GOAT MEAT PRODUCTION POTENTIAL IN THE DEVELOPING COUNTRIES

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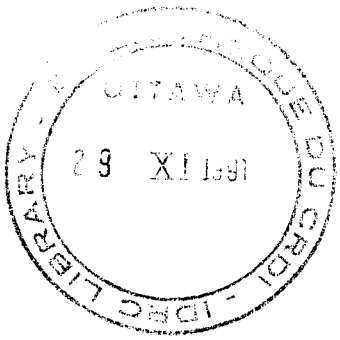

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ABSTRACT

Goat meat production in the developing countries is discussed with reference to the current level of production, production trends, types of production, factors affecting production, total edible and saleable percentages and by-products from slaughter. Goats in the developing countries currently produce about 93% of the total world production, and this production increases at about 3.3% annually. Three types of meat are produced : from kids (8-12 weeks), young goats (1-2 years) and old goats (3-6 years). A comprehensive review is presented on the factors affecting production : breed, age, sex and the environment of which variations in nutrition significantly influence carcass yield and quality, especially the muscle and fat content, and was further reflected in changes in chemical composition of the tissues. Total edible (meat plus some offal) and total saleable (meat plus all offal) percentages are important indices of commercial value, however, these do not appear to be used more widely. Several by-products from goats are important and include skins, intestines and blood. Skins are particularly sought after in the leather trade and produce a number of value-added products. Development strategies need to focus more fully on the whole meat production and post-production process involving both the producer and the consumer. Associated with these, there is a concurrent need to address consumer preferences and also post-production aspects of collection, handling, marketing, slaughter facilities and also identify these aspects with increased efficiency of growing meat goats in sustainable production systems in the developing countries.

I. INTRODUCTION

Goat meat production is the principal function of goats in the developing countries wherever there is a strong tradition for consumption of this meat (Devendra and Owen, 1983). Milk production is secondary to this function, even in situations where dual-purpose goats are used.

The meat is relished throughout the developing countries wherever goats are reared across various agro-ecological zones, and in some parts such as in Latin America, the Caribbean, Africa, South and South East Asia, it is even preferred over mutton and other meats. This preference is associated with a very high income of demand, reflected by very high price per unit of meat in the market, boosted by not only local demand but also export potential in Near East markets.

Goat meat production potential is therefore one of increasing importance in the developing countries. This potential is associated with several factors : demand for the meat in response to trends in real income and population growth, preference for lean meat, means of alleviating rural poverty, considerable market opportunities and possibilities of increasing the output of the meat and also by-products from slaughter through increased efficiency in the use of resources and systems of production.

The paper presents a comprehensive review of the current status of goat meat production in developing countries. In particular, it examines the more important factors concerned with potential possibilities of increasing the contribution of meat from goats in the developing countries, emphasises the importance of considering both production and post-production systems including all aspects of collection, transportation, marketing of goats and products and by-products from them, and the development of strategies that need to be sustained to achieve this objective.

II. GOAT MEAT PRODUCTION

Table 1 presents the distribution of the total world population of goats by region. Goats in the developing countries accounted for about 94% of the total world population, which is very sizeable. Between 1980 and 1989, the average annual rate of growth of the goat population was 1.1%, which is relatively high compared to buffaloes, cattle and sheep. Within the developing countries, the highest annual growth rates were found in Asia and the Far East, followed by Latin America.

The contribution of goats to meat production indicated that approximately 93% of the total output of goat meat was produced in the developing countries. Parallel to the high populations in Africa and Asia, these regions also produced about 62% of the total production of goat meat in the developing countries.

The table also provides an indication of the trends in meat and milk production by region within the developing countries. Asia had the highest growth rate in meat production of 3.6%, followed by Latin America of 1.5% and 1.4% in Africa. Overall goat meat production increased by 3.3% annually over the period 1980 to 1989.

