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SUSTAINABLE SMALL RUMINANT PRODUCTION SYSTEMS IN ASIA

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ABSTRACT

Sustainable small ruminant production systems are discussed in the context of the meaning of sustainability, diversity of goat and sheep genetic resources, products and services from both species, advantages and disadvantages of small ruminants, current research thrusts, and development imperatives. Small ruminant production systems are of four categories: (i) rural landless systems, (ii) extensive systems; (iii) systems combining arable cropping (roadside, communal and arable grazing systems, tethering, and cut-and-carry feeding); and (iv) systems integrated with tree cropping. Among these, integrated systems involving tree crops are neglected and underestimated and have much potential. Current research thrusts, based on an extensive review of the literature and trends, indicate that emphasis is given to feeding and nutrition, breeding and genetics and animal health. Much of the research relates to evaluation and assessment of component technology, have a strong commodity focus, and is undertaken mainly at the experiment station or university levels. Crossbreeding is rampant especially in India and China, and increasingly in South East Asia, but the precise objectives and reasons for it are often not clear. The development imperatives need to give increased attention to clear production objectives, choice of species and use of available breeds, increased numbers, strategy for feed utilisation, production – post – production and consumption systems, and marketing involving rural, urban and international markets. These and other aspects present major challenges and opportunities for the development in the future of sustainable small ruminant production systems in Asia.

Key words: Small Ruminants, Sustainability, Production Systems, Research Thrusts, Development Imperatives, Asia

INTRODUCTION

Throughout the Asian region, goats and sheep or small ruminants are important animals for a variety of reasons. They are owned and reared by farmers, and especially the resource-poor. They are variously integrated into the farming systems in all countries without exception. Yet the fact remains that both species are not being adequately exploited to the fullest extent to maximise their contribution. Their development in most countries is being limited by lower priority, inadequate resource use, investments, clear production targets, and technology application at the farm level. Consequently, their current contribution is not commensurate with their potential importance and capacity, and provides major opportunities to redress the situation.

The justification for enhancing increased small ruminant production is directly linked with the need for more animal proteins, and the search for efficiency in the management of natural resources. This is necessary in a region that is buffeted by a rapidly changing external environment with such factors as rapid population growth, urbanisation, increased incomes, demand-led processes, changing consumer preferences for foods of animal origin, and zoonosis. These factors place unprecedented pressures on prevailing small ruminant production systems. The projected total meat and milk human consumption levels in 2020 are far in excess of anticipated supplies and place unprecedented pressure on the management of the natural resources (land, water, crops and animals), and provide major challenges for increasing productivity from animals(Devendra, 2004a). The contribution by components of the animal industries, and more importantly, the efficiency of individual animal production systems is being challenged and is therefore very compelling. The question that is being asked concerns the capacity of the systems to match the projected needs and, more importantly, the opportunities for improving and significantly increasing the productivity from animals in the future.

This paper focuses on the significance of sustainability, management and use of the production resources, prevailing small ruminant production systems and trends, issues relevant to improved production systems, and discusses potential opportunities for enhancing the current level of contribution in the future.

SUSTAINABILITY

It is useful to keep in perspective the meaning of sustainability and its relevance to production systems and agriculture. There are several definitions of sustainability, such as TAC (1989) and Chantalakhana and Skunmun (2002). The most widely used one is that from TAC (1989):

" *Sustainable agriculture should involve the successful management of resources for agriculture to* satisfy *changing human needs while maintaining or enhancing the quality of the* environment *and conserving natural resources* ".

More recently, **the** Millennium Ecosystem Assessment (2005) has given the following definition for sustainability: "A *characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or population in other locations to meet their needs.* "

The concept of agricultural sustainability initially focused on environmental aspects, but has now been expanded to include broader socio-economic and political elements. : -

Ecological: focus on environmental protection to enhance ecosystem resources and preservation of biodiversity

Socio – economic: concerns the value and management of the natural resources, their enhancement, socially acceptable technological improvements, farmers` organisations and cooperatives, and improved livelihoods of poor farmers.

Figure 1 illustrates a conceptual framework for sustainable ruminant production systems .Given the agro-ecological zones, small farm systems, bio-physical and socio-

economic environment, the major targets for development are efficiency in the management of the natural resources, income growth, poverty alleviation, food security, economic viability, minimum dependence on external non- renewable inputs, response to changing consumer preferences, rural growth, and self- reliance. The key sustainability issues are environmental protection, knowledge of traditional systems, preservation of biodiversity, maintenance of soil fertility, increased access to markets, socially acceptable improvements, wide adoption of improved technologies, farmers' organisations and cooperatives, and replicability.

