

ILRI in Asia

An assessment of priorities for Asian livestock research and development

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Preface

The International Livestock Research Institute (ILRI) is one of 16 centres supported by the Consultative Group for International Agricultural Research (CGIAR). The CGIAR recognises the importance of livestock in agricultural systems and the potential for livestock to contribute to the goals of the CGIAR—poverty alleviation, food security and environmental protection. Prior to 1995, CGIAR livestock research focused on sub-Saharan Africa. However, in 1995, ILRI's mandate was expanded to include Asia, Latin America and North Africa.

First priority was given by ILRI's Board to new programme development in Asia. Consultations with leaders of national livestock research were convened in South and South-East Asia. Next, a detailed analysis was commissioned of demographic, economic and dietary trends in Asia, the expected impact on regional livestock production, and the priorities for livestock research and development at the national and regional levels. Results from this analysis are presented in this report.

The report highlights the dramatic increases in demand for high quality animal products that will accompany the anticipated economic growth in the region and the associated changes in the standard of living and eating habits. This projected increase in demand over the next decade presents major challenges for research to provide the information and technologies needed for economically viable, socially equitable and environmentally sustainable development in Asia.

This report was developed by the Working Group and the Steering Committee, comprising livestock specialists representing relevant scientific disciplines, countries and experience. The first stage comprised the detailed analysis by the Working Group and included a thorough evaluation of that analysis by the Steering Committee. The second stage involved additional analysis and interpretation, identification of broad priority areas for collaborative research between ILRI and national agricultural research systems (NARS), and examination of how ILRI might best operate in Asia. The revised report and recommendations were endorsed by the Steering Committee. Finally, in May 1997, a conference involving livestock specialists from the region was convened by ILRI and hosted by the National Institute of Animal Husbandry, Hanoi, Vietnam. The report and recommendations for research priorities for Asian livestock development were discussed and agreed upon by the scientists and country representatives. The proceedings from this conference are available.

We thank all those who have contributed to this report, including the CGIAR members whose financial contributions support ILRI. The Australian Centre for International Agricultural Research (ACIAR) provided specific financial support for this study.

Hank Fitzhugh
Director General
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Executive summary

Agricultural land in Asia represents 35% of the world's agricultural land and the population devoted to farming represents 73% of the world's total. Asia also contains significant proportions of the world's cattle, small ruminants, pigs, chickens, ducks and buffaloes.

Asia contains many countries with high economic growth rates, declining rates of population increase and rapidly increasing demand for animal products. It also contains some countries, mainly in South Asia, whose economies are growing at negligible rates, have high population growth rates and which present a different set of challenges to the livestock industries. In all countries of the region the population is becoming more urbanised with some now exceeding 50% from an average value of around 35% 25 years ago. This Discussion Paper examines these trends in selected countries in South and South-East Asia (regions that differ significantly in their ecoregional, cultural and economic indicators), analyses future scenarios in relation to demands for livestock products and the likely sources for increased supply, and recommends strategic research activities for the International Livestock Research Institute (ILRI) in the region. It also indicates options for how these activities might be conducted.

The per capita consumption of ruminant and non-ruminant meats has generally been increasing, with the consumption of non-ruminant meats showing faster growth rates, especially in the wealthier economies of South-East Asia. Meat from small ruminants forms 17–27% of all meat eaten in South Asia but makes little contribution to the diet in South-East Asia. Meat from large ruminants is the most variable (2% in Malaysia to 60–70% in India and Sri Lanka). Pork as a proportion of all meat eaten is highest in China, Indo-China and the Philippines and poultry forms 73, 56 and 37% of the meat diets in Malaysia, Thailand and Indonesia, respectively. The demand for ruminant meat is increasing in most of Asia and will be the most difficult to satisfy with current practices.

Numbers of buffalo are decreasing in countries like Thailand, Malaysia and the Philippines, where, amongst a variety of factors impacting on slaughter rates, mechanisation is replacing their traditional use for draft. Numbers are increasing in India and Pakistan where they remain important producers of milk. The data indicate that sheep populations in Thailand and Malaysia are increasing rapidly, albeit from very low bases. The reasons for, and the consistency of, these trends are unclear. In Sri Lanka the populations of both large and small ruminants are declining but the reasons for this are obscure. The pattern of livestock numbers and production reflects the cultural, economic, ecological and climatic differences within the region.

Some countries of the region are net importers of ruminant meat, e.g. Malaysia, Thailand and the Philippines while India is a net exporter. Malaysia, Thailand, Vietnam and China are amongst the net exporters of non-ruminant meat. This production and trade situation, coupled with the shortage of land and feed resources in some countries, is reflected in their demands for coarse grains, an effect that will become more pronounced in the next decade. The predicted economic growth of China will have a significant impact on the world trade in grains and it will be particularly marked in the Asian region.

The growth rates in annual milk production vary widely in the region from 20% for Thailand to about 1% for the Philippines. India and Pakistan are self-sufficient in milk, with buffaloes contributing a high proportion (47 and 73%, respectively) of the total consumption. Thailand, Indonesia and Bangladesh are moving towards self-sufficiency in the next decade or so, but for the Philippines, Vietnam and Cambodia, demand will continue to outstrip supply and the gap between the demand and the supply will widen.

Projections indicate that by 2010, some of the countries that are currently exporters of ruminant meat will drift back to self-sufficiency, e.g. India, and amongst those countries where the demand for ruminant meat is projected to be high, e.g. Malaysia, Thailand, Philippines and Indonesia, there will be greater reliance on importation of beef and live cattle from inside (Australia and New Zealand) and outside the region (the Americas and perhaps southern Africa). A number of countries in the region including India, Indonesia, the Philippines, Thailand and Vietnam are projected to be self-sufficient for non-ruminant meat. Pakistan is forecast to be a significant net importer of non-ruminant meat. These projections can be distorted by the political environment and policy decisions. Nevertheless the implications on intra- and inter-regional trade are considerable.

ILRI's mandate is primarily concerned with ruminants but in the South-East Asian context the opportunities for improvements in non-ruminant production, particularly pigs and poultry (village chickens, ducks and geese) have special significance in mixed farming systems, i.e. mixtures of livestock and crops, perhaps including fish. ILRI's awareness of these opportunities and its ability to capitalise on them will increase as its analysis of the important systems progresses.

Four broadly defined production systems will be called upon in the next decade to contribute most to the increases in production of ruminant and non-ruminant products that are necessary to (i) keep pace with the human population increases and (ii) to meet the increased demand associated with the enhanced economic status of a higher proportion of the population. These are the mixed livestock–cropping systems in the rainfed and irrigated areas of the following ecoregional zones—arid, semi-arid, and humid and subhumid regions. The Steering Committee recognised the differences in needs associated with the scale of operation associated with the production system, e.g. village-based 'backyard' operators, village-based smallholder systems and commercial-type operations. ILRI's prime target is to assist village-based smallholder systems in the transition towards more efficient, minimal risk and sustainable enterprises with a more commercial outlook.

Despite its focus on the above systems in the tropics and subtropics, some of the problems of the region are associated with grazing systems in the dry mountainous regions, e.g. Pakistan, Nepal and Bhutan. ILRI's African experience could warrant a minor input into any policy analysis of these issues.

Research and development needs for Asian livestock have been identified in country consultations conducted by ILRI in South and South-East Asia. They are driven by the projected supply and demand for products, the species that can provide them and the systems most capable of responding to the improvements in technology that will be forthcoming.

The annual and seasonal variations in the quantity and quality of the feed supply are the major constraints to productivity improvement but the impact of health issues, genetic improvement and how these three components are assembled and integrated in particular systems and situations are prime areas for research. Changes towards higher levels of productivity and higher inputs will have significant impact on the environment. New technologies have to be thoroughly evaluated for their potential positive and negative effects on the environment and the natural resource base. Infrastructural inadequacies and the need for sound policy analyses are also important; their relativity and potential synergies changing with circumstances, production system and level of development.

Appendix II identifies the needs and indicates the ways in which ILRI, utilising its existing strengths and its comparative advantage, should invest in Asian livestock research. Appendix II also illustrates the synergies and complementarities with NARS and other players. The appendix incorporates the recommendations by the Steering Committee and the Working Group as to how ILRI could conduct its research in South and South-East Asia. It recommends *using co-operative, joint venture structures with leading NARS institutions, advanced research institutions (ARIs), and non-governmental organisations (NGOs) (on a project-by-project basis) and extensive networking that will capitalise on the capacities of the Asian livestock research institutions.*

ILRI should move quickly to establish and advertise its presence in Asia.

1. Introduction and background

'It has been estimated that within 40 years Asia will represent the major share of the wealth of this world and will be richer than North America and Europe put together. Food requirements will not include more rice or cassava, but products such as wheat, meat, dairy produce, fruit and vegetables as a result of increases in income.' Professor Derek Tribe in an address to 'Future of Agriculture', a seminar organised by NSW Royal Agricultural Society in 1993

Introduction

More than half the world's underfed people live in Asia. During the next five years the world's population is predicted to rise by one billion and a high proportion of this increase will take place in Asia. According to 1995 World Bank statistics there were 3386 million people living in Asia. This is almost 60% of the total population of the world. It is critical that these people, many of whom are underfed, have a healthy diet. Plant protein sources, most notably pulses, will remain important but increasingly, animal protein will assume a significant role in a healthy diet especially for the vulnerable (pregnant, lactating and growing) sectors of the population. Malnutrition, including that associated with a lack of high-quality protein, has many consequences: low resistance to infection, absence from school or work, ignorance and poverty and in the extreme case poor mental development.

The establishment and sustainability of small village production systems are essential at a time when there is migration of rural populations to overcrowded cities. It is estimated that in the foreseeable future 50% of the total population of Asia will be urban-based. This potentially damaging situation can be reduced by establishing economically viable and sustainable production systems that will help maintain both family links and the social fabric of villages.

While agricultural land in Asia represents only 35% of the world's total agricultural land, the population devoted to farming represents 73% of the world total. Livestock population expressed as a per cent of the world's population in the region accounted for 33% of the 1288 million cattle, 96% of the 149 million buffaloes, 55% of the 12,002 million pigs, 50% of the 41 million tonnes of eggs, 31% of the 46 million tonnes of chicken meat and 84% of the 680 million ducks.

Finally, livestock should not be considered solely as a source of animal protein (eggs, milk, meat and blood); they are kept for draft power, for hair and hide, as a source of manure and urine, fat for cooking, recreation and culture, as a savings bank, and as an indicator of social and economic status. An increase in livestock production is seen as integral to the process of evolving from a developing to a developed nation. The important role of aquaculture to meet the protein needs of the underprivileged in Asia should not be underestimated, particularly in integrated fish-livestock systems. However, it is outside the scope of this document to consider fish farming.

Background

The purpose of this discussion paper is, firstly, to promote debate amongst potential clients of ILRI's research in South and South-East Asia on what ILRI could do in these regions, in collaboration with the NARS, that will assist the development of the livestock industries and, secondly, to provide advice to the ILRI Board and management on the rationale for ILRI involvement in the regions, the nature of that involvement, and the mechanisms and processes by which ILRI might maximise the benefits from its investment into research and development (R&D), particularly in these regions.