TABLE 1. MEAT PRODUCTION FROM GOATS IN THE DEVELOPING COUNTRIES (FAO, 1989)

Region	Goat population (10^6)	Distribution (%)	Goat meat production (10^3 MT)	Contribution (%)	Growth rate (1980-1989, %)
Africa	147.0	29.7	531	24.2	1.4
Latin America	35.2	7.1	117	5.3	1.5
Near East	57.5	11.6	285	13.0	1.4
Asia and the Far East	172.4	34.8	838	38.2	3.6
Asian Centrally Planned Economies	82.9	16.8	424	19.3	0.6
Other developing countries	0.2	0.0	1	0.0	-
TOTAL DEVELOPING COUNTRIES	495.1	100.0	2196	100.0	3.3

\+ Represents 94.1% of the total world production of 562.4 x 10^6 MT of goat meat
++ Represents 92.9% of the total world production of 2365 x 10^3 MT of goat milk

Table 2 illustrates the relative importance of goat meat and milk compared to all meat and milk produced. It can be seen that in some countries like Ethiopia in Africa, Bangladesh and India in Asia, and Cyprus in the Near East, the contribution of goat meat is relatively high, of about 31-43% of the total meat produced. In the Near East region, milk production was relatively more important than in other regions, and in Cyprus and Greece, up to 25% of the milk came from goats. In Bangladesh, Somalia and Haiti, as much as 35-36% of milk produced came from goats. In Mexico, milk relative contribution of goat milk is higher than that of goat meat.

TABLE 2. THE RELATIVE IMPORTANCE OF GOATS FOR MEAT AND MILK PRODUCTION IN SELECTED DEVELOPING COUNTRIES
(FAO, 1988)

	As percentage of the total production of :	
Country	All meat*	All milk*
AFRICA :		
Africa	17.2	10.1
Ethiopia	42.9	49.7
Sudan	7.3	19.1
ASIA :		
Bangladesh	29.6	34.7
China	27.3	3.0
India	42.6	3.0
Indonesia	16.5	-
Nepal	9.6	6.2
CENTRAL AMERICA :		
Haiti	11.9	56.0
Mexico	2.9	4.1
SOUTH AMERICA :		
Brazil	1.0	0.7
Peru	5.9	2.2
Venezuela	3.8	-
NEAR EAST :		
Cyprus	30.8	20.0
Greece	21.7	24.8
Lebanon	14.3	24.4
Syria	5.4	6.1
Turkey	11.6	9.8

* From buffaloes, cattle, goats and sheep

III. GOAT MEAT PRODUCTION TRENDS

In view of the primary importance of goat meat, it is of further interest to s the real trends in terms of the percentage of carcass meat accounted for by goat me the per caput supply over the period 1978-1988 (Table 3). With the exception of Asi the situation in all the other three regions is that the contribution by goat meat on the decline. For the developing countries as a whole, the per caput supply of go meat is static.

Over the period 1961-65 and 1973-77, the growth of per caput consumption of go meat and mutton in 104 developing countries was 1.7% respectively. By comparison, t growth of per caput of goat milk was 1.2% (Sarma and Yeung, 1985).

With specific reference to goat meat, there exists inadequate rates production of this meat to meet the needs of human population growth. This continu situation is unfortunate and has six interrelated implications (Devendra, 1987) :

1) Inadequate supplies of goat meat have resulted in a trend towards t increased price of per unit of goat meat relative to all other meats. Th is reflected in many countries such as in the Association of South E Asian Nations (ASEAN) region (Devendra, 1979), also the Near E (Devendra, 1985) and elsewhere. In many parts of Asia, the prices of go have increased by about 10-12% annually. In South Thailand for examp goat meat is highly sought after and Saithanoo et al. (1985) have repor that this meat was 90, 26, 30 and 43% more expensive than the meats f buffalo, cattle, pigs and chicken.

2) There have been increased importance of feral goat notable from Austral New Zealand to markets in the Near East and the West Indies.

3) The high price of goat meat has encouraged unscrupulous substitution important mutton from poorer quality sheep.

4) Inadequate goat meat supplies have also resulted in the increased price live goats, including breeding animals.

5) The demand for goat meat has encouraged increased slaughter of breed animals with a consequent erosion of the base population in quantitat and qualitative terms.

6) The reduced availability of improved breeding animals has also resulte some countries to shift from goats to sheep production.

The last point merits more rigorous planning taking into consideration special attributes of goats, their particular abilities especially in situations wh feed is of very poor quality and their potential contribution to the rural poor. World Bank (1983) report based on an analysis of 80 research and/or development proje on a regional basis confirms that there is inadequate planning and investment on goa There is therefore a need for more concerted development of goats as an import component of the animal genetic resources and contribution to food production in future.