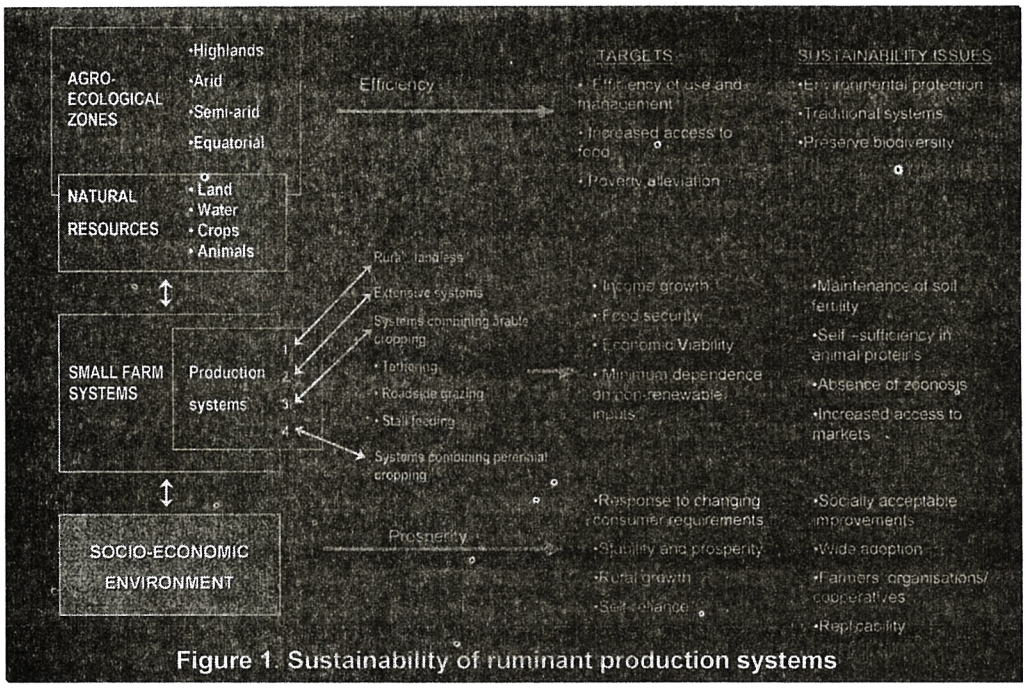

Figure 1. Sustainability of ruminant production systems

GOAT AND SHEEP PRODUCTS AND SERVICES

Goats and sheep provide a number of products and services of value to man. In a socio-economic context, these are often overlooked and underestimated, with the result that they are not considered in development programmes. The contributions of both species especially to food production, the socio-economic well being and stability of poor farm households, and a variety of services are especially significant (Table 1) In these circumstances, the value of the species increases with decreasing quality of available feeds and also the environment (Devendra, 2002).

DIVERSITY OF GOAT AND SHEEP GENETIC RESOURCES

The size and extent of the goat and sheep genetic resources in Asia is considerable. Table 2 presents the size of the goat and sheep populations in Asia. The size of individual populations are considerable, with goats and sheep accounting for 95.7% and 63.3% of the total world population, and 26.2% and 26.5% as percentage of the total number of grazing ruminants (buffaloes, cattle, goats and sheep) in the developing countries. Asia has the largest population of goats (64 % of world population), within which the largest populations were found in India (35.2%), China (29.3%) and Pakistan (12.0%). These countries together accounted for about 84% of the population of goats in Asia. FAO data indicates that there exist 570 breeds, of which

146 are found in Asia. By comparison, the largest populations of sheep are found in China (43.7%), India (17.8%) and Pakistan (11.0%). China, India and Pakistan together accounted for about 72% of the total population of sheep in Asia. There exists an estimated 920 breeds of sheep. The annual growth rates of goats and sheep were 2.7 % and 2.4 % respectively.

Table 1. Goat and sheep products and services in Asia (Devendra, 2006a)

Products	Services
Meat (raw, cooked, blood, soup, goat meat extract - " Zeungtang " in Korea)	Cash income and investment
Milk (fresh, sour, yoghurt, butter, cheeses)	Security and insurance
Skins (clothes, shoes, water/grain containers, tents,	Prestige in ownership
handicraft ,shadow play in Indonesia,thongs etc.)	Gifts and loans
Hair (cashmere, mohair, garments , coarse hair	Religious rituals eg. Sacrificial slaughter
rugs, tents, ropes, wigs, fish lures)	Human nutrition – characteristics of meat and milk
Horns	Pack transport and draught power
Bones (handicraft)	Draught power
Manure and urine (crops, fish)	Medicine
	Control of bush encroachment
	Guiding sheep

With goats: Total edible proportion: 61 %
Total saleable proportion: 82 %.