The final outcomes of the discussion paper will be consistent with the Consultative Group on International Agricultural Research (CGIAR) and ILRI mandates and with Technical Advisory Committee (TAC) of the CGIAR policies and guidelines for the future directions of the CG system (TAC 1992; ILRI 1996).

The terms of reference of the discussion paper are to:

- (i) identify economic trends by major countries in the region and livestock production trends based on forecast demand for livestock products,
- (ii) estimate the current and future balances/relative importance of numbers and species of livestock; per head production of meat and milk, differentiation between red and white meat sources,
- (iii) predict trends for livestock product trade within the region, imports into the region and exports out of the region,
- (iv) predict the likely impact of these trends on Asian livestock industries,
- (v) identify the technological and other constraints to achieving environmentally and economically sustainable improvements,
- (vi) evaluate the comparative capacity of Asian NARS to contribute to international livestock research vis-a-vis other suppliers of research-based technologies,
- (vii) indicate priority areas for ILRI involvement which recognise the mandate and goals of ILRI and the CGIAR,
- (viii) suggest ways in which ILRI should develop its research interests in partnerships and networks in the region.

The region

For the purposes of this discussion paper two regions are considered; South Asia, consisting primarily of India, Pakistan, Bangladesh, Sri Lanka and Myanmar with some reference to the smaller nations bordering these countries in the north (Bhutan and Nepal), and South-East Asia, consisting primarily of Indonesia, Malaysia, the Philippines, Thailand, South China, Laos, Cambodia and Vietnam.

Within each region there are three prime ecoregional zones of relevance to livestock production and, therefore, to ILRI. These are the semi-arid, subhumid and humid, with upland and lowland variations in each of these. The relative importance of each ecoregional zone varies between the regions; semi-arid ecoregions predominate in South Asia and the humid ecoregions predominate in South-East Asia. Semi-humid ecoregions are important in both regions.

Because of variations between countries in wealth, culture and preferences, the countries of these regions are generally considered separately and the results aggregated so that general conclusions can be made. The data used to establish trends, analyse possible impacts and predict future requirements are those from the Food and Agriculture Organization of the United Nations (FAO) data bases, the inputs for which have been provided by the individual countries. These data are known to have deficiencies, e.g. the movements of livestock amongst countries that are not recorded and the magnitude of which is largely guesswork. Nevertheless these data are the best available and sufficiently accurate for the major purpose of this Paper. However, figures in the tables that have been queried by the Steering Committee have been noted. The activities in which ILRI could participate will have a high priority in terms of long-term economic benefits to rural populations, providing high quality protein to increasingly urban populations, contributing to the conservation of the natural resource, and adding value to the existing efforts of ILRI and its partners.

Some sections of the discussion paper are necessarily descriptive and qualitative judgements rather than quantitative assessments. It is in these areas particularly that the Steering Committee and the consultations with senior livestock scientists and policy makers in the region have been most useful.

The discussion paper looks initially at the economic trends in selected countries in both regions and assesses the likely impact of this on dietary preferences and priorities. Having established the potential demands in the regions for the major livestock products (meat, milk, draft-power, eggs and, to a lesser extent, leather, wool and hair) in the next decade or so, the ways in which deficits in supply can be met from existing systems are assessed. The major constraints to improved production are identified and the role that technologically based research can play in alleviating these constraints is examined. The discussion paper then canvasses options for ILRI's participation, facilitation and leadership in some areas of priority research for the region and some possible mechanisms by which ILRI might achieve such objectives are detailed.

TAC priorities

Briefly, the priorities of TAC are:

- that activities must be research-related with two major objectives: to generate relevant new knowledge or new products, and to disseminate this knowledge and/or product to NARS in such a way that it impacts on the local/regional practices
- that activities be international in character and target CGIAR priorities
- the activities conducted must be those in which the CGIAR has a comparative advantage and can provide scientific leadership
- the activities must acknowledge world concerns about sustainability, food security and poverty reduction.

ILRI has identified the following important trends:

- increases in production will derive from intensification of livestock components in mixed farming systems
- urbanisation of consumers will encourage specialist producers
- smallholder systems will continue to dominate the production of milk, beef, mutton, goat meat, and pork in the foreseeable future despite rapid trends to commercial systems in some countries
- pastoral areas have a limited scope to increase production but, *together with cropping systems* (our emphasis added), will continue to present significant challenges in natural resource management
- new scientific developments have a major role to play in meeting the production targets.

ILRI priorities

ILRI has endorsed the seven priority research areas for animal research identified by TAC. Three of the seven, animal health, animal genetics and nutrition, are considered global in orientation, while the other four, feed resources, production systems, natural resource management and farming systems (socio-economic analysis), have an ecoregional orientation.

The discussion paper will assess the relevance of these broad areas of research to the Asian situation, and, in light of the predicted economic and social trends, identify specific problems, needs and ways of operating, where activities will be of maximum benefit.

2. Economic trends and impacts on livestock demand and production

Introduction

The demand for livestock products in South and South-East Asia has generally increased (particularly for meat and milk), with strong potential for further growth in the next century (Chantalakhana 1996).

Whilst some similarities in terms of consumption and production trends can be identified on a regional basis, broad generalisations are not possible due to the different sets of political, economic, social and cultural conditions that exist at a country and intra-country level. Therefore, the current and likely future balance of domestic production and consumption of meat and milk are analysed and discussed on a country-by-country basis by examining trends in consumption, livestock numbers, production and economic trends in each selected country in South and South-East Asia. The most obvious implications for inter-regional trade in the future are drawn from this analysis and discussed on a commodity-by-commodity basis for countries in the region.

Consumption of non-ruminant meat on a per person basis in South-East Asia is generally higher than consumption of ruminant meat, in some cases by a factor of ten (Table 1). However, the reverse is true in South Asia where ruminant meat consumption dominates total meat consumption.

Table 1. Annual meat consumption per person by type for selected Asian countries, 1994.

Country	Total ruminant and non-ruminant meat (kg/person)	Ruminant meat (kg/person)	Non-ruminant meat (kg/person)
Bangladesh	2.8	2.1	0.7
Cambodia	12.4	3.3	9.1
China	36.0	4.1	31.9
India	4.3	3.3	1.0
Indonesia	9.5	2.3	7.2
Laos	10.8	3.0	7.8
Malaysia	48.0	4.1	43.9
Pakistan	12.6	10.6	2.0
Philippines	24.2	3.6	20.6
Sri Lanka	4.8	1.9	2.9
Thailand	20.1	5.4	14.7
Vietnam	16.6	2.5	14.1

Note: Apparent meat consumption per person (abbreviated to meat consumption per person for brevity in the text) was estimated by adding net imports to meat production estimates and dividing by the total population estimate for that year, assuming carry-over stocks of meat did not change from year to year.

Source: FAO (1995a, 1995b).

Total meat consumption by country

Most of the observed changes in an individual country's total meat consumption over time can be explained in terms of population expansion, consumer income growth and price effects (Mubyarto et al 1973; Cornell and Sorenson 1986).

Structural changes in dietary habits have been divided into stages when related to real income: an initial increase in the consumption of traditional staple foods (such as rice); followed by an increase in the consumption of non-traditional staple foods (such as wheat and secondary products derived from traditional staple material); diversification in consumption habits including the time and place of consumption; and finally an increase in the consumption of a greater variety and volume of higher value and higher protein

foods including ruminant and non-ruminant meats, eggs, milk and milk products in addition to fish (Yuize 1978; Garnaut and Ma 1992). The transition from a diet dominated by starch staple to one including substantial amounts of animal products is a general feature sometimes referred to as Bennett's Law. The importance of non-ruminant products in the transition in Asia is shown in Table 2.

Estimates of the average annual growth rates in total meat consumption per capita from 1970 to 1994 for each of the selected countries are shown in Figure 1. With the exception of Bangladesh and Sri Lanka, total meat consumption per capita has increased, the highest rates being indicated for Malaysia and Indonesia.

Table 2 *Non-ruminant meat consumption and selected economic trends in selected Asian countries for 1995 (unless otherwise specified).*

	Annual average income per capita (AAI) (\$) 1994	Forecast AAI (%) change (1996)	Population (millions)	Population growth (1990–2000) (%)	Eggs (kg)	Poultry meat (kg)	Pig meat (kg)	Duck meat (g)
Bangladesh	230	5.3	120	2.2	0.6	0.75		14
Cambodia		6.8	10	2.7	1.0	1.6	7	470
China	530	8.9	1,221	1.1	10	5.5	24	1,250
India	310	6.5	935	1.8	1.5	0.43	0.5	
Indonesia	880	6.8	197	1.5	2.1	2.8	1	61
Laos	320		5	2.9	7.2	5.9	2	100
Malaysia	3,520	8.0	20	3.3	17.4	28.3	15	43
Pakistan	440	6.0	140	2.6	1.8	2.3		57
Philippines	960	5.5	68	1.7	3.9	4.9	12	307
Thailand	2210	8.0	59	0.8	7.2	12.7	2	1,450
Vietnam	190	9.0	75	1.7	1.8	1.7	10	512

Sources: Watt's Poultry Statistical Year Book (1996), Asian Development Bank statistics, cited in *World Poultry*, 6(11):42.

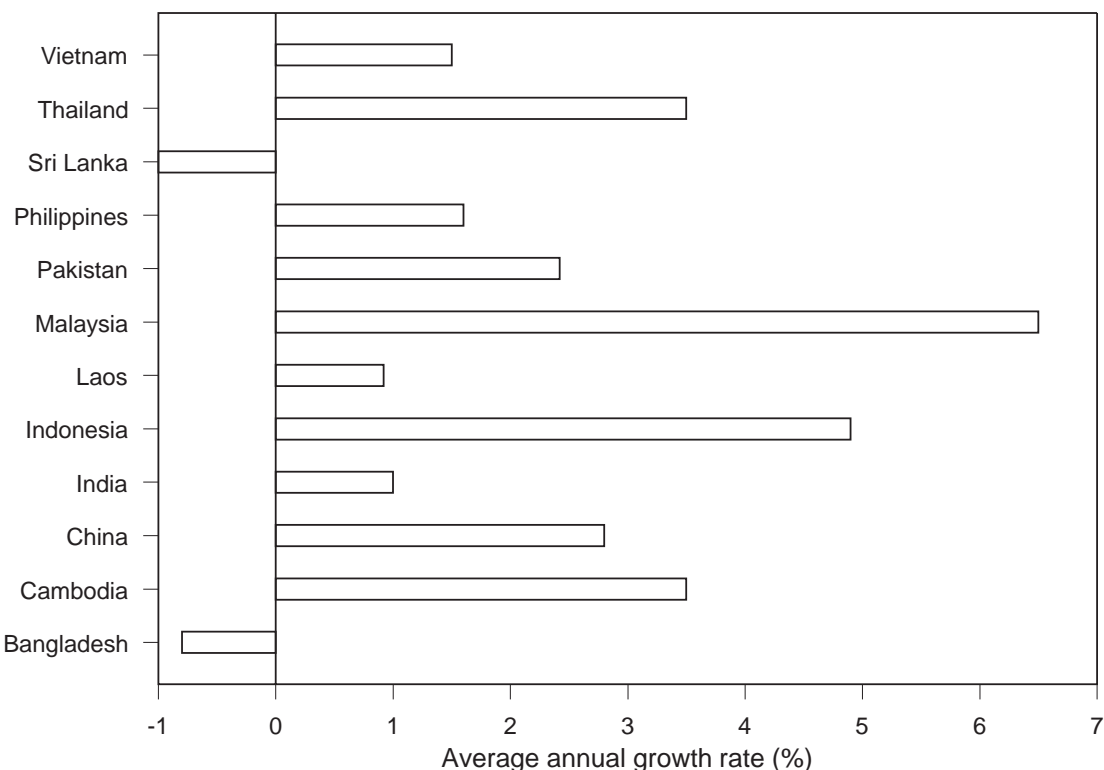


Figure 1. *Average annual growth rates in total meat consumption for selected Asian countries, 1970–1994.*

Source: FAO (1995a, 1995b).

