 1973) to 3.8:1 for Jamunapari and 4.9:1 for Barbari goats (Srivastava et al. 1968).

In view of the demand for lean meat in India and the price differential for different carcass joints, attempts have been made to evaluate the percent bone content in the carcasses of almost all breeds of goats. The percentage of bone is higher in crossbreeds than in indigenous purebreds slaughtered at 12 months. The differences in bone content between indigenous breeds and crossbreeds could be due to the faster development of bone than of muscle, which is a comparatively late-developing tissue (Gaili et al. 1972).

Muscle composition

The chemical composition of the muscle depends on the degree of fattening and the cut used for analysis. The variation in intra-muscular fat content with regard to anatomical location, influence of castration, sex, and breed has been thoroughly reviewed by Devendra and Owen (1983). The longissimus dorsi muscle had a high level of intramuscular fat (Ladipo 1973; Owen et al. 1978). Because the quantity of lean meat in the carcass has been found to be strongly related to the area of eye muscle (Devendra and Owen 1983), this muscle has been used as an index to assess chemical composition. The deposition of intramuscular fat was lower (0.94 to 1.5%) in indigenous breeds of the Indian subcontinent (Mishra 1981; Keshava Rao et al. 1984) when compared with Alpine, Toggenburg, Nubian, and Saanen goats (2.01%) over a range of live weights (Ladipo 1973). In Alpine x Beetal castrates, slightly higher levels of fat (1.8%) were observed than in intacts (1.5%) (Chawla and Iqbal Nath 1980); the moisture, protein, and mineral contents were similar in intact and castrated animals.

References

Argañosa, F.C., Ibarra, P.I., Malabanan, M.M. 1977. Live measurements and carcass yields of native goats. Philippine Agriculture, 61, 166–175.

Bhatia, P.R. 1985. Performance of kids on different combinations of Pala and a cheaper concentrate mixture. In Annual report of the All-India Coordinated Research Project on Goats for Meat. Division of Genetics and Breeding, Central Sheep and Wool Research Institute, Avikanagar, Rajasthan, India. pp. 63–67.

Chawla, D.S., Iqbal Nath. 1980. Note on weights of different carcass cuts and organs of Beetal and its exotic crosses. Indian Journal of Animal Science, 50, 1021–1024.

Devendra, C. 1966. Studies in the nutrition of the indigenous goat of Malaya. I. The body measurements, composition of sample joints and their relationship to carcass composition. Malaysian Agricultural Journal, 45, 345–369.

——— 1987. The role of goats in feed production systems in industrialised and developing countries. In Proceeding of the 4th International Conference on Goats, 13–18 March 1987, Brasilia, Brazil. Empresa Braileira de Tesquia Agropecuaria, Brasilia, Brazil. pp. 3–40.

Devendra, C., Burns, M. 1983. Goat production in the tropics. Commonwealth Agricultural Bureaux, Farnham Royal, U.K. Technical Communication No. 19. 183 pp.

Devendra, C., Owen, J.E. 1983. Quantitative and qualitative aspects of meat production from goats. World Animal Review, 47, 19–29.

Fehr, P.M., Sauvant, D., Delage, J., Dumont, B.L., Boy, G. 1976. Effect of feeding methods and age of slaughter on growth performance and carcass characteristics of entire young male goats. Livestock Production Science, 3, 183–194.

Gaili, E.S.E., Ghanem, Y.S., Mukhtar, A.M.S. 1972. A comparative study of some carcass characteristics of Sudan Desert sheep and goats. Animal Production, 14, 351–357.

Ghanekar, V.M., Bhatwadekar, S.D., Soman, B.V. 1973. Effect of age on the weight of the carcass and its different cuts in male kid of Angora cross. Indian Journal of Animal Science, 43, 133–135.

Ibrahim, A.A., Gaili, E.S. 1985. Performance and carcase traits of goats fed on diets containing different proportions of mosquite (*Prosopis chilensis* (Molina) Stuntz). Tropical Agriculture (Trinidad), 62, 97–99.

Joshi, J.D. 1979. Important Indian breeds of goats. In Sahni, K.L., Singh, R., ed., Proceedings of the Summer Institute on goat production. Central Institute for Research on Goats, Makhdoom, Mathura, India. pp. 4–8.

Keshava Rao, V., Anjaneyulu, A.S.R., Lakshmanan, V. 1984. A note on carcase and meat characteristics of Black Bengal male goats. Journal of Food Science and Technology, 21, 183–184.