Table 2. Goat and sheep genetic resources in the Asia (FAOSTAT, 2005).

Characteristic	Goats	Sheep
Population (10^6)	519.3	456.6
Percent of world population (%)	64.3	42.3
Annual growth rate (%)++	2.7	2.4
Number of breeds +	146	233
Percent of all breeds (%)	26	18
As % of all grazing ruminants (%)	36.1	22.3
Carcass weight (kg / head)	12-13	14-16

+ 66% of the goat breeds and 57% of the sheep breeds are found in China, India and Pakistan.
++ For 2001-2005

Corresponding to the relative populations of goats and sheep, the volume of goat meat produced is higher than that of sheep. Current levels of goat meat and mutton and lamb production are 94.6% and 57.9% of the total world output respectively. These data reflects the relative importance of the species, but is also associated with species differences in fertility, income elasticity of demand for goat meat, and value to poor people throughout the developing countries.

Native goats are also found in Taiwan, Korea, Japan and many parts of China. Two common features about these goats are that they are predominantly black and are meat breeds with an adult live weight range of between 25-30 kg. In more recent years, there have been crossbreeding with imported Saanen goats, resulting in white colours as well. It is possible that all the goats bordering the South China Sea belong to one breed group, the dispersal of which has occurred through trade routes from west Asia. Goat husbandry culture is considered to have been dispersed along two routes (Devendra and Nozawa, 1976): -

1) One from Iran, Afghanistan and Turkistan to Mongolia and northern China along the "silk road ", and,
2) The second was via the Indian sub-continent through the Khyber Pass

The native goats in the western side of Taiwan are descendents of native goats in the Guandong Provice of China which were brought by Chinese immigrants since the 17th century. These goats resemble the Katjang goat, suggesting a common ancestry. In Japan similar goats are found in the islands of Okinawa, Amami and Tokara archipelagoes, due to various introductions. In Korea, it has been suggested that the goats were introduced across the Yellow Sea from eastern China around the 14th century.

One aspect about the diversity of goats is the presence in many countries in Asia. of 'improver breeds', that is , those breeds that have such important traits as meat, milk, fibre or skins producing capacity, and are therefore potentially important for enhancing goat production (Devendra and Burns ,1983). There exist in this context at least 19 such breeds in Asia (table 3), and include such breeds as Ma`tou (meat) from China; Katjang (meat) from Indonesia ; Jamnapari , Sirohi (for meat) from India; Brabari, Beetal and Malabar (milk) from India; Damani. Dera Din Panah , Kamori (milk) from Pakistan ; Bac Thao (milk) from Vietnam ; Black Bengal (prolificacy and skins) ; and Kashmri (fibre) from India. Not enough is being made of these breeds within –country, and good possibilities also exist to use them in other countries with similar climates, recognizing that there are disease issues that must be settled.

Table 3 . Potentially important "Improver goat breeds" in Asia (adapted from Devendra and Burns, 1983)

Speciality	Breeds	Country of Origin
Meat	Chengdu brown	China; temperate
	Fijian	Fiji; tropical, humid
	Katjang	Indonesia; tropical, humid
	Korean native Black	Korea; temperate
	Ma `tou	China; sub-tropical, humid
	Sirohi	India; tropical, dry
Milk	South China Black	China; sub-tropical , humid
	Bach Thao	Vietnam; tropical , humid
	Barbari	India; tropical, dry
	Beetal	India; tropical, dry
	Dera Din Panah	Pakistan; tropical, dry
	Jamnapari	India; tropical, dry
	Kamori	Pakistan; tropical, dry
	Malabar	India; tropical, humid
Prolificacy	Barbari	India; tropical, dry
	Black Bengal	India; tropical, dry
Pashmina (cashmere)	Malabar	India; tropical, dry
Skins	Ma `tou	China; sub-tropical, humid
	Kashmiri	C. Asia; high mountains, cold
	Lioning	China; temperate
	Mongolian	Mongolia; temperate
	Black Bengal	India; tropical, dry
	Quinshang	China; temperate

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ADVANTAGES AND DISADVANTAGES OF SMALL RUMINANTS

It is appropriate to keep in perspective. The advantages and disadvantages of small ruminants (Devendra, 1987; Devendra, 2004) are as follows:-

(i) **Adaptation and environment**

Advantages

- Generally wide adaptation to most environments
- Suitability to small farm systems
- Less effected by droughts, with no after effects on reproduction
- Use browse and feeds more effectively
- Use marginal land effectively
- Are well suited for integration into perennial tree crop systems
- Major source of survival and assets for the land less and very poor
- Food and nutritional security
- Promote social values (village cohesiveness and recreation)
- Trypanotolerance and helminth disease resistance.