Both ruminant and non-ruminant meat consumption per capita has generally been increasing in the selected Asian countries. However, non-ruminant meat consumption per capita has generally grown at a faster and more consistent rate than that of ruminant meat consumption over the period of investigation (Figure 2). Most of the demand for animal protein will come from the rapidly emerging middle class and the demand will be met most easily by the poultry sector and to a lesser extent by pigs. In the case of the latter this can only occur in the non-Muslim countries. The technology, infrastructure and resources in the non-ruminant sector are more portable and change little from country to country. However, in many Asian countries substantial production will continue to come from small production units.

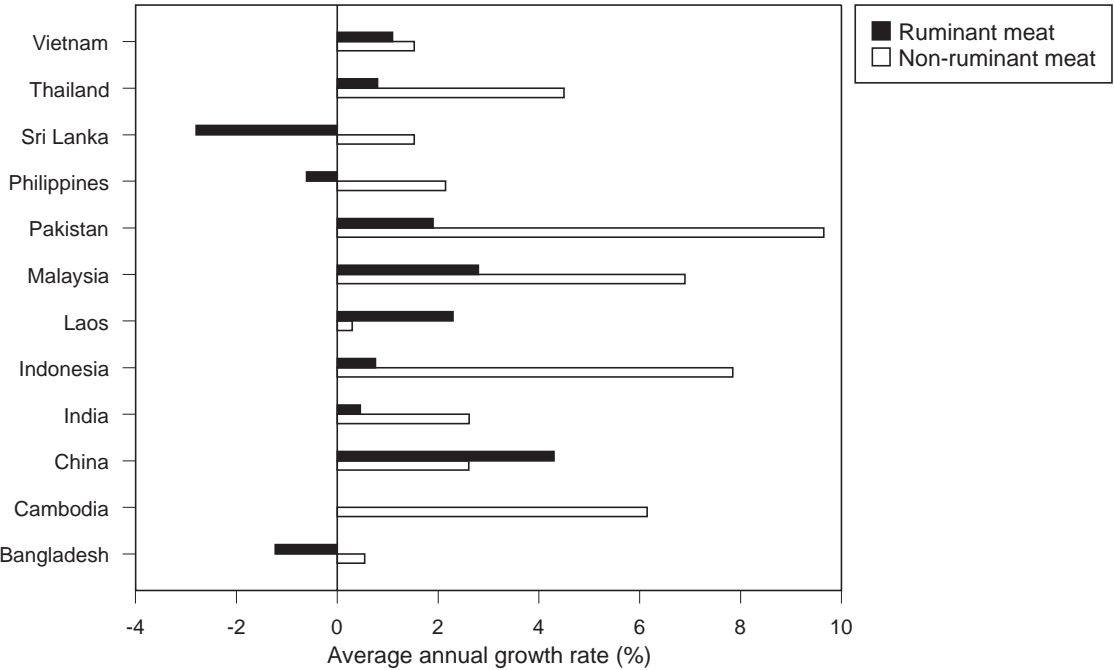


Figure 2. Average annual growth rates in meat consumption by type for selected Asian countries, 1970–1994. Source: FAO (1995a, 1995b).

Empirical studies of meat consumption by type

Historically, most variations in ruminant meat (particularly beef) consumption over time have been explained by changes in consumer income, own prices (i.e. the price of the specific product), prices of close substitutes to the specific product, consumer tastes and population.

Econometric studies have shown that income elasticities of demand for ruminant meat are positive and generally lowest in the countries with higher per capita beef consumption levels. The own-price elasticities of demand for ruminant meat for the selected countries are all negative but vary widely. Generally, however, the consumption of ruminant meat appears to be very sensitive to own-price changes in most of the South and South-East Asian countries studied. Within a particular country, poorer consumers are likely to be more responsive to price changes than wealthier consumers (Alderman 1986).

Overall, low positive cross-price elasticities indicate that relatively large price increases in pork and poultry are required to increase the demand for ruminant meat significantly. The annual changes in the ratio of ruminant to non-ruminant meat consumption per capita demonstrates the consistent and increasing dominance of non-ruminant meat consumption in most of the countries investigated (Figure 3).

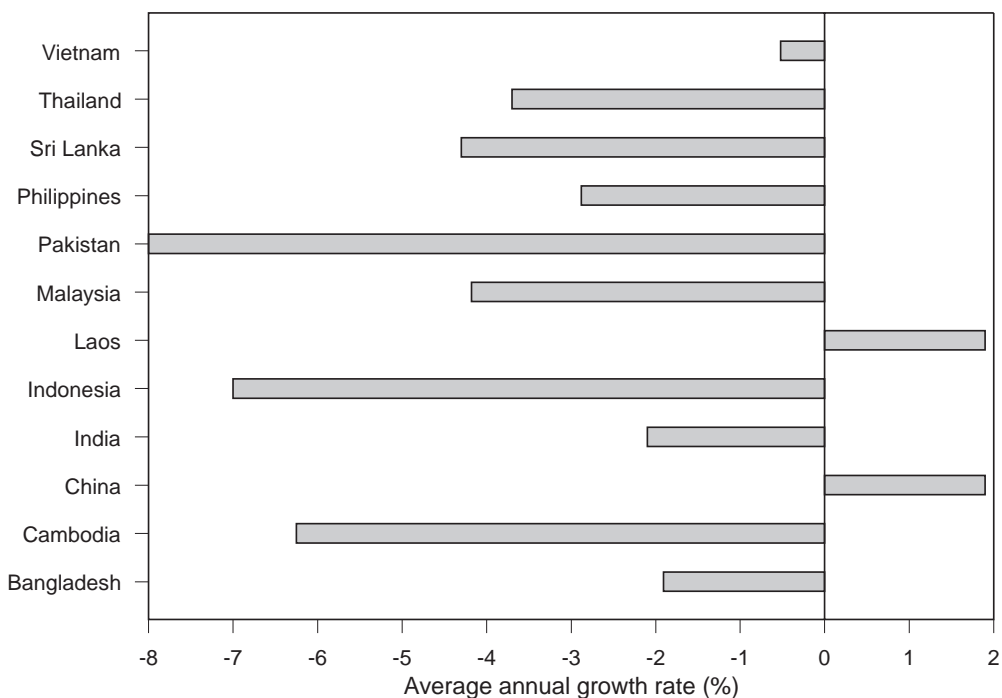


Figure 3. Average annual growth rates in the ratio of ruminant to non-ruminant meat consumption per capita for selected Asian countries, 1970–1994.

Source: FAO (1995a, 1995b).

The nature of meat production in South and South-East Asia

Ruminant and non-ruminant meat production in South and South-East Asia has been analysed by examining trends in livestock numbers, identifying the contribution of specific livestock species to meat production and assessing constraining factors.

Livestock numbers: importance in meat production in South and South-East Asia

Meat production in South and South-East Asia is derived from a number of livestock species (Tables 3, 4 and 5). Average annual growth rates for large ruminants are generally positive and largest in Indo-China. However, buffalo numbers are falling in Thailand, Malaysia, Sri Lanka and the Philippines (Figure 4). In Asia, cattle and buffaloes are an important source of milk, draft power and manure and are usually only sold or slaughtered when they are no longer useful for these purposes. In Indonesia, 25% of smallholders own cattle or buffalo (usually 1 to 3 head) that are used as draft animals in rice production and/or as a form of saving, providing nearly 70% of the draft power in Indonesia (DGLS 1992). Increased farm mechanisation has reduced the demand for draft cattle and buffalo and produced a swing from the production of draft animals to the production of meat from a range of species (particularly non-ruminants) and to egg production (see Table 5).

Goat and sheep numbers have also fallen in Sri Lanka whilst sheep numbers have increased rapidly in Thailand and Malaysia, albeit from a relatively small base, perhaps because they are more efficient producers of meat than buffalo (Figure 5). The negative growth rates in sheep and goat numbers in Sri Lanka are a cause for concern when considered in conjunction with the decline in buffalo and cattle numbers. The growth rates in non-ruminant numbers across all species (but particularly for pigs and chickens) have been generally greater and more consistent than those for ruminants (Figure 6). These trends are discussed in more detail in the following section on meat production systems in South and South-East Asia.

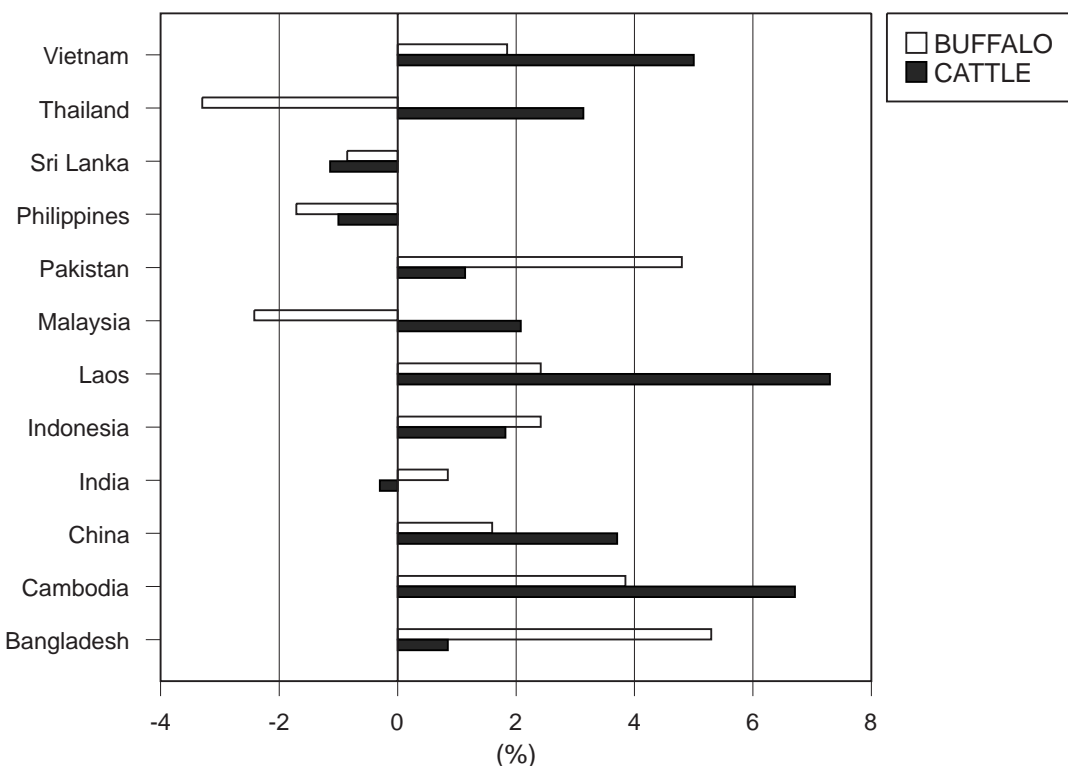


Figure 4. Average annual growth rates in cattle and buffalo numbers in selected Asian countries, 1983–1993.