TABLE 3. THE PERCENTAGE OF THE INDIGENOUS PRODUCTION OF CARCASS MEAT ACCOUNTED FOR BY GOAT MEAT AND PER CAPUT SUPPLY IN 1977 AND 1988 IN SELECTED REGIONS (FAO, 1977; 1988)

Region	% of indigenous production[+]		Per caput goat meat supply (kg/yr)[++]	
	1977	1988	1977	1988
Africa	10.9	12.6	1.00	1.00
Latin America	0.7	0.7	0.11	0.11
Near East	12.0	6.4	0.62	0.40
Asia	8.0	10.6	0.15	0.22
Developing countries	3.9	3.7	0.18	0.18

[+] As percentage of beef and veal, mutton and lamb,goat meat, buffalo meat, pig and poultry meats

[++] Includes offal

Additionally, self-sufficiency ratios calculated on assumptions concerning population growth, trends in per capita income, income elasticity of demand and projected consumption of meat in 1990 and 2000 including detailed analyses of projected output and demand for all meats, suggests that the trend will be towards a widening gap between output and demand (Sarma and Yeung, 1985). Table 4 indicates that the self-sufficiency ratios for meat and milk are lowest in North Africa/Middle East and Sub-Sahara Africa. It has been suggested in this context that developing countries cannot afford to be complacent about declining goat meat supplies. Strategies must urgently be developed to increase the current level of production (Devendra, 1987).

Elasticity considerations which link the demand for goat meat to changes in income indicate that the income elasticity of demand is greater than unity (Amir, 1988). This, if personal incomes increase by 10%, the demand for goat meat will also increase by more than 10% in average. It has been suggested that with improved per capita incomes in the future, the demand for goat meat will further increase.

IV. TYPES OF MEAT PRODUCTION

Three types of meat are consumed in the developing countries (Devendra 1981) :

- o Meat from kids (8-12 weeks);
- o Meat from young goats (1-2 years) and
- o Meat from old goats (3-6 years).

Kid meat is a speciality common mainly in Latin America, the Caribbean, parts of Africa, and Southeast Asia. Kids are slaughtered at weights of 6-8 kg. Young goat is the most common type consumed and is the main topic of discussion in this paper. In terms of quality, the best young goat meat is produced at a live weight range of 11-25 kg, depending on breed and environment. Owen (1975), for example, in a study of goats slaughtered at 4-8, 9-14 and 15-24 months, reported that mature goats were superior to younger goats in meat production. Likewise, yearling (12-20 months) Angora goats produced chops and roats that were juicier and more tender ($P<0.05$) than those from 3- to 5- month-old kids (Smith et al., 1978). Goat meat is consumed in three forms: fresh, chilled, or frozen; fresh meat is by far the most popular.

TABLE 4. SELF-SUFFICIENCY RATIOS FOR LIVESTOCK PRODUCTS BY REGION, 1961-65 AND 1973-77 AVERAGES AND PROJECTIONS TO 1990 AND 2000 (Adapted from Sarma and Yeung, 1985)

Product/Period	Asia	North Africa/ Middle East	Sub-Saharan Africa	Latin America
Meat[+]				
1961-65	97	95	103	112
1973-7	94	89	103	108
1990	73	62	77	96
2000	61	52	57	91
Milk[++]				
1961-65	94	94	91	92
1973-77	93	87	82	92
1990	79	67	53	91
2000	71	57	38	96

[+] Includes beef, veal, buffalo meat, mutton and goat, pig and poultry meat.

[++] Includes cow, buffalo, goat, sheep, camel and milk products(expressed as whole milk equivalents)

V. FACTORS AFFECTING CARCASS YIELD AND QUALITY

Several factors affect the yield of goat meat as well as the quality. These indicate breed, age, sex and environmental factors. The latter exerts significant effects on carcass yield and quality and good evidence exists about this from numerous studies in several countries.

(i) Muscle

Growth includes two aspects: increase in mass per unit time and changes in form and composition resulting from differential growth of the component parts of the body (Fowler, 1968). The process of growth and the physiological factors governing it in young animals also apply to kids. This involves centripetal body growth and successive growth and development of the tissues: bones, muscle, and fat, in that order.

However, the tissue compositional characteristics are somewhat different in the kid. This refers particularly to water, lipid, and ash contents, which are lower than in lambs (Gaili, 1976).

The pattern of growth obviously varies with breed and environmental factors and is reflected, for example, in the adult body weight of selected breeds of meat goats with a live weight range of 11.2-24.6 kg at 12 months age (Devendra and Burns, 1983). These differences are a manifestation of adaption and function because of the plane of nutrition. Particular reference is made to the studies on the East African goat in Uganda (Wilson, 1985a,b, 1960); Katjang goats in Malaysia (Devendra, 1966); Barbari and Jamunapari goats (Sengar, 1975) and Osmanabadi goats (Gaffar and Biabani, 1986) in India; Boer goats in South Africa (Skinner, 1972); and Sudan Desert goats (Gaili, 1976). These studies, with the exception of those in India, have been recently reviewed by Devendra and Burns (1983).