Disadvantages

- Need for controlled management to prevent environmental damage
- More numbers needed to meet household/community/national needs.

(ii) **Small size**

Advantages

- Easy management
- Low production inputs and capital investment
- Low risk
- With meat, high proportion of total edible and saleable products.
- No storage requirements for meat and milk.

Disadvantages

- More easily stolen
- Susceptible to predators.

(iii) **Production and products**

Advantages

- Produce meat, milk, fibre and skins, and also provide draught power in mountain areas
- Utilise non-marketable crop residues and available grazing to generate value-added products such as meat, milk, fibre and skins
- Dung and urine promote soil fertility especially in the semi-arid and arid areas
- Promote effective use of unpaid family labour, with concurrent low labour requirements
- Provide ready means to consume meat and milk, without need for storage
- Skins are a growing source of value-added income
- Production systems provide considerable opportunities to accelerate research and development efforts.

Disadvantages

- Breeding programmes are difficult to control in more extensive systems
- Susceptibility to disease, with poor access to services
- Poor overall resource allocation for research and development.

SMALL RUMINANT PRODUCTION SYSTEMS

Small ruminant production systems, there are of four categories: (i) rural landless systems, (ii) extensive systems; (iii) systems combining arable cropping (roadside, communal and arable grazing systems, tethering, and cut-and-carry feeding); and (iv) systems integrated with tree cropping. Of the four systems, the first three are by far the most common. The fourth is generally neglected, but potentially very important.

Rural landless production systems involve a variety of mitigating practices to overcome the constraints of harsh environments, namely high temperatures, inadequate water, droughts, and chronic feeds shortages (Devendra, 2006b). These systems are extensive, and are associated with resource-poor nomads, transhumants or agricultural labourers and seasonal migrations with small ruminants, cattle and camels (Devendra 1999a; 1999b).

They are very common in the arid and semi-arid regions notably Pakistan and India, and also in the Hindu-Kush Himalayan region in South Asia. The movements are annual cycles that are triggered by reduced feed and water supplies, and market opportunities. They are also a way of life for the poor. Two common problems are overgrazing and environmental degradation due to "slash and burn "for agriculture.

In India, the migrating flocks of goats and sheep are often used overnight to fertilise crop land, and crop farmers pay relatively high prices or give cereals in return for their service. In northern India, this means for example, 2000-3000 goats and sheep folded on 0.2 ha of land costing 1 US$ per 100 animals per night or 60-80 kg of grain in return (Devendra ,1999b). In many parts of China, landless rural households often keep poultry and pigs for home consumption and also sale. Similarly, in the rice growing countries in South East Asia and East Asia, landless farmers produce ducks and sell these after feeding on fallen grains and also weeds after the rice harvest.

Among the production systems, integrated systems involving tree crops are generally neglected and underestimated. The decreased availability of arable land in many areas and the need for more food from animals could encourage further integration of ruminants with tree crops in the upland areas. The development and intensification of potentially important integrated ruminants – tree crops or silvopastoral systems is a realistic objective, given the extent of farmer experience, the periodic collapse of world prices for plantation commodities, the projected demands for animal products in the future, and the advances that have already been made in Asia. The potential importance of integration with oil palm (Devendra, 2004b), and more importantly, the opportunities for further expansion of this system has recently been reviewed (Devendra, 2005).

New technologies to intensify production and better scientific guidelines for managing the components of silvo-pastoral systems are now available that can lead to higher farm incomes and a more protected environment. Future development of these integrated systems will require policy support concerning land use and also to encourage the introduction of ruminants and to increase total factor productivity.

Table 4 summarises examples of significant economic benefits from 14 case studies concerned with integrating various ruminants in six countries in Asia. The economic benefitrs include increased animal productivity, crop yields, and total farm income.