Source: FAO (1995b).

Table 3. Livestock numbers by type in selected Asian countries, 1993.

	Cattle (‘000 hd)	Buffalo (‘000 hd)	Pigs (‘000 hd)	Sheep (‘000 hd)	Goats (‘000 hd)	Chickens (mill. hd)	Ducks (‘000 hd)
Bangladesh	239,323	866		989	25,967	109	14,441
Cambodia	2,468	804	2,043			10	3,800
China	82,641	22,217	393,965	109,720	97,812	2,688	429,719
India	192,700	78,555	10,547	44,608	117,547	435	
Indonesia	11,000	3,452	8,200	6,300	11,800	620	30,000
Laos	1,010	1,167	1,559		144	9	327
Malaysia	735	186	2,983	308	352	95	12,500
Pakistan	17,779	18,740		27,668	40,225	92	3,195
Philippines	1,781	2,561	7,954	30	2,562	65	8,394
Sri Lanka	1,600	870	90	19	500	9	40
Thailand	7,190	4,747	4,800	136	151	134	16,000
Vietnam	3,320	2,956	14,861		300	83	29,800

Source: FAO (1995b).

Table 4. *Livestock species' contribution to meat production in selected Asian countries, 1993.*

Country	Beef and veal (%)	Buffalo meat (%)	Pig meat (%)	Mutton and lamb (%)	Goat meat (%)	Poultry meat (%)
Bangladesh	43.1	0.9		0.6	27.2	28.1
Cambodia	20.0	12.0	40.0			28.0
China	5.1	0.8	75.1	2.0	1.8	15.2
India	32.4	30.1	9.9	4.7	12.2	10.7
Indonesia	12.9	3.5	39.5	3.2	3.8	37.2
Laos	10.3	20.1	48.2		0.2	21.4
Malaysia	1.5	0.4	25.5			73.3
Pakistan	19.7	27.7		16.2	26.7	9.7
Philippines	6.9	3.9	60.2		2.6	27.4
Sri Lanka	42.8	25.0	3.6		3.6	25.0
Thailand	16.3	3.2	24.3		0.1	56.0
Vietnam	7.9	8.5	66.9		0.6	16.1

Source: FAO (1995a, 1995b).

Table 5. *Populations of pigs, ducks and broiler chickens and egg production in selected countries, 1995.*

Country	Pigs (millions)	Ducks (millions)	Broiler chickens (millions)	Eggs (tonnes)
Bangladesh		12.0	123	73,401
Cambodia	2.0	4.0	16	10,400
China (all) †	(430)	(525)	(5,500)	(12,340,000)
India	11.0	10.0	451	1,446,000
Indonesia	8.0	33.0	690	420,000
Laos	1.6	0.35	35	37,000
Malaysia	2.8	6.5	473	350,000
Myanmar	2.8	4.0	99	46,921
Pakistan			225	258,000
Philippines	9.5	9.5	270	264,000
Sri Lanka	0.2		40	48,950
Thailand	6.0	18.5	580	423,500
Vietnam	14.0	32.5	190	136,000
Total	55.1	130	3,192	3,514,172
	†20% (86)	70% (368)	31.5% (1,732)	20.2% (2,492,680)

†South China's contribution but not included in the total.

Sources: Watt's Poultry Statistical Year Book (1996), FAO (1993), Chuang and Quinzhou (1995).

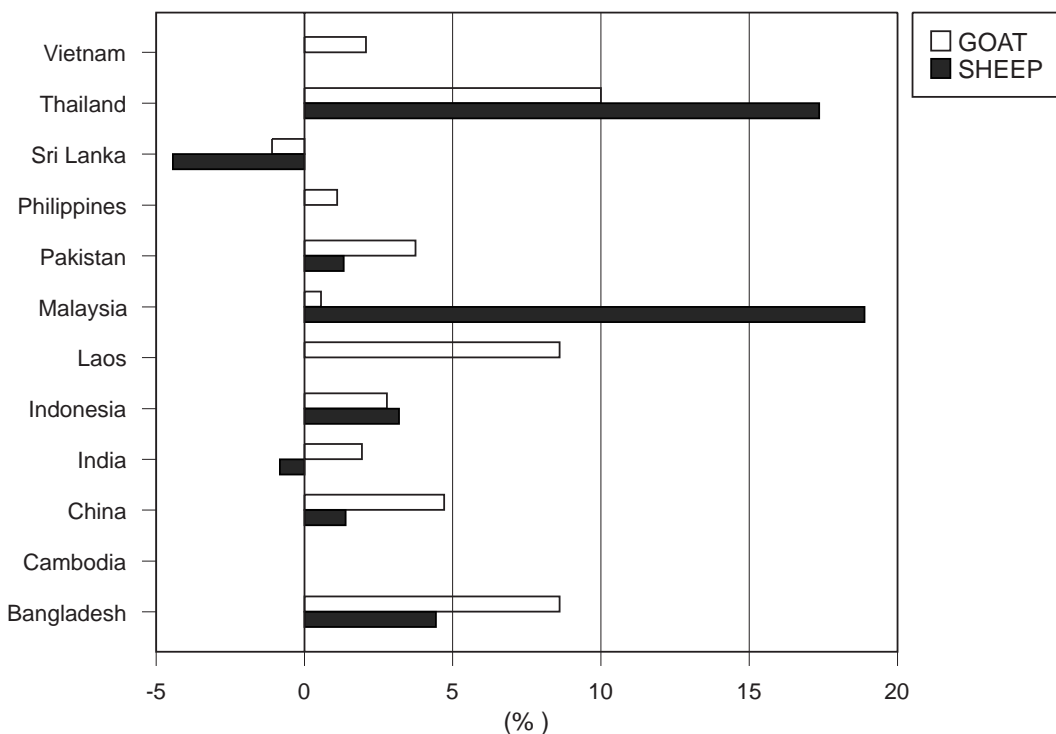


Figure 5. Average annual growth rates in goat and sheep numbers in selected Asian countries, 1983–1993.

Source: FAO (1995a).

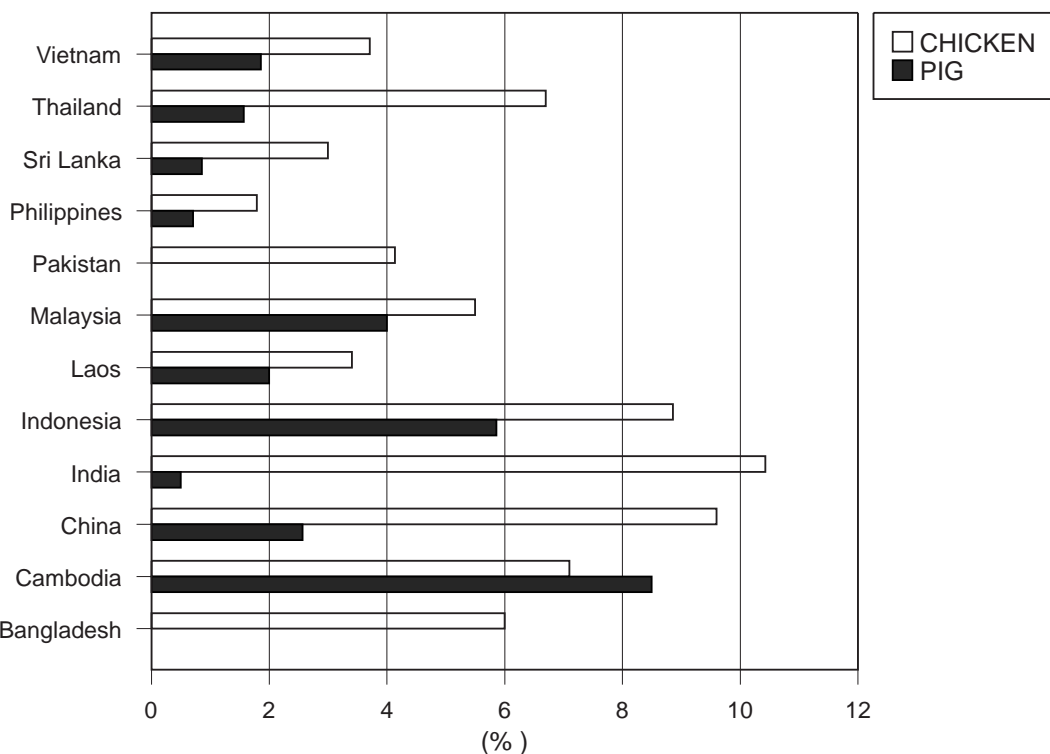


Figure 6. Average annual growth rates in poultry and pig numbers in selected Asian countries, 1983–1993.

Source: FAO (1995a).

Meat production in South and South-East Asia

Meat production in the region is dominated by smallholder systems, especially in the lower income South-East Asian countries and particularly in the ruminant meat sector. For poultry there has been a rapid transition to larger, commercial scale systems in the wealthier countries. For example, as a result of structural changes in Indonesia's livestock and poultry industry, from 1969 to 1991 the composition of Indonesia's total meat production changed rapidly; e.g. the contribution from beef dropped from 53 to 24%, buffalo meat from 16 to 4% while on the other hand poultry meat increased from 13 to 53%. The most evident change was the introduction of large-scale commercial production in the broiler industry in the early 1980s (DGLS 1992). Pig production is still largely a part of smallholder, rural-based, mixed systems but is in transition to larger scale operations in some of the wealthier countries.

Estimates of ruminant and non-ruminant meat production per person in South and South-East Asia reflect the consumption estimates by meat type (with a few notable exceptions), and indicate the countries' position as a net importer or net exporter of ruminant and/or non-ruminant meat (Tables 1, 4 and 6). China's non-ruminant production estimates are above consumption estimates, reflecting the fact that China continues to be a strong net exporter of non-ruminant meat (with net exports of 370,000 tonnes in 1994, the majority being pig meat exports). However, China has changed from being a net exporter of ruminant meat in the period 1988 to 1991 to a growing net importer of ruminant meat (with net imports of 52,000 tonnes in 1994). In considering economic growth and trends, the overriding influence of China cannot be ignored. Spectacular increases in per capita consumption of animal protein have occurred between 1983 and 1994 (Table 7) and these increases are likely to continue.