The early classical work of Wilson (1958a,b, 1960) on the growth and development of kids from birth to slaughter indicated that the nutritional status had a considerable effect on live weight gain and external measurements. In kids weighing about 2.2 kg at birth, the greatest linear increase was shown by body length; least, by length of the lower hind leg. Sex differences were apparent for all the external measurements studied when the results were compared on the basis of equal age, male kids having significantly larger measurements than female kids. The effect of nutritional regime produced significant differences in all external measurements studied on the basis of equal age and equal weight, with low-plane kids having larger measurements than high-plane kids. A high plane of nutrition had a significant effect on growth rate: high-plane kids reaching 15 kg at approximately 20 weeks; low-plane kids reaching 15 kg after 48 weeks. The sex difference in live weight increased markedly after 16 weeks. Whereas the weekly growth of females slowed to approximately 0.2 kg/head, the males continued at the rate of approximately 0.5 kg/head. The kids showed a marked recuperative capacity when changed from low- to high-plane feeding,

indicating the significance of good feeding for growth, even at a later stage.

In comparative studies between goats and sheep, Owen et al. (1978) and Gaili and Ali (1985e) have reported that goats tend to have more carcass muscle and bone than sheep. Both studies also reported that the muscles of the neck, thorax, and forelimb regions of the goat were better developed than in sheep. However, the back and leg muscles were less developed in goat than in sheep. In all the muscles studied by Gaili and Ali (1985a), goats had significantly ($P<0.05$) thicker fibres than sheep; the differences between species were more marked in fattened animals compared with the control (Table 5). These results suggest clearly that goats respond more to nutritional treatment than do sheep, since the differences of the results between species were greater for goats than for sheep. Thus, for example, the differences for semitendinosus, longissimus thoracis et lumborum (thoracic part), and biceps brachii muscles in goats were 24.7, 26.6, and 19.5 um, respectively; the corresponding values in sheep were 9.1, 20.3, and 4.1 um. When the data for goats were expressed as a percentage of the corresponding fibre diameter of the control animals, the results were 65.3, 77.5, and 43.1% respectively; the corresponding values for sheep were 25.1, 62.4, and 9.6%. In both species, the longissimus thoracis et lumborum (thoracic part) increased most in fibre thickness and biceps brachii exhibited the lowest increase. Semi-tendinous was intermediate.

(ii) Fat

The effects of dietary energy and protein variables are particularly conspicuous on adipose tissue. Breed differences are apparent in the deposition of adipose tissue and perhaps even in the mobilization of the lipids depending on function (meat, milk, or dual purpose). Subcutaneous fat deposition is low and, in any case, occurs late in the growth process Visceral fat deposition such as renal and mesenteric fat follow later.

The content of adipose tissue is dictated principally by the plane of nutrition, especially the availability of dry matter (DM), level of feeding, and energy and protein contents. Generally speaking, the higher the availability of DM, energy and protein, the greater the process of growth and deposition of at. This is seen in the total content of the tissue in the carcass and its distribution, Wilson (1960) also demonstrated this point, including the fact that females contained more fat than males.

Between goats and sheep, species differences in the deposition of fat in terms of amount and location are evident. The comparative study of Gaili and Ali (1985a) involving control and fattened animals showed that sheep has less developed omental and mesenteric fat depots than goats because of an increased response by the latter of deposit fat in these locations.

In all the muscles studied, goats had significantly ($P<0.05$) thicker than sheep; the differences between species were more marked in fattened animals compared to the control (Table 5). The results also suggested that goats respond more to nutritional treatment than do sheep.

The extent of fat deposition is controlled principally by the plane of nutrition, a poor covering of fat on the carcass is a reflection of inadequate dietary nutrients. This was evident, for example, in the quality of goats slaughtered for meat to serve Madras city in India. The animals came from rural areas with a background of poor nutrition in which no supplements were provided (Thulasi and Ayyaluswami, 1983). Live goats and sheep from India were preferred in Saudi Arabia for their lean and tender meat as compared with sheep from Australia, presumably on account of the lesser fat content in the carcasses of the former (IIFT, 1978). Likewise, Gaili and Ali, (1985a) reported a poor deposition of subcutaneous fat in Sudan Desert goats and sheep, which they attributed to the arid environment. It is pertinent to note that there is one practical implication of carcasses with a low content of subcutaneous fat. The evaporative losses could be higher and this must be minimized by better packing and storage of the meat.