The prevailing production systems are unlikely to change in the foreseeable future (Mahadevan and Devendra, 1985; Devendra; 1999). New proposed systems and returns from them would have to be demonstrably superior and supported by massive capital and other resources. There will however, be increasing intensification and a shift within systems, especially from extensive to systems combining arable cropping, induced by population growth. The principal aim should therefore be improved feeding and nutrition, maximum use of the available feed resources, notably crop residues and low quality roughages, and various leguminous forages as supplements.

CURRENT RESEARCH THRUSTS

Research and development programmes are largely focused on the main commodities from both species, namely meat, milk and fibre. Most of these programmes are concerned with the first two, but limited research exists on pashmina fibre and wool from sheep in India and Pakistan. Research and development of skins is even more limited, but some useful work has been made at the Central Leather Research Institute in India.

An assessment of current research thrusts on small ruminants in the Asian region have a number of features about them that are worthy of mention (Devendra, 2006b). These are as follows:-

- There is a strong commodity focus, with emphasis on meat and secondarily on milk.
- Country research thrusts have a strong disciplinary bias in which, feeding and nutrition, breeding and genetics , and animal health issues are most common
- National research programmes were limited by resource inputs and funding for research and development.
- Conflicts in resource use between production and health were also apparent
- Much of work continues at the experiment station and university level, and real on-farm participatory work with farmers is negligible.
- Research to address constraints to small ruminant production often tended to be perceived, not needs –based and responsive to small farmers, holistic systems, and issues of sustainability
- The research programmes seldom involve researcher- farmer-extension staff partnerships to push development
- Many non-government organizations and development agencies are actively involved with technology delivery in participatory work with farmers, and, International funding support for research and development activities on small ruminants is generally scarce.

Table 5 summarises country research thrusts, based on an extensive review of the literature and trends. The table reflects the considerable emphasis given to feeding and nutrition, and breeding and genetics. Much of the research work relates to evaluation and assessment of component technology, technology assessment, and these are largely undertaken at the experiment station or university levels. Crossbreeding is rampant especially in India and China, and increasingly in South East Asia, but the precise objectives and reasons for it are often not clear. One consequence of this is the erosion of the indigenous breeds, their conservation and improvement. A consistent feature of much of the research is that invariably, it is not linked it to delivery systems

that involve large scale technology transfer and development at the farm level. The research programmes seldom involve researcher- farmer- extention staff partnerships to push development. It is not surprising therefore that there is in general, very poor adoption of improved technology, with continuing inefficient small ruminant production systems

Table 4. Summary of examples and extent of benefits from integrated ruminants-crop systems in Asia and the Pacific .

Type of crop-animal system	Country	Estimated profitability/net income (US $)	Source
1. Coconuts – beef cattle pastures	W. Samoa	Income from native pastures : 21-41% Income from improved pastures : 42-71%	Reynolds (1995)
2. Three-strata forage system	Indonesia	Without project - 106 With project – 186 Benefit - 75.5%	Nitis *et al.*(1990)
3. Oil palm – cattle – goats	Malaysia	With integration - 110.8/ha/yr	Devendra (1990)
4. Oil palm - cattle integration	Malaysia	Increased yield of 0.49 mt FFB / ha	Samsuddin (1991)
5. Coconuts-crops- animals	India	More profitable than coconuts alone	Das (1991)
6. Improved grass-legume pastures in coconut plantations integrated with cattle	Philippine	Net profit - 510	Deocareza and Deista (1993)
7. Coconuts – dairy cattle integration	Sri Lanka	Increased nut and copra yields by 17 and 11% .Reduced cost of fertiliser use by 69%	Liyanage *et al.*(1993)
8. Oil palm – cattle integration	Malaysia	Increased yield of fresh fruit bunches (FFB) by 30%	Chen *et al.*(1993)
9.. Small ruminants under coconuts (1991-1994)	Philippines	Net income without and (with)project: Sheep - 25 (127)Goats: - 35 (229)	PCARRD (1994)
10. Food crops, rubber and animal production system (1 cow, 3 goats and 11 chickens)	Indonesia	Net farm income : Without project: 24-81; With project: 124-138, Benefit: 149.5 %	CRIFCE(1995)
11. Integration of leguminous hedgerows on steep slopes (sloping agriculture land technology)	Philippines	Net profits 865.8-1940.1	Laquihon *et al (*1997)
12. Rubber – sheep integration	Indonesia	Benefit: 116.9%	San NuNu and Deaton (1998)
13.. Coconuts –dairy farming-poultry integration	India	Milk yield increased by 20%	Maheswarappa et al. (2001)
14.Oil palm - cattle integration	Malaysia	Reduced cost of weeding by 68.6 %	Ongah (2004)