Table 6. *Meat production per person[†] by type for selected Asian countries, 1994.*

Country	Meat from cattle, buffalo, sheep and goats (kg/person)	Meat from poultry and pigs (kg/person)
Bangladesh	2.1	0.7
Cambodia [‡]	3.3	9.1
China	4.0	32.2
India	3.4	1.0
Indonesia	2.2	7.2
Laos [‡]	3.0	7.8
Malaysia	1.0	44.2
Pakistan	10.6	2.0
Philippines	3.1	20.6
Sri Lanka	1.9	2.9
Thailand	5.4	17.3
Vietnam	2.5	14.2

[†] Apparent meat production per person (abbreviated to meat production per person for brevity in the text) was calculated by summing meat obtained from the slaughter of live animals and dividing by the total population estimate for that year.

[‡] Trade figures were not available for Cambodia and Laos so production estimates were assumed to approximate consumption estimates.

Source: FAO (1995a, 1995b).

Table 7. *Meat consumption per person (kg) in China in 1984 and 1993.*

	Pig meat	Beef and mutton	Poultry meat	Eggs
1984	13.0	1.24	1.35	3.91
1993	24.0	3.12	4.93	10.14

Source: FAO (1995a).

Malaysia has been consistently increasing its net imports of ruminant meat (e.g. net imports of 61,000 tonnes in 1994) and has become a net exporter of non-ruminant meat (mainly chicken) since 1989 (e.g. net exports of 5000 tonnes in 1994). The Philippines and Indonesia have also been consistently increasing imports of ruminant meat, with net imports of 36,000 and 5000 tonnes in 1994, respectively. Conversely, India continues to be a strong net exporter of ruminant meat (with net exports of 126,000 tonnes in 1994). Thailand and Vietnam are both net exporters of non-ruminant meat, with net exports of 153,000 and 9000 tonnes, respectively in 1994. Thailand's strong net export position is attributable mainly to chicken meat whilst Vietnam's position is attributable almost exclusively to pig meat exports.

The underlying reasons for a number of the selected countries being net importers of ruminant meat (with the exception of India) and net exporters of non-ruminant meat are examined below in the discussion of factors constraining meat production.

Factors constraining meat production

Typically, in much of South and South-East Asia, meat production, particularly beef production, is constrained by one or more of the following factors (Simpson and Farris 1982; Piggot et al 1993):

- the availability of land for livestock raising and livestock feed production
- the availability of skilled labour in animal husbandry
- the availability of resources to control diseases and promote animal health
- the availability of capital and infrastructure at all meat marketing stages
- the general lack of related and supporting industries
- conditions governing the production and marketing of ruminant meat such as the country's social, cultural and religious history and political environment.

To highlight the effect of some of the more quantifiable factors on meat production, cross-sectional data on selected variables were collected and regressed against ruminant and non-ruminant meat production in two separate equations for the countries selected for the consumption studies (FAO 1995a, 1995b; World Bank 1992).

The results of this study indicated that the availability of permanent pasture land and the presence of a dairy industry are important factors in ruminant meat production whilst permanent cropping land, domestic coarse grain production and imports are important factors in non-ruminant meat production (Table 8). Permanent cropping land was expected to be an important factor in ruminant meat production given the reliance of ruminant production systems on crop by-products.

Land and feed resources

Given that the availability of land, specifically land suitable for animal and crop production, is an important factor in domestic meat production, the lack of this resource in most Asian countries (see population densities in Table 9) impacts negatively on meat production, particularly extensive ruminant meat production. The effects are felt via the availability of land for economically viable grazing, forage production and grain production for animal feeds.

Another important factor relevant to improvements in the various sectors of the Asian livestock industry is feed production, a factor linked to land availability and suitability. As countries develop, structural changes occur in feed grain self-sufficiency as a result of changes in meat production systems (Longmire and Gardiner 1984; Unnevehr 1991). Meat consumption increases with increasing incomes, thus encouraging domestic production. However, the traditional livestock and feed production techniques cannot adequately meet the growth in meat consumption. With rising incomes this leads to an increase in meat imports and/or changes in livestock production systems to those using greater amounts of feed grain per unit of livestock output (Table 8).

Table 8. Summary of factors affecting meat production per person[†] in selected countries, 1991.

Variable	Ruminant meat production per person (kg/person) Adjusted R ² = 0.87 Coefficient (t value)	Non-ruminant meat production per person (kg/person) Adjusted R ² = 0.37 Coefficient (t value)
Permanent pasture land (ha/'000 persons)	0.004 (4.36) ***	0 (0.141)
Permanent cropping land (ha/'000 persons)	0.032 (0.039)	0.208 (2.209) **
Dairy cattle/capita (hd/'000 persons)	0.38 (12.071) ***	0.013 (0.354)
Domestic production of coarse grains (kg/person)	0.03 (1.063)	0.14 (4.23) ***
Net coarse grain equivalent imports [‡] (kg/person)	-0.02 (-0.504)	0.165 (3.792) ***

[†] Apparent meat production per person (abbreviated to meat production per person for brevity in the text) was calculated by summing meat obtained from the slaughter of live animals and dividing by the total population estimate for that year.

[‡] Net coarse grain equivalent imports include actual volumes of barley, maize, rye, oats, bran and their milling by-products and double the volume of oilseed cake, meal and other vegetable oil residues traded.

** significant at 5%; *** significant at 1%.

Source: FAO (1995a, 1995b).

Table 9. Population densities for selected countries, 1993.

Country	Population density (persons/km ²)
Bangladesh	800
China	120
India	270
Indonesia	100
Laos	20
Malaysia	60
Pakistan	150
Philippines	220
Sri Lanka	270
Thailand	110
Vietnam	220

Source: World Bank (1995).

The process of structural change and increased productivity is generally slower in the more extensive ruminant sector compared to the more intensive pig and poultry industries where technology is more readily adapted (Longmire and Gardiner 1984). As a result of slower structural change, ruminant meat production has generally grown slowly, even declining in countries such as Malaysia, Sri Lanka, the Philippines and Bangladesh (APO 1990; Costales 1990; Figure 7).

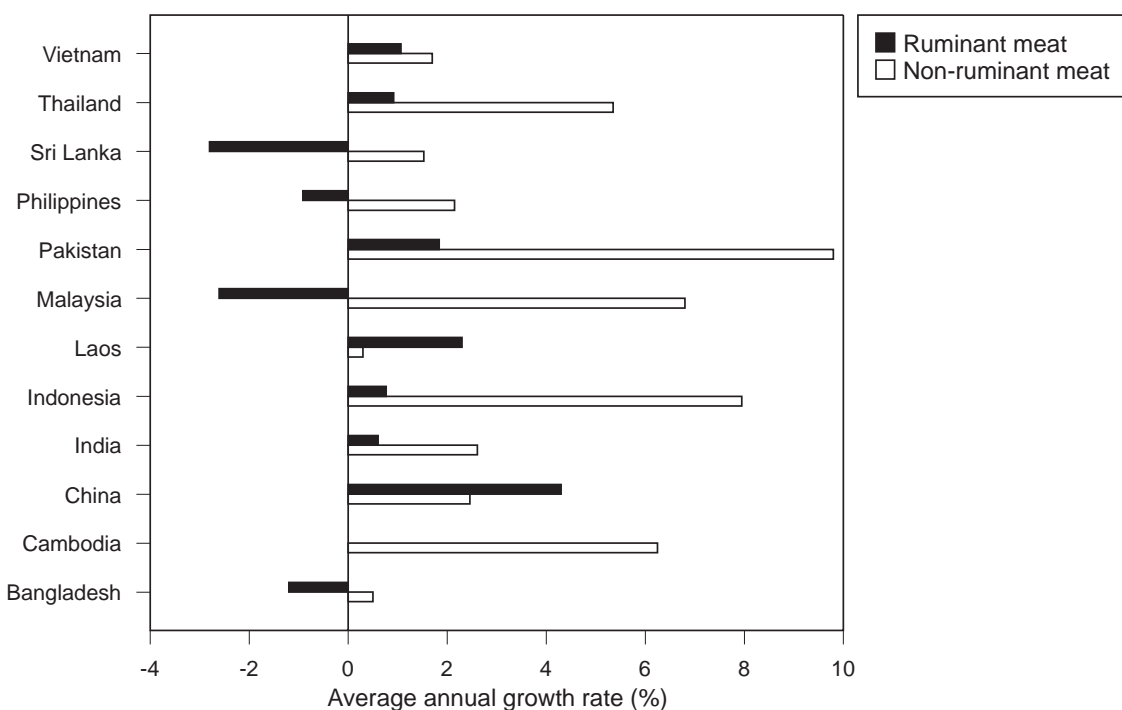


Figure 7. Average annual growth rates in meat production by type for selected Asian countries, 1970–1994.

Source: FAO (1995a, 1995b).

The proportion of non-ruminants that are grain fed is generally lower in lower income South and South-East Asian countries compared to the higher income countries of the region, but the proportion is growing more rapidly in the lower income countries (Tyers and Anderson 1992). As mentioned previously, due to land constraints on domestic feed grain and pasture production, structural changes in the livestock industries leads to a growth in feed grain imports and a reduction in livestock feed self-sufficiency. For example, in the Philippines, the value of imports of feedstuffs for animals (excluding unmilled cereals) quadrupled from 1985 to 1989, reaching US\$180 million in 1989, amounting to 13.5% of the total value of agricultural imports (Costales 1990).

Agricultural developments that have occurred throughout Asia in recent years have been largely based on the introduction of high-yielding strains of cereals and associated increased requirements for inputs such as chemical fertilisers and skilled labour under the Green Revolution that began in the 1960s. These improvements were especially strong for rice and wheat in Asia although the net impact on the availability of feed grains was also positive (CIMMYT 1992). As Asia develops, even with increased cropping density, it will become increasingly difficult for it to maintain its past growth rates for arable land and for land productivity as diminishing returns intensify with technological advances and production moves to more marginal lands (Hayami et al 1976; Hooke 1989). The sustainability of such systems is of concern.

Further increases in ruminant livestock production are less dependent on the availability of feed grains than the non-ruminant sectors in much of South-East Asia owing to the availability of agro-industrial by-products. Ruminant livestock feeding enterprises often develop around a food-processing plant or oil mill to take advantage of available, often low-cost, by-products. By-products, as a ruminant feed source, are often limited by insufficient availability. This is due to the seasonality of the crop and its high moisture content, limiting the distance the by-product can be transported to the ruminant meat producing areas without further processing. However, whilst their low cost is considered to be a major advantage in beef production, the cost of utilising these feed inputs is usually understated in terms of foregone export opportunities for feed and/or

reduced soil fertility and structure. Also competition has increased between the users of palm kernel cake in Malaysia, namely domestic feedlots and overseas intensive feed suppliers. As a consequence, feedlot input costs have risen and the viability of feedlotting based on palm kernel cake has declined.

The growth in meat production in Asian countries, especially that in non-ruminants, is likely to lead to a reduction of feed grain self-sufficiency (Table 8; Longmire and Gardiner 1984; Unnevehr 1991). As an indication of dependence on total grain imports, estimates of coarse grain self-sufficiency are provided for selected Asian countries (Table 10).

Table 10. *Coarse grain self-sufficiency in selected countries, 1990.*

Country	Self-sufficiency [†] (%)
Malaysia	2
Thailand	149
Philippines	82
Indonesia	106
China	98

[†]Self-sufficiency rate = (domestic production/domestic consumption) × 100

Source: FAO (1995a, 1995b).