Kirton, A.H. 1970. Body and carcass composition and meat quality of New Zealand feral goat (*Capra hircus*). New Zealand Journal of Agricultural Research, 13, 167.

Kumar, R., Kumar, A., Singh, H. 1980. Note on the effect of castration on meat production in goats. Indian Journal of Animal Science, 50, 1160–1162.

Ladipo, J.K. 1973. Body composition of male goats and characterization of their fat depots. Cornell University, Ithaca, NY, USA. PhD thesis.

Louca, A., Eccnomides, S., Hancock, J. 1977. Effect of castration on growth rate, feed conversion efficiency and carcass quality in Damascus goats. Animal Production, 24, 387–391.

Mishra, R.R. 1979. Cross-breeding of goats for milk production. In Sahni, K.L., Singh, R., ed., Proceedings of the Summer Institute on goat production. Central Institute for Research on Goats, Makhdoom, Mathura, India. pp. 61–68.

——— 1981. Exploitation of indigenous goat genetic resources for chevon production. In Basuthakur, A.K., Acharya, R.M., ed., In Proceedings of the 1st Society and National Seminar on Sheep and Goat Production and Utilization. Indian Society for Sheep and Goat Production, Jaipur, Rajasthan, India. pp. 122–129.

Nair, B.R.K. 1979. The Malabari goat. In Sahni, K.L., Singh, R., ed., Proceedings of the Summer Institute on goat production. Central Institute for Research on Goats, Makhdoom, Mathura, India. pp. 42–49.

Owen, J.E. 1975. The meat producing characteristics of indigenous Malawi goat. Tropical Science, 17, 123–128.

Owen, J.E., Norman, G.A., Fisher, I.L., Frost, R.A. 1977. Studies on the meat production characteristics of Botswana goats and sheep. 2. General body composition carcass measurements and joint composition. Meat Science, 1, 283–306.

Owen, J.E., Norman, G.A., Philbrooks, C.A., Jones, N.D. 1978. Studies on the meat production characteristics of Botswana goats and sheep. 3. Carcass tissue composition and distribution. Meat Science, 2, 59–74.

Pant, G.B., Saxena, V.S., Mishra, D.S., Sethi, M.S., Singh, S. 1974. Effect of age, sex, season and live weight on dressing percentage of goats. Journal of Food Science and Technology, 11, 290–292.

Parthasarathy, M., Singh, D., Rawal, P.S. 1984. Performance of feed lot kids on different dietary regimen. Indian Journal of Animal Science, 54, 130–131.

Prasad, V.S.S. 1985. Carcass evaluation. In Annual report of the All-India Coordinated Research Project on Goats for Meat. Division of Genetics and Breeding, Central Sheep and Wool Research Institute, Avikanagar, Rajasthan, India. pp. 22–35.

Reddy, T.J., Raghavan, G.V. 1988. Effect of plane of nutrition on growth and carcass composition of indigenous goats. Indian Veterinary Journal, in press.

Senger, O.P.S. 1978. Goat breeding and management for meat production. In Seminar on goat development in Asia. National Dairy Institute, Karnal, India.

Sidhar, H.C., Gangwar, P.C., Gill, G.S., Aroa, B.S. 1978. Effect of castration on growth rate in goats. Indian Veterinary Journal, 55, 767–770.

Singh, D.K., Nath, S., Singh, C.S.P., Verma, S.K., and Singh, S.K. 1985. Feed lot performance. In Terminal report of All-India Coordinated Research Project on Goats for Meat. Birsa Agricultural University, Ranchi, Bihar, India. pp. 91–106.

Singh, S.N., Senger, O.P. 1970. Investigation on milk and meat potentialities of Indian goats. Department of Animal Husbandry, and Dairy Technology, Raja Balwant Singh College, Bichpuri, Agra, India.

Srivastava, V.K., Raizada, B.C., Kulkarni, V.A. 1968. Carcass quality of Barbari and Jamunapari type goats. Indian Veterinary Journal, 45, 219–225.

Tulloh, N.M. 1963. The carcass composition of sheep, cattle and pigs as functions of body weight. In Symposium on carcass composition and appraisal of meat animals. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia.

Wilson, P.N. 1958. The effect of plane of nutrition on the growth and development of the East African dwarf goat. 2. Age changes in the carcass composition of female kids. Journal of Agricultural Science, 51, 4–21.