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Table 5. Country research thrusts (Devendra, 2006a)

Feeding and Nutrition

- Supplementary feeding with local crop residues and by-products
- Supplementary feeding with leguminous tree fodders
- Nutrient requirements
- Treatment and feeding of crop residues
- Meat and milk response tests
- Balanced diets for growth and milk production
- Fodder production and grazing management
- Mineral supplementation
- Integration with tree crops
- Evaluation of rangeland grazing

Breeding and Genetics

- Characterisation and identification of production traits
- Selective breeding of local breeds
- Crosbreeding with imported breeds (meat and milk)
- Evaluation of imported breeds

Health

- Health surveys
- Development of diagnostic procedures
- Development of vaccines
- Testing of vaccines
- Treatment for endoparasites

Advanced technology

- Embryo transfer
- Biotechnology
- Molecular genetics
- Mapping of quantitative traits loci
- DNA analyses .

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DEVELOPMENT IMPERATIVES

Production objectives

An important prerequisite for improved small ruminant production and the efficiency of meat, milk or fibre production is the need for clear production objectives. These are specific to both species and breeds within- species. In many country situations, these production objectives remain to e fully defined and are often not clear, with the result that the quality of products produced are not the best. It is essential that these production objectives are well defined. Table 6 summarises some on the considerations involved.

Table 6. Production objectives for improved quantity and quality of goat and sheep products.

Commodity	To improve quantity (improvement/increase)	To improve quality
1. Meat (goat meat and mutton)	Total meat yield per animal Total amount of lean meat in the carcass Growth rate Total number of animals available for slaughter	Control of the quantity and distribution of fax-excess, undesirable except for some Middle East markets
2. Milk	Total yield Lactation Length Number of lactations	• Control of milk composition (butter-fat and solid-not-fat)
3. Skins	Total number Weight per unit	• Skin thickness • Surface area • Any external damage • Grain structure • Elasticity • Improved storage
4. Carpet wool	Amount of clean wool	• Fibre diameter (coarse fibre desirable) • Staple length • Presence of medullated fibres (hair) • Removal of kemp (shed fibres, or those with the medulla occupying 90% of the diameter)

Choice of species and use of available breeds

Associated with clear production objectives is the concurrent need to identify these with appropriate breeds within-species. While the husbandry of goats and sheep is complementary, and both species are often run together in traditional management systems, each species has some distinct characteristics and it is important that these are recognised in the choice of animals appropriate to individual production systems. This requires knowledge of the prevailing species and breeds in individual agro-ecological zones, their individual characteristics, and potential contribution. Where there a specific demand for products from one or the other species or when the prevailing situation favors a particular species, the appropriate choice is therefore realistic. The relative price of meats in an important consideration and also the market demand for these. Biomass production is dictated by age at first breeding, interval between parturitions, litter size, lifetime productivity and mortality. In the absence of clear production objectives, choice of individual species and breeds within- species, it is impossible to maximise the contribution from both species, with the result that the potential contribution from small ruminants is never realised. Additionally, inability to identify and use the more important breeds has the risk of encouraging random crossbreeding with various exotic breeds, with consequent genetic erosion.

Indonesia has a small ruminant population of about 22 million animals, of which goats account for about 66 %. Both exotic sheep and goat breeds have been introduced over time, but the real reasons for why this was done remains unclear. With goats, the Etawah breed (synonymous with the Jamnapari from India) selected as a milch breed was introduced in situations where meat and not milk was the main need. Farmers are quick to repond to marker demands , as is evident in parts of Central Jawa in the switch from thin –tailed sheep to fat- tailed sheep due to a preference by consumers for meat with more fat in the carcass.

Need for increased numbers

In many countries throughout the region, increased contribution from both species is constrained by inadequate numbers. A major development initiative therefore is the need for more small ruminant numbers, not only to support breeding programmes, but more importantly to sustain animals required for slaughter for meat production. Average carcass weight is a rough measure of the efficiency of meat production. The number of animals maintained will reflect the biological cost, and the amount of meat produced the returns. Improvements to the latter will indicate increased net return to the producers. In good breeding programmes, increased meat production and more numbers for local slaughter are associated with replacements in production systems that match efficient use of especially feeds. On the other hand, decreased production per head is inevitable due to overgrazing in the face of reduced feed supplies.An examination of carcass weight per head in the developing countries of Asia over the last two decades indicates that the average weight in sheep (14.4 kg) was higher that in goats (11.8 kg). The difference is due to the use especially in sheep of imported improved breeds, crossbreeding, breeding more than once a year, control of production and access to improved technology from industrialised countries.