Other constraints

Marketing systems in Asia have been criticised for inefficiencies. The marketing of livestock and livestock products in many Asian countries is often handicapped because of the dispersed nature of production and the consequent need to assemble supplies from many small farm holdings, transport discontinuities between islands, inadequate transport infrastructure and refrigeration facilities, and a large number of market intermediaries (Unnevehr 1991; Anderson 1992; Rae et al 1992). Shipping cattle from outer islands in particular tends to reduce the quality of the cattle and subsequently the beef derived from them (Mubyarto et al 1973).

The non-ruminant sector in Asia is generally well supported, e.g. with disease investigation centres; vaccine and drug production, animal drug assay and diagnostic laboratories; meat laboratories; animal health posts; regional animal quarantine centres; slaughter houses; regional centres for breeding and forage production; and artificial insemination centres. In Indonesia, some 100 feed mills, 1400 veterinary drug sellers, 88 parent stock farms and 14 grandparent stock farms support the domestic poultry industry. By contrast, in 1991 there were only five slaughter houses in Indonesia capable of slaughtering cattle to a suitable standard for processing and marketing to supply the higher-priced beef market segments. The lack of carcass processing facilities has been described as even more restrictive (AMLC 1993).

Milk production and consumption in South and South-East Asia

The nature of milk production in South and South-East Asia is varied (Figure 8; Table 11). The range in milk production in 1993 was from approximately 130 kg/capita in Pakistan (sourced largely from buffalo) and 70 kg/capita in India (sourced largely from cattle and buffalo) to approximately 1 kg/capita in the Philippines (also sourced from buffalo and cattle).

Average annual growth rates in total milk production from 1983 to 1993 also vary widely across the selected countries, ranging from an average of almost 20% per annum in Thailand (36,000 tonnes in 1983 to 170,000 tonnes in 1993) to being slightly negative for the Philippines. These patterns are reflected in the average annual rates of growth in cattle and buffalo numbers as the major contributors to milk production in each case (Table 11; Figure 8).

Only India and Pakistan are totally or nearly self-sufficient with respect to milk requirements as indicated by 1992 estimates of domestic milk as a percentage of total domestic milk consumption per capita

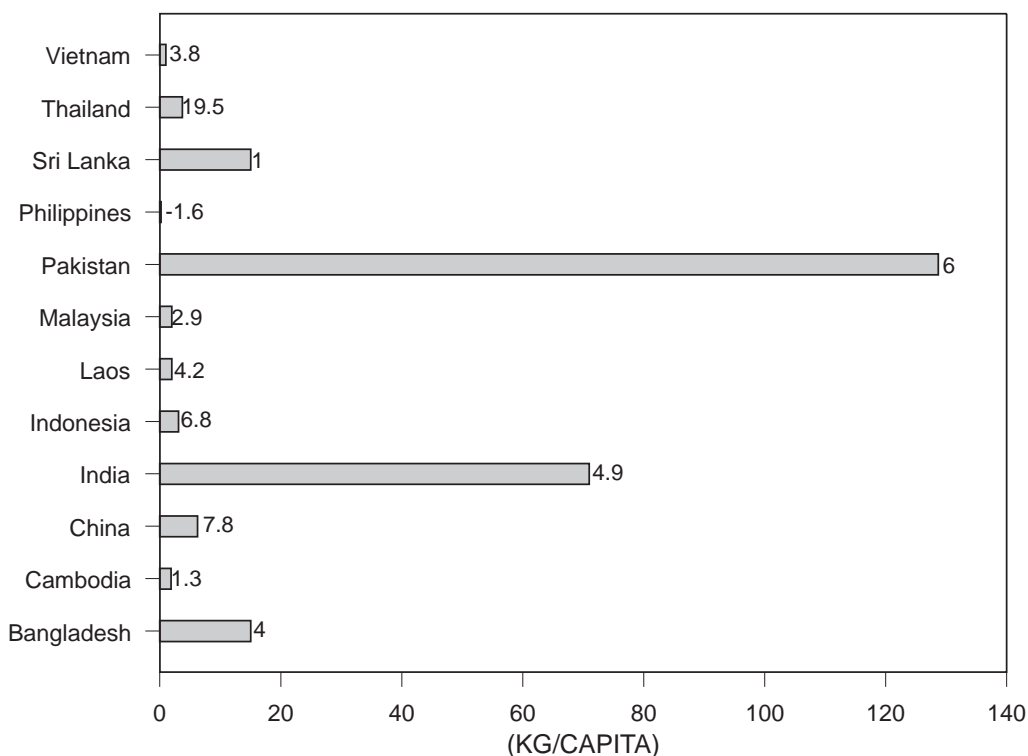


Figure 8. Milk production per capita in selected Asian countries, 1993, and annual average growth rates in total milk production, 1983-93 (interior labels).

Source: FAO (1995a, 1995b).

Table 11. Total milk production (tonnes) and sources of milk production as a percentage, in selected countries, 1993.

Country	Total (t)	Cow (%)	Buffalo (%)	Goat (%)	Sheep (%)
Bangladesh	1,806.0	43	1	55	1
Cambodia	18.7	NA	NA	NA	NA
China	8,134.3	65	25	2	8
India	61,000.0	50	47	3	—
Indonesia	661.4	61	NA	28	11
Laos [†]	11.2	NA	NA	NA	NA
Malaysia	43.4	76	24		
Pakistan	17,120.0	23	73	4	>1
Philippines	32.0	52	48		
Sri Lanka	280.7	74	24	2	
Thailand	151.0	96	4		
Vietnam [†]	68.8	59	41		

NA = not available.

[†] Values disputed by some members of the Steering Committee.

Source: FAO (1995a).

in that year (Table 12). For the majority of the countries studied, domestic milk production is supplemented with imported milk to satisfy domestic consumption requirements, particularly in the Philippines, Malaysia and Thailand. The prediction of trends in the case of Laos is impossible given the available data and the very low level of consumption.

Table 12. Domestic milk contribution to total domestic milk consumption, 1992, and the percentage change since 1982.

Country	Domestic milk contribution to consumption 1992 (%)	Change in domestic milk contribution 1982–1992 (%)
Bangladesh	88.8	–0.5
Cambodia	69.2	–30.8
China	90.2	6.9
India	99.3	0.2
Indonesia	64.8	71.4
Laos [†]	100.0	85.9
Malaysia	4.3	–36.8
Pakistan	98.9	2.3
Philippines	2.7	–22.9
Sri Lanka	51.5	–26.1
Thailand	19.2	56.0
Vietnam	70.5	11.9

[†]Values considered unreliable by some members of the Steering Committee.

Source: FAO (1995a).

Forecasts of milk self-sufficiency

Milk production and consumption per capita have been forecast. These estimates are based on milk production and consumption per capita estimates for 1994 and applying average annual growth rates in production (estimated for 1983–1994) to estimate per capita production in 2000 and 2010, assuming the long-term trend in growth rates continued (Figures 9 and 10). Consumption estimates for milk have been derived in the same manner described previously for meat, using the whole milk conversion factor of 8.2 to convert the weight of dry milk to fluid milk equivalents (Australian Dairy Corporation, unpublished data).

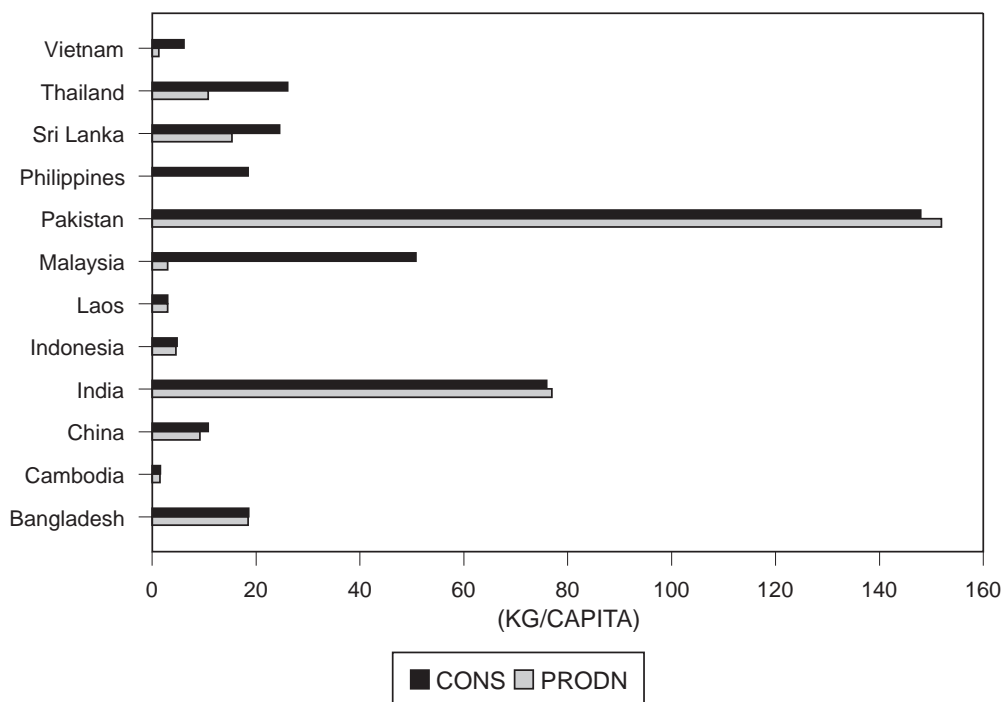


Figure 9. Milk production and consumption forecasts in selected Asian countries, 2000.

Source: FAO (1995a, 1995b).

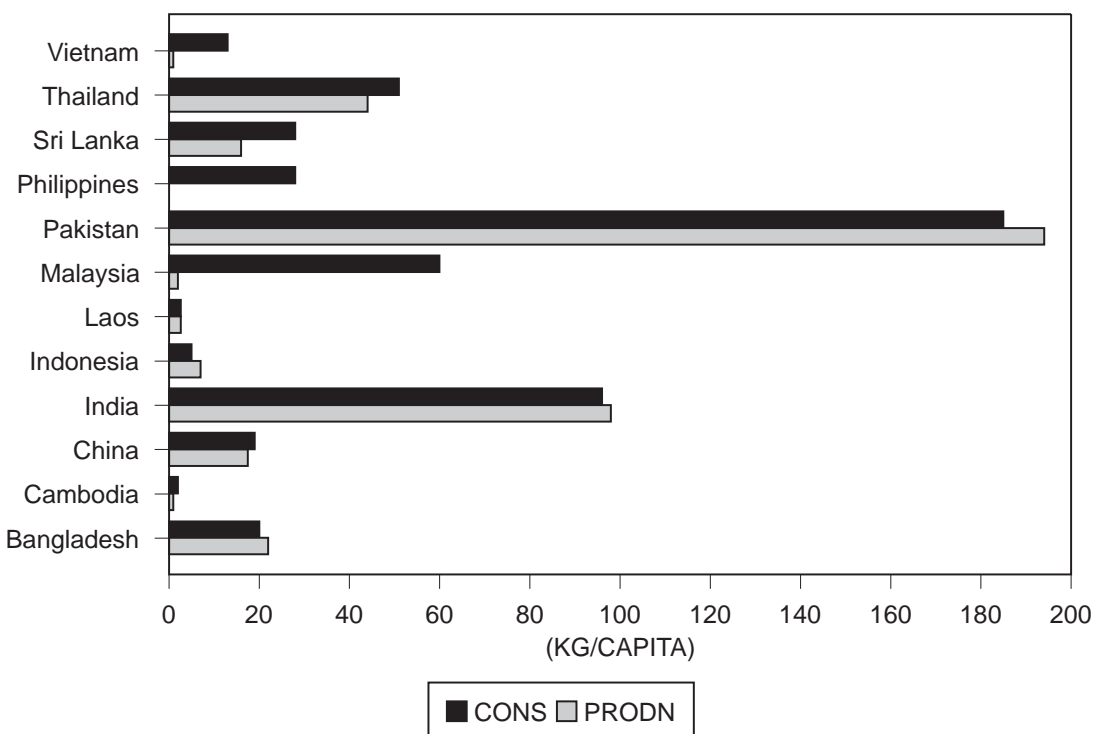


Figure 10. Milk production and consumption forecasts in selected Asian countries, 2010.