TABLE 5. MEAN FIBRE DIAMETER (UM) OF THREE MUSCLES FROM CONTROL AND FATTENED SUDAN DESSERT GOATS AND SHEEP
(Gaili and Ali, 1985b)

	Sheep		Goats		
Muscle	Control	Fattened	Control	Fattened	SE[+]
Semi-tendinosus	35.8	44.9	37.8	62.5	0.96[+]
Longissimus (lumbar)	32.5	52.8	34.3	60.9	0.62[++]
Biceps brachii	41.7	45.8	45.2	64.7	0.79[++]

[+] Standard error of the difference between two means.
[++] Row means differ significantly ($P < 0.05$).

The specific effects of varying nutrition regimes of two breeds of goats is reflected in a long term study in India. Growth was retarded and significantly low ($P<0.05$) with low levels of energy and protein and manifested in reduced live weight at slaughter, dressed carcass weight, dressing percentage, edible offal as

percentage of empty live weight (Table 6), and bone, muscle and fat composition, especially in the Barbari goats. The effect of the protein and energy variables on length and depth of the eye muscle, back-fat thickness, and thickness of fat cover on ribs, however, was not significant. Similar results on the carcass characteristics of Osmanabadi bucks have been reported by Gaffar and Biabani, (1986). In Mauritius, diets based on sugarcane, sugarcane tops, and leucaena significantly influenced carcass tissues (bone, $P<0.01$; meat, $P<0.01$; fat, $P<0.05$; tendon, $P<0.001$) in local and Anglo-Nubian goats (Jotee, 1984).

Table 6. THE EFFECT OF PLANE OF NUTRITION ON CARCASS CHARACTERISTICS OF BARBARI AND JAMUNAPARI BUCKS SLAUGHTERED AT 24 MONTHS IN INDIA (Adapted from Sengar, 1975)

Characteristics	Plane of nutrition[+] HH	MM	LL	Significance[++]
	Barbari			
Live weight at slaughter (kg)	18.7	19.4	11.4	$P < 0.05$
Dressed carcass (%) weight (kg)	9.2	9.7	4.5	$P < 0.05$
Dressing (%)[+++]	57.3	58.3	53.7	$P < 0.05$
Edible offal (%)[+++]	21.4	20.0	20.6	$P < 0.05$
	Jamunapari			
Live weight at slaughter (kg)	20.3	21.0	15.8	$P < 0.05$
Dressed carcass (%) weight (kg)	9.7	9.8	6.1	$P < 0.05$
Dressing (%)[+++]	53.2	53.2	55.5	NS
Edible offal (%)[+++]	18.9	20.1	22.9	-

[+]HH, high energy, high protein; MM, medium energy, medium protein; LL, low energy, low protein.
[++]NS, not statically significant
[+++]Expressed as percent of empty live weight

VI. EFFECT OF NUTRITION ON CHEMICAL COMPOSITION

Nutritional treatment has a definite effect on the chemical of tissues, notable the protein, fat, and ash contents on Barbari and Jamunapari goats. Gaffar and Biabani (1986) showed that a high dietary energy significantly increased ($P<0.01$) the fat content, daily energy gain, and total energy deposited in the carcasses of Osmanabadi bucks (Table 7). These results are similar to the situation in Barbari goats (Sengar 1975) and sheep (Andrews and Orskov 1970; Ali 1975). Gaili and Ali (1985b) showed that nutritional treatment and species had a significant ($P<0.01$) effect on the protein, fat, and ash contents of the muscles of goat and sheep. The effect of the nutritional treatment species interaction was significant ($P<0.01$) in all muscles for protein and fat but not for ash.

Osmanabadi bucks yielded more protein in the supraspinatus muscle than did sheep. In both the semimembranosus and the longissimus thoracis et lumborum (lumbar part) muscles, control or fattened goats had more protein than both groups of sheep (Table 7). More recently, varying delay protein intakes were shown to have no effect on the carcass performance of Tanzanian goats, however, concentrate supplement significantly gave higher dressing percentages, kidney and gut fat (Mtenga and Kitaly, 1990)

TABLE 7. EFFECT OF DIETARY PROTEIN AND ENERGY VARIABLES ON THE BODY COMPOSITION ABD NUTRIENT DEPOSITION IN OSMANABADI BUCKS IN INDIA (Adapted from Gafar and Biabani, 1986)