Currently, small ruminant meats are produced from sheer numbers available for slaughter at the abattoirs. These include both young (8-12 months old), mature and unproductive cull animals (six years and above). With goats, most of the animals

slaughtered are young because of the very high market demand for goat meat. During some periods of the year, especially festivals, relatively more mature and especially fattened sheep are sold at much higher live weights. The key point in these circumstances is that numbers, and to a lesser extent live weight at slaughter, are the major driving forces for the sale of animals. Quality of animals or meat is not a consideration in the marketing of the animals. The market demand is thus mainly met by the availability of animals, which in turn also affects the relative prices of the meats. Uncontrolled sale of animals for slaughter has the serious effect of depleting breeding animals, the genetic base, and the inability of both species to sustain the need for number.

Associated with this situation is the rampant substitution of goat meat by both locally produced and imported mutton to benefit from the higher prices of goat meat. Often, the consumer is put to a disadvantage with unscrupulous marketing and delivery of poorer quality mutton with a much higher content of subcutaneous fat. It is pertinent to draw attention to the considerable demand for these meats in Middle East markets. The response to this potentially lucrative demand for goat meat and mutton. In these circumstances, it is relevant and compelling to ask how the efficiency of small ruminant meat production can be improved, and specifically what can be done to improve the situation.

Concerning quantity, total amount of lean meat in the carcass, measured by live weight at slaughter, and total number of animals available for slaughters are important factors. The features are related to two important parameters:-

(a) $\frac{\text{Mean number of offsprings born at one parturition}}{\text{Interval between parturitions}} \times 365$

(b) Total weight of offsprings measured/year/female exposed to the male

(c) Flock meat productivity can be calculated as follows:

Flock meat productivity =
litter size/year x litter size x number of offsprings weaned x kid weaning weight x annual mortality in does.

An important management issue influencing productivity concerns the productive lifespan of females in the heard. With goats for example, fertility is at a peak around the fifth parturition, corresponding to about four to five yeas of age. It is essential therefore that breeding females are kept in the herd for not less that seven years of age to couple rising levels of fertility, generation of numbers, and increased economic benefits.

In Korea, there is a small but advanced industry on the commercial production and marketing of goat meat extract as medicinal products for a variety of human ailments (Song and Min, 2000). The process involves the use of meat from young kids of about six months of age which is mixed with a variety of herbs to get the extract rather than the production of meat *per*

Strategy for improved feed utilisation

Feeding and nutrition are the major constraints to animal production throughout South East Asia (Devendra *et al.,* 1997) and South Asia (Devendra *et al.*,

2000). The strategy for feed resource use needs to take cognisance of the following interrelated issues:-

- Knowledge of the totality of available feeds
- Appropriateness and effective use within production systems
- Cost of feeding as a percentage of total production costs are about 50-60 % for ruminants and 65-80 % for non –ruminants in intensive production systems
- Feeds and their use should be identified with farming systems and self – reliance, and
- Potential promotion of linkages between rural and peri-urban areas in the use of production inputs, intensification, nutrient flows, and marketing of produce that is consistent with environmental integrity.

The final objective should be the development of sustainable all year round feeding systems. Associated with this, there should concurrently be efforts to increase feed supplies to overcome shortages, seasonal constraints and expanded production systems (Devendra, 2000). Examples of such approaches include food – feed cropping (Devendra, Sevilla and Pezo, 2001), forage production in rice buds and under tree crops, and alley cropping. Efficiency of feed use especially for ruminants must also identify priorities for using crop residues. Table 7 summarises how this can be achieved.

Table 7. Priorities for crop residue use by animals in Asia (Devendra, 1997)

Type of residue	Nutrient potential	Species (product/service)
Good quality (e.g. oilseed cakes and meals, cassava leaves)	High protein High-energy supplement Mineral	Pigs, chickens, ducks, ruminants* (milk, meat)
Medium quality (e.g. coconut cake, palm kernel cake, sweet potato vines)	Medium protein	Pigs, chickens, ruminants (meats, milk)
Low quality (e.g. cereal straws, palm press fibre, stovers)	Low protein, very fibrous	Ruminants (meats, draught), camels, donkeys, horses (draught)

'ruminants' refers to buffalo, cattle, goats and sheep

Production - Post-roduction – consumption systems

It is essential to link production, post –production to consumption systems to enhance market opportunities. Prevailing inefficiencies in the chain, together with weak marketing arrangements pose a major constraint in production to consumption systems, and to the owners and producers of animals.