Source: FAO (1995a, 1995b).

Pakistan and India are likely to be self-sufficient with respect to milk production and consumption in 2000 and 2010. However, on present trends, domestic consumption requirements are likely to be greater than domestic production in the remaining countries by 2000, particularly in Malaysia, the Philippines, Thailand, Sri Lanka and Vietnam. The gap between domestic milk consumption and production is forecast to increase in the Philippines, Vietnam, Laos (despite the appearance of self sufficiency for the very low consumption) and Cambodia but to decrease in Thailand, Indonesia and Bangladesh, with the last two countries becoming self-sufficient by 2010.

Forecasting meat production and consumption in South and South-East Asia

The demand for meat is likely to continue to increase as a result of population growth, continued urbanisation and increases in real disposable income (Hooke 1989). For example, in 1995 approximately 55% of the populations of the Philippines and Malaysia were urban, a 59 and 74% change in the last 25 years (Figure 11). Without rapid structural transformation and increases in productivity, the population pressures are likely to restrict profitable domestic beef, dairy and feed grain production, thereby further reducing dairy, beef and/or feed grain self-sufficiency in a number of countries.

Forecasting meat production and consumption by type in South and South-East Asia

Ruminant and non-ruminant meat consumption in selected South and South-East Asian countries has been projected for the years 2000 and 2010 using 1993 consumption figures as the base (Tables 13 and 14). These

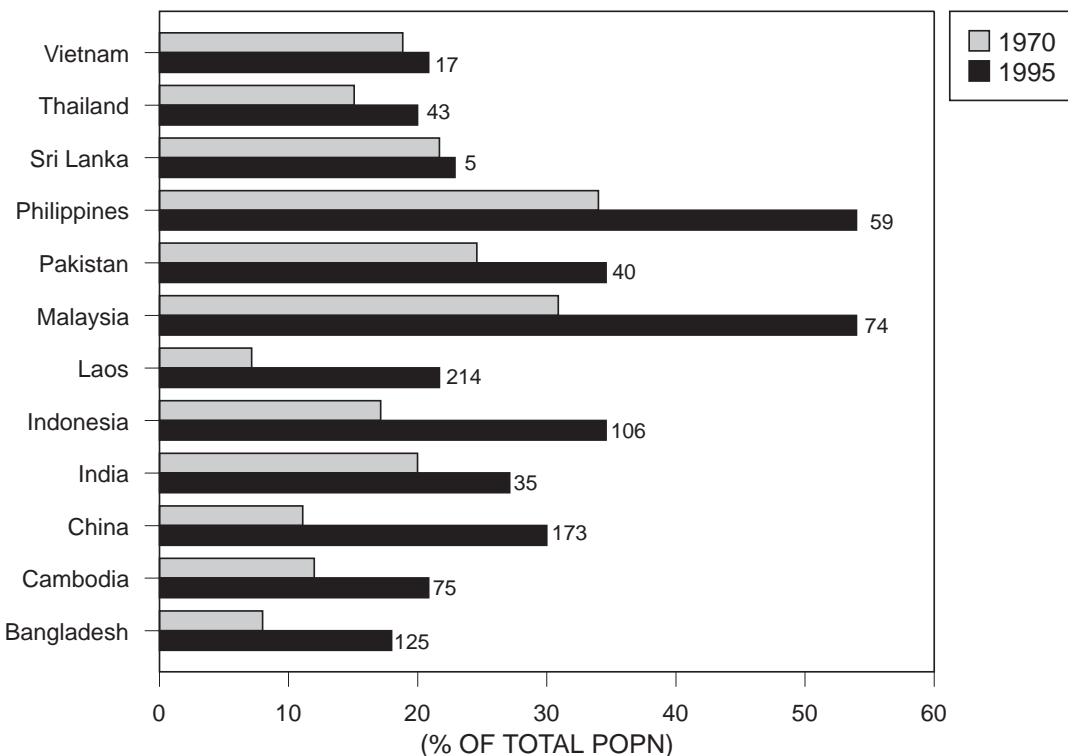


Figure 11. *Urban population as a percentage of the total population in selected countries, 1970 and 1995 (percentage change from 1970–1995 indicated with interior labels).*

Source: FAO (1995a).

estimates, together with estimates of rates of population growth, per capita income growth (i.e. GNP/capita) and income elasticities of demand for ruminant and non-ruminant meat, have been used to project percentage changes in meat consumption following the method described by Holtzman (1988). The methodology is described in Appendix I.

Ruminant and non-ruminant production per capita forecasts were also estimated. These estimates were based on ruminant and non-ruminant production per capita estimates for 1994 and applying average annual growth rates in production (estimated for 1970–1994) to estimate per capita production in 2000 and 2010 assuming the long-term trend in growth rates continued (Tables 13 and 14).

Ruminant meat

Given the forecast changes in population and in income (Tables 15 and 16), the forecasts of ruminant meat production and the predicted upper and lower values for ruminant meat consumption for the year 2000, the indications are that domestic production will be unable to meet future ruminant meat consumption in most of the selected countries, with the possible exceptions of China, Pakistan and perhaps Vietnam. In Malaysia there is a large discrepancy in the production/consumption balance suggesting an increasing reliance on ruminant meat imports to satisfy the domestic demand for ruminant meat.

For China, these forecasts indicate a swing back to the earlier trend of being a net exporter of ruminant meat in the period prior to 1992. The projections indicate that India's present position of being a net exporter of ruminant meat will change to one of being self-sufficient.

Forecasts of ruminant meat production and consumption to 2010 reveal the same general trends as those forecasts for 2000. Widening gaps between domestic production and domestic consumption requirements are particularly evident for Malaysia and Thailand (despite production increases) with the converse being true for China.

Table 13. *Forecast ruminant and non-ruminant meat production and demand per person, 2000.*

Country	Ruminant meat demand (kg/capita)	Ruminant meat production (kg/capita)	Non-ruminant meat demand (kg/capita)	Non-ruminant meat production (kg/capita)
Bangladesh	2.3–2.4	1.9	0.8–0.8	0.7
Cambodia [†]	3.6–3.9	3.3	9.7–10.5	9.1
China	4.1–5.1	5.4	38.4–48.5	38.5
India	3.7–4.1	3.6	1.1–1.2	1.2
Indonesia	3.1–3.6	2.3	8.3–9.7	12.3
Laos [†]	3.2–3.5	3.0	8.4–9.0	7.8
Malaysia	4.4–4.9	0.8	49.6–56.5	71.0
Pakistan	11.5–12.7	12.1	13.3–14.9	3.8
Philippines	3.4–3.6	2.9	21.5–23.0	24.0
Sri Lanka	2.1–2.3	1.6	2.6–2.9	3.2
Thailand	6.0–7.4	5.7	20.4–25.6	25.0
Vietnam	2.7–2.9	2.7	15.8–17.2	16.0

[†]In the absence of trade information, the ruminant and non-ruminant meat production estimates for Cambodia and Laos were not forecast but given as the 1994 estimates for approximate comparison purposes.

Source: FAO (1995a, 1995b).

Table 14. *Forecast ruminant and non-ruminant meat production and demand per person, 2010.*

Country	Ruminant meat demand (kg/capita)	Ruminant meat production (kg/capita)	Non-ruminant meat demand (kg/capita)	Non-ruminant meat production (kg/capita)
Bangladesh	3.0–3.4	1.7	1.0–1.2	0.8
Cambodia [†]	5.2–5.9	3.3	14.2–16.3	9.1
China	5.8–7.4	8.5	54.5–71.3	49.8
India	5.1–6.2	3.8	1.5–1.9	1.6
Indonesia	4.6–6.0	2.5	12.3–16.7	26.2
Laos [†]	4.8–5.4	3.0	12.4–14.2	7.8
Malaysia	6.3–7.9	0.6	73.7–93.9	139.6
Pakistan	16.9–20.3	14.6	19.8–24.5	9.8
Philippines	4.4–4.9	2.7	27.8–31.7	29.8
Sri Lanka	2.7–3.3	1.2	3.4–4.3	3.8
Thailand	10.1–14.8	6.3	35.5–53.5	42.3
Vietnam	3.6–4.2	3.0	21.5–25.2	18.9

[†]In the absence of trade information, the ruminant and non-ruminant meat production estimates for Cambodia and Laos were not forecast but given as the 1994 estimates for approximate comparison purposes.

Source: FAO (1995a, 1995b).

Beef and live cattle imports redress the imbalance in domestic beef production and consumption. Asia already contains some of the world's largest beef and live cattle importing countries. Live cattle imports are generally favoured over imports of beef by Asian government policies for a number of reasons, including contribution to domestic value-adding in the case of cattle requiring further feeding and processing before slaughter. They may also improve the productivity of the local beef herd in the longer term, in the case of imports of breeder cattle. Imports of live animals for slaughter, rather than importing meat, overcomes the problems of storage and distribution associated with the lack of refrigeration. Local slaughter also overcomes any special cultural requirements, such as halal procedures and observances. Relative to the major exporting countries, the Asian countries currently importing live cattle possess a comparative advantage in the latter stages of beef production such as the availability of low cost agro-industrial by-products, low labour costs and consequently lower meat processing charges, government underwriting of some operations and lower health and hygiene requirements.

Table 15. *Population estimates for selected countries, 1993, 2000 and 2010.*

	Population (‘000) 1993	Population AAGR 1980–1993	Population (‘000) 2000	Population % change 1993–2000	Population (‘000) 2010	Population change (%) 1993–2010
Bangladesh	115,203	1.8	130,526	13.3	156,018	35.4
Cambodia [†]	9,683	3	11,909	23	16,005	65.3
China	1,196,360	2.9	1,461,401	22.2	1,945,016	62.6
India	901,459	1.7	1,014,361	12.5	1,200,611	33.2
Indonesia	191,671	1.6	214,196	11.8	251,044	31
Laos	4,604	3.2	5,740	24.7	7,865	70.8
Malaysia	19,246	2.3	22,567	17.3	28,329	47.2
Pakistan	132,941	2.7	160,196	20.5	209,101	57.3
Philippines	64,800	1.8	73,419	13.3	87,758	35.4
Sri Lanka	17,897	1.1	19,321	8	21,555	20.4
Thailand	57,584	1.4	63,470	10.2	72,937	26.7
Vietnam	71,323	2.1	82,492	15.7	101,547	42.4

[†]In the absence of consistent estimates of average annual growth rates in the population from 1989 to 2000, an average annual growth rate of 3.0 was assumed for Cambodia based on an estimate by FAO from 1991 to 1995.