Treatment	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Gross energy (Mcal/kg)	Total protein deposited (kg)	Total energy deposited (Mcal)	Daily protein gain (g)	Daily energy gain (kcal)
Control	74.1	16.3	4.0	3.4	3.92	1.0	6.35	-	-
LP: LE	67.1	18.8	7.8	4.5	4.78	4.1	34.45	9.7	88.91
LP: ME	66.3	18.7	9.0	4.9	5.09	3.8	34.48	9.7	89.80
LP: HE	62.8	12.7	10.0	2.5	5.38	4.2	41.69	10.0	112.71
HP: LE	65.9	19.6	7.6	4.8	4.68	4.1	33.17	13.3	116.76
HP: ME	65.2	19.9	8.5	5.0	5.49	4.4	41.99	12.3	130.85
HP: HE	61.1	19.6	12.4	5.1	5.93	4.1	48.49	14.5	195.98
SE[++]	1.49	3.85	0.95	0.93	0.33	0.06[**]	1.39[*]	0.35	6.34[*]

Note : 1 cal = 4.19 J.

[+] LP : LE, low protein, low energy; LP:ME, low protein, medium energy; LP:HE, low protein, high energy; HP:LE, high protein, low energy; HP:ME, high protein, medium energy; HP:HE, high protein, high energy.

[++] Standard error: [*], $P < 0.05$; [**], $P < 0.01$

VII. EFFECT OF MANAGEMENT NUTRITIONAL VALUE

Management factors do significantly affect the quantity and quality of meat produced. In India, Kansal et al. (1982) studied the effects of different methods of castration and vasectomy on the proximate composition and eating quality (palatability) of Alpine x Beetal bucks between 2 and 6 months of age (Table 8). The moisture content of the meat of intact goats was 76.4%. This decreased significantly ($P<0.01$) in animals whose testes were removed at the age of 6 months. No significant differences were found in vasectomization at 2, 4, or 6 months, castration by burdizzo at 2 or 4 months, or testes removal at 2 months (Table 8). These results differ from those of Bailargeon et al. (1971), who observed that the mutton from intact lambs contained more water than that from lambs castrated by burdizzo.

Differences in protein content were statically significant only in the cases of goats vasectomized at 4 or 6 months ($P<0.05$) and in those castrated by burdizzo at 2 months ($P<0.01$) (Table 7). Similarly, a slightly lower level of protein than in intact animals has been reported in sheep castrated by testes removal or by stopping blood supply to the testes (Bailargeon et al., 1971).

The intramuscular fat in intact goats was less than that in goats vasectomized, castrated by burdizzo, or with testes removed. The increase in intramuscular fat was statistically significant ($P<0.01$) in goats vasectomized at 2, 4 or 6 months, castrated by burdizzo at 2 months, or with testes removed at 6 months (Table 8). In Botswana, Owen et al. (1978) found that castrated goats had a higher proportion of both dissectable and total fat in the carcass.

The eating quality or palatability of the meat is associated with tenderness, juiciness, flavour, and aroma. Kansal et al. (1982) undertook a sensory evaluation of Alpine x Beetal meat using a 1-9 scoring scale and reported that there were no differences in tenderness, flavour, or juiciness between intact goats and those castrated by burdizzo, with testes removed, or vasectomized. Similar results were obtained for mutton by Bailargeon et at. (1971). Smith et al. (1974), however, reported that goat meat was less tender than lamb, beef, and pork but compared favourably with beef and pork in juiciness. Kansal et al. (1982) also found that goats castrated by burdizzo at 2 or 4 months had significantly more pepsin- and trypsin-digestible proteins than intact goats (Table 8).

TABLE 8. EFFECTS OF DIFFERENT METHODS OF CASTRATION ON MOISTURE, PROTEIN AND FAT CONTENTS OF MUSCLES AND IN VITRO DIGESTIBILITY OF MEAT PROTEIN OF ALPHINE X BEETAL BUCKS IN INDIA (Kansal et al., 1982)

Method	Age[+]	Moisture (%)	Fat (%)	Protein (%)	Pepsin digestion (%)	Trypsin digestion (%)
Burdizzo	2	75.7	2.6*	19.6***	26.2**	46.3**
	4	76.7	1.3	20.6	28.4**	49.9*
Testes removal	2	76.2	1.6	20.7	22.5	37.1
	6	73.2**	2.5**	21.3	37.1	37.1
Vasectomy	2	75.5	2.4	20.6	19.5	33.2
	4	75.4	1.9**	20.0*	23.3*	41.8
	6	75.9	2.5**	20.1*	16.5	37.1
Intact control		76.4	1.3	21.7	16.7	34.2