The production – post-production- consumption concept that links the producer, distributor and consumer has two development effects. Firstly, it will encourage the location of production, slaughter and distribution, marketing and product flows. Secondly, it will also significantly enhance the linkages between rural and peri-urban areas. With improved marketing systems, the current large market demand for small ruminant meats has the potential to promote rural growth. Beyond the production to consumption chain, attention also needs to be given to by-products from meat production. These have considerable economic value, but their collection, processing and use are underestimated. The sale of small ruminant skins is a major export earner in India (Naidu, 2000) and Indonesia (Soedjana, 1993). Associated with the production to

consumption markets is the need for a pro-active agri-business orientation. This situation will also help shift production from subsistence to a more commercial outlook.

Marketing systems

Presently, the marketing of small ruminants and their products is weak and haphazard and leaves much to be desired. These inefficiencies persist, due to the failure of traditional marketing patterns to expand into urban markets as well as adapt to a changing environment, consumer preferences and demands much more information is required on the marketing of small ruminants and their products from them especially in South East Asia, similar to the exhaustive studies in India (Naidu *et al.*, 1991).

More information on the following aspects is especially wanting and include *inter alia:*

- Marketing infrastructure and facilities
- Market channels and outlets
- Buyer preferences for live animals and their meats
- Major market players
- Government intervention
- Role of the private sector.

The market chain involves rural, peri-urban, urban and international markets. Rural markets are especially important to rural communities and their households, and are also used for the sale of live animals for slaughter in the urban areas. In order to provide good links between rural, peri-urban and urban markets, appropriate infrastructural and communication facilities must be in place, as also collection and processing centres. Because of the greater market demand for animal products in urban areas, such facilties become essential. Urban markets are the outlets for exports, and promote international trade.

Marketing infrastructure and facilities involved with small ruminant production include holding pens in farms, collection centres, fattening units, rural and urban abattoirs, cold storage, meat processing plants, and public markets. Market channels and outlets for live animals and meat include several components from the producer to consumer and include village agents, village markets, middlemen, city dealers, retail butchers and consumers. Not enough is also known about the proportion of the meats used in the rural and urban areas, and the reasons for buyer preferences of goat meat or mutton, and the price differentials. Such market intelligence data can have the effect of producers targeting specific buyer categories and timing to sell animals as well as the meats. Major market players include producers, village agents, middlemen, butchers and retailers.

The demand for goat meat and mutton, as with all the meats from animals is very income elastic. With rapid income growth, consumer preferences and patterns also undergo marked changes. The extent to which farmers and producers can respond to these demand developments will be influenced by government intervention as well as organised marketing. It will be also important to know the role and functions of the private sector in the production and marketing of both live animals and their meats. The concept of contract farming involving both the producer and private sector is a case in point.

Small ruminant meats are in very great demand in the Middle East countries. In order to compete in world markets however, quality standards, processing and storage facilities become essential. For the Muslim world and the huge markets in the Middle East region, meeting "halal "standards is also necessary. Associated with international trade are the impact of globalisation and the lowering of tariff and non-tariff barriers, involving opening of market opportunities for countries, and on the other, severe competitiveness for low cost products. Efficient production, post –production and marketing systems are therefore crucial to maintain a competitive position.

CONCLUSIONS

Given the importance of small ruminants, their functions and potential contribution, their expanded development can significantly contribute to increased food production of animal origin and improved livelihoods in the future. The task will however require the collective participations of the farmers and owners of these animals, and also institutional support and commitment the following aspects are important considerations:-

a. Recognition of the concept of production, post –production to-consumption systems
b. More efficient use of available breeds and commercially-oriented production systems can significantly increase productivity, in which production systems need to shift more aggressively from a subsistence base to more market-oriented outlook to match the market demand with changing consumer preferences
c. Research and development to address constraints must be needs-based, participatory in approach, and responsive to small farmers, holistic systems, and issues of sustainability
d. Improved delivery systems, technology transfer and wide dissemination of information is necessary to promote wide adoption and replicability
e. Improved understanding of markets and marketing systems and the links between rural, urban and international markets is necessary
f. Increased resource use, public and private sector investments, and institutional commitment are urgently needed to target increased productivity from both species in the future.

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