Sources: FAO (1995a), World Bank (1995).

Table 16. *Income statistics for selected countries, 1993, 2000 and 2010.*[†]

	GNP/C 1993	GNP/C AAGR 1980–93	GNP/C 2000	GNP/C % change 1993–2000	GNP/C 2010	GNP/C % change 1993–2010
Bangladesh	220	2.1	254	15.5	313	42.3
Cambodia	280	2.1	324	15.7	399	42.5
China	490	8.2	794	62	996	103.3
India	300	3	369	23	496	65.3
Indonesia	740	4.2	987	33.4	1,489	101.2
Laos	280	2.1	324	15.7	399	42.5
Malaysia	3,140	3.5	3,995	27.2	5,635	79.5
Pakistan	430	3.1	532	23.7	723	68.1
Philippines	850	1.6	950	11.8	1,113	30.9
Sri Lanka	600	2.7	723	20.5	944	57.3
Thailand	2,110	6.4	3,242	53.6	6,029	185.7
Vietnam	170	2.1	197	15.9	242	42.4

[†] Due to the absence of data on GNP per capita for Cambodia and average annual growth rates in GNP per capita for the same, Laos and Vietnam, estimates were used. In addition, the average annual growth rate in GNP per capita for China was reduced to the average for middle income countries of 2.3 by the year 2000 and then remained at 2.3 to 2010. The positive average annual growth rate in GNP per capita for the Philippines for the period 1965 to 1990 of 1.6 was used in preference to the estimate of –0.6 for the period 1980 to 1993 for forecasting purposes.

Source: World Bank (1995).

Non-ruminant meat

Non-ruminant meat production in most of the selected countries is forecast to meet consumption requirements. Countries such as Malaysia and Indonesia are likely to be net exporters of non-ruminant meat. Pakistan, on the other hand, is forecast to have a significant imbalance between non-ruminant meat consumption and production, suggesting an increased reliance on imports to satisfy domestic consumption. Forecasts of non-ruminant meat production and consumption to 2010 indicate the same general trends as

forecasts for 2000, with Indonesia and Malaysia being net exporters of non-ruminant meat and Pakistan being a net-importer (Tables 13 and 14).

These forecasts are based on the assumption that previous trends can be used to predict future trends. However, key factors such as the political environment surrounding both ruminant and non-ruminant meat production can affect these forecasts. For example, current South-East Asian government policies favour the importation of live cattle versus beef. These policies include general policies such as higher import tariffs on beef (up to 60% compared to 3–30% for cattle) as well as more specific government importing programmes for breeder cattle and policies affecting the beef sector directly (such as import restrictions on beef and live cattle, price and marketing controls, subsidised credit and the curtailment or implementation of government importing programmes) or indirectly (such as import, production or price restrictions in other livestock and feed sectors).

Political environment

Until recently, the broad national policies regarded as being conducive to development, and thus adopted by most developing countries, were based on fostering industrialisation via import substitution in the manufacturing sector (Bautista 1988; Krueger 1992). More recently, the political focus has moved away from import substitution towards a more efficient utilisation of resources in a more balanced approach to development.

Policy biases towards agricultural production increased in a number of Asian countries in the 1980s, reflecting their aspirations towards achieving greater food self-sufficiency and security in animal- and plant-sourced protein, particularly from ruminant livestock and rice, respectively (Simpson and Farris 1982; Longworth, 1983; AIDAB 1989; Blair and Lefroy 1990; Fitzpatrick 1991; Manzo and Tanguin 1992; Piggot et al 1993). In the period 1980 to 1989, nominal rates of protection for beef in South-East Asia were positive (except in Indonesia) although important regional differences were identified (Rae and Lough 1989). More recent estimates of the nominal rate of protection for beef in Indonesia of 7% indicate that the traditional bias against domestic beef production in Indonesia has also been reversed (Trewin et al 1995).

Estimates of the effects of policies ignores the indirect distortions of other incentives and non-tariff barriers (Tyers and Anderson 1992). Import policies affecting live cattle trade more indirectly include such things as tariffs on other livestock industry imports (including pig and poultry meat) and inputs such as feed, semen, veterinary medicines and farm machinery. Feed-grain trade in the Pacific Basin, however, is generally not distorted by trade policies of importing countries (Harris et al 1990).

Future policy effects

The recent rounds of the World Trade Organisation (previously the General Agreement on Tariffs and Trade—GATT) demonstrate that policy makers are now pushing for liberalisation as a means of achieving greater economic development, using measures that generally involve neutralising incentives for exports and imports, e.g. removal of import quotas and other quantitative restrictions or their conversion to tariffs. Other such measures include a reduction of the level and dispersion of import tariff rates, compensatory devaluation of the national currency, and the removal or reduction of export taxes. These measures typically form the core of comprehensive structural adjustment measures adopted in response to conditional finance available from multilateral financial institutions such as the World Bank and the International Monetary Fund (Shafaeddin 1994).

Regionalisation, and associated trading arrangements, has become the latest international trade policy issue (Garnaut and Drysdale 1994; Wu 1995). Special bilateral or regional trading arrangements are evolving between developing countries in Asia and some of the larger Organisation of Economic Co-operation and Development (OECD) countries (Hooke 1989). To date, Asia's regional trading arrangements have been focused on intra-ASEAN and Asia-Pacific trading arrangements. For example, the Asia-Pacific Economic Cooperation (APEC), now with 16 member countries including Australia, Brunei, Canada, China, Hong Kong, Indonesia, Japan, Korea, PNG, Malaysia, New Zealand, the Philippines, Singapore, Taiwan, Thailand

and the United States, was initiated in 1989 with the aim of facilitating regional trade liberalisation in a manner consistent with GATT principles. In addition, in January 1992, the Asian Free Trade Area (AFTA) was established with the aim of facilitating the expansion of intra-ASEAN trade, and thus economic growth, via the reduction of tariff and non-tariff barriers for participating member countries.

Implications for intra-regional and inter-regional trade of livestock products

Based on the forecasts of ruminant and non-ruminant meat production and consumption, some future intra- and inter-regional trade opportunities are evident. For example, China theoretically could supply South and South-East Asia with ruminant meat. Similarly, evidence from Malaysia and Indonesia suggests that these countries will be net exporters of non-ruminant meat by the year 2000, potentially meeting the shortfall of non-ruminant meat production that is forecast for individual countries in the region, e.g. Pakistan. Regional trading arrangements such as AFTA would serve to promote this trade in the region.

Other countries in and adjacent to the region such as Australia and New Zealand and possibly even some South American countries are well positioned to help meet the future demands for ruminant meat and/or cattle of the region. Again, the potential impacts of APEC in facilitating this trade are considered to be significant.

Of the countries studied, Malaysia, Indonesia, China and Thailand export fresh and dry milk whilst India and Sri Lanka export dry milk. All, however, are net importers of milk. This suggests that limited inter-regional trade in both fresh (particularly China) and dry milk (particularly Malaysia) occurs where countries have secured a competitive advantage in selected markets. However, most of the traded product is imported fresh and dry milk from countries such as Australia, New Zealand and the European Union.

Finally, as a result of trade reform, the prices of beef and dairy products are predicted to increase in the range of 3 to 51% depending on the degree of liberalisation. Depending on how these market signals are transmitted throughout the market, the impacts on livestock production in the region could be significant, requiring a re-appraisal of forecast trends in domestic consumption and production as well as intra- and inter-regional trade opportunities.

Conclusion

There is a growing demand for livestock products in South and South-East Asia as a result of economic development (i.e. increasing income per capita), increasing population sizes, and changes in tastes and preferences. Based on historical evidence, the problem for a number of countries studied will be how to meet the increasing domestic demand for livestock commodities, particularly ruminant meat.

Structural changes in domestic industries leading to increased self-sufficiency in meat production, particularly in the non-ruminant sectors of the livestock industry, and for milk production, are evident in the region. However, the resultant increase in meat and milk self-sufficiency is at the expense of feed-grain self-sufficiency, which will impact on, and may undermine, food security. Furthermore, the socio-economic and environmental considerations such as poverty alleviation and environmental protection may be better served by alternative solutions, such as freeing trade to facilitate the capture of the gains from specialisation and trade in ruminant and non-ruminant meat production.

Ducks and other minor species, often important components in mixed farming systems, are likely to play a more significant role in providing a diversity of animal products as nations become more affluent. The vexed question as to who will actually benefit directly from this projected increase in the supply of animal protein will not be addressed here.

As countries of the region strive for self-sufficiency in meat and milk (and eggs), the challenge for ILRI and its collaborators is to identify those production systems most likely to contribute to the required production increases, to participate strategically in the development of technologies that will underpin the productivity increases, and to assist in the identification and promotion of those aspects of national

agricultural policy and the marketing systems that will drive the production imperative and the associated economic benefits.

Quantification and understanding of the direct and indirect policy effects is critically important to future development. This is particularly so for the agricultural sector and its sub-sectors because of their importance in economic development. Regionalisation and associated trading arrangements are international trade policy issues that are likely to be major features affecting development in the region.

3. Meeting the demand for livestock products

Background

Section 2 has identified the trends in demands for livestock products in selected countries of South and South-East Asia as well as some surpluses and shortfalls that are likely on the supply side, if present trends continue. Although some of the deficits will be satisfied by importation from within or without the region, particularly amongst the wealthier countries, a substantial proportion of the projected increase in production will be achieved by each country from within its existing resources. Given the projected population increases in most of Asia, even to maintain existing levels of per capita consumption will require substantial increases in production. The challenge for ILRI is to contribute to the ability of these countries to respond to the increased demand by conducting targeted, strategic research and development (R&D) in close concert, or in collaboration with NARS.

Production systems

Livestock production systems of the world have been recently characterised in both quantitative and qualitative terms by FAO (1996) and conveniently summarised by Sere et al (1995) at the ILRI Nairobi consultation. Eleven systems have been identified based on the following three main criteria: integration with crops, relation to land and agro-ecological zone. The new classifications incorporate the earlier descriptions of South and South-East Asian production systems by Camoens (1991) and de Boer (1992). In South and South-East Asia the most relevant of these systems to livestock production, in terms of their productivity and the population they support, are the:

- mixed rainfed in arid and semi-arid tropics and subtropics (MRA)
- mixed rainfed in humid and semi-humid tropics and subtropics (MRH)
- mixed irrigated in humid and subhumid tropics and subtropics (MIH)
- mixed irrigated in arid and semi-arid tropics and subtropics (MIA).

Grazing-based, transhumant systems are important to small areas of the region, e.g. in parts of India and Pakistan and in Nepal and Bhutan. However, they support a very small proportion of the population and do not offer significant opportunities for