[+] Age in months

Note: Values are the means of 14 determinations. *, $P < 0.05$; **, $P < 0.01$

VIII. TOTAL EDIBLE AND SALEABLE PERCENTAGE

The total edible (meat and some offal) and commercially valuable (meat and offal) portions of the carcass are important aspects of the economic value of goats for meat production (Devendra and Owen 1983). They are important indices of value throughout the tropics (Table 9). The total edible portions include the offal, which are valuable for two reasons. First, they are extensively consumed in varying ways. Second, the value of the offal offsets the cost of slaughter.

In most developing countries, the value of meat animals is reflected in the commercial value of the carcass and the cuts that comprise it. The latter refers primarily to the edible components. With reference to goats, the traditional reference to only the carcass and its components is not entirely realistic because, as Table 9 suggests, there are other noncarcass components that are important for edible and commercial reasons. Total fat, for example, is a function of nutritional treatment in terms of the extent of fat deposition, especially in the viscera, and is important in estimations of total edible and total saleable percentages. It is suggested that, so far as goats are concerned, nutritional treatment and growth responses in economic and commercial terms must consider the carcass as well as the total saleable value, including noncarcass components as units of trade.

Age has a marked effect on carcass composition and on total edible and saleable percentages. In the study of Wilson (1985b), female East African goats were killed at birth and at weights of 4.1, 7.3, 11.3, and 13.6 kg; the carcasses were then evaluated. Since the economic value of the African goat keeper is its meat, edible offal, edible fat, and skin, the dissection data were grouped to show how these components varied with changed in live weight. The proportion of meat in the live animal increased from 24.5 to 37.5% between birth and 4.1 kg; thereafter, the proportion of meat decreased irregularly to 34.9 at 13.6 kg live weight. The proportion of edible offal fell from 6.4% of the total live weight at birth to 4.8% at 13.6 kg. Edible fat increased from 2.6% at birth to a maximum of 11.3 kg and fell to 8.6% at 15 kg live weight. The proportion of skin fell from 12.4% at birth to 7.2% at 13.6 kg.

TABLE 9. TOTAL EDIBLE AND TOTAL COMMERCIALLY VALUABLE MEATS OF VARIOUS BREEDS OF ADULT GOATS IN THE TROPICS

Breed (sex)[+]	Location	Total edible (%)	Total commercially valuable (%)	Source
Small East African (F)	Uganda	48.3	55.5	Wilson (1958b)
Katjang (F)	Malaysia	61.2	81.5	Devendra (1966)
Indigenous (M)	Malawi	74.5	80.5	Owen (1975)
Barbari (M)	India	87.6	-	Sengar (1975)
Indigenous (M)	Botswana	72.3	79.6	Owen et al. (1978)
Indigenous (M)[++]	Botswana	71.8	79.2	Owen et al (1978)
Indigenous (F)	Botswana	74.3	80.9	Owen et al. (1978)
Boer(F)	Botswana	70.0	78.0	Owen et al. (1978)
Katjang(F)	Malaysia	71.5	96.2	Devendra (1980)

[+] F, female; M, male
[++]Male castrates.

IX. BY-PRODUCTS FROM GOATS

The production of goat meat concurrently produces a variety of by-products during the slaughter process. Presently a good deal of this is wasted and/or underutilised and can be put to more effective use in the future.

The major products from the slaughter of goats are skins, intestines and blood. The skins are used extensively in the production of a variety of leathers, value added and consumer products. The intensives are used in edible products and sausage casings.

Table 10 sets out the extent of the by-products produced from the slaughter of the goats in three locations in Botswana, Sudan and Thailand. When translated into actual value, the revenue generated is very significant, especially in those countries where there exists high populations of goats.

Skins, intestines and blood are the major by-products and account for about 15-20% of live weight. In India, the value of good skins is considerable and about 60% of the total production is exported, and of this 95% of the total export earnings represented finished leathers and products (Seshagiri Rao, 1988). It is significant to note that the value added for raw goat skins is about 500 per cent.

Table 10. PRODUCTS FROM THE SLAUGHTER OF GOATS (APPROX. % OF LIVE WEIGHT)

Component	Owen et al. (1977) (Botswana)		Babiker et al. (1985) (Sudan Desert)+		Pralomkorn et al. (1991)++ (Thai native)	(50% A.Nubian)
	Kid	Adult	Entire	Castrate	Doe	Doe
Carcass	43.3	48.3	45.8	47.6	60.1	43.4
Blood	3.7	2.8	-	-	2.5	4.9
Skin	7.3	6.6	7.3	7.0	9.2	8.9
Head	6.3	5.3	8.4	8.7	6.2	7.5
Liver	1.6	1.6	2.2	2.1	1.6	1.7
Heart	0.4	0.2	0.5	0.5	0.3	0.4
Spleen	-	-	0.3	0.2	0.2	0.2
Kidneys (two)	-	-	0.4	0.5	0.3	0.3
Lungs and trachea	1.3	1.2	2.4	2.4	0.8	0.8
Intestines + contents	-	-	-	-	5.9	6.1
Stomach contents	-	-	-	-	11.9	12.5
Digestive tract	11.4+++	11.5+++	9.5	10.2	-	-
Head	-	-	-	-	6.2	7.5
Feet	-	-	-	-	2.1	2.1
Tract contents	16.1	13.7	-	-	-	-

+ Values are calculated on an empty body weight basis

++ Values are calculated on a fasting body weight basis

+++ Including spleen and pancreas

X. POST-PRODUCTION ASPECTS

The value of efficient systems to produce goat meat is futile, if this is not matched with distinct links with post-production systems in which there is organised collection, transportation and marketing of goats, to include products and by-products from them. These aspects are generally very neglected throughout the developing countries resulting in several severe implications:-

(i) Reduced revenue to farmers. Observations in several countries in Asia suggest that farmers generally receive 55-60% of the total value of the animal, the remaining 40-45% going to middlemen and or butchers whose total effort in terms of production process time is about 1-2 days.

(ii) Reduced revenue from the sale of animals as well as their products. These involve the meat, skins, by-products and derivation of value added products from skins. Recent studies in India indicate that goats transported for over 400 km for 15-38 hours indicated weight losses were 9-10%, which in quantitative terms is quite high. This data excludes losses also due to the effects on poorer quality products, by-products and also herd wastage (Naidu et al., 1991).

(iii) The quality of the animals slaughtered specifically for goat meat production is doubtful. In several countries, animals from unknown background and production systems with no reference to consumer preferences are slaughtered at random. The majority of animals sold (70-80%) are 1-2 years old.

(iv) Where goat meat demand and consumption is widespread, and organised programmes are not in place, there is serious erosion of the breeding population in which increasingly younger animals are slaughtered. The net effect is reduced output of goat meat. Surveys in two states in India indicated that between 50-73% of the goats slaughtered were below six months of age, and 26-50% of 6-12 months of age (Naidu et al., 1991).

The sale process and price paid for goats is very variable as also the methods of collection and transportation. Invariably, the price paid by the middleman is arbitrary and subjective and is associated with apparent size, age, sex, castration, constitution and value of skins. Probably because of size, males generally fetch higher prices than females. Animals in poor constitution receive the lowest prices. Slaughter methods are generally appalling in most countries, especially in rural areas, and so also the use of the by-products. All these components of the post-production systems merit urgent considerable research and development attention.

XI. DEVELOPMENT STRATEGIES

Development strategies that are geared towards increasing the production of goat meat and the overall contribution from goats needs necessarily to consider the whole production and post-production process. This means establishing defined links between producer and the consumer to include collection, handling, marketing and processing.

The following issues are relevant :

(i) Production

- o Quantity - Total amount of lean meat in the carcass (measured by live weight at slaughter)
- o Quality - Quantity and distribution of the fat (excess undesirable).

The quantity of meat produced is directly related to age at first meeting, fertility, kidding frequency, productive life span and annual mortality.

This phase assumes efficiency at levels of meat production involving the appropriate use of resources and their cost-effectiveness. In particular, it is especially important to maintain very good management of the animals in order that animals are well grown and also of good quality. In this task, efficient nutrition management exerts a very high influence on the quality of the animals produced. In turn, this effort makes the post-production phase more relevant in order to ensure that production matches the needs of consumers.

(ii) Post-production

- o Collection - methods of collection including transportation are important and affect slaughter weight.
- o Handling - includes mode, duration of transportation, and management during it.
- o Marketing - distinct presence and its capacity. What are its requirements
- o Slaughter facilities - size, adequacy, hygiene, strategic location, and methods to salvage by-products.
- o Consumer requirements- nature, extent and characteristics. Are the trends changing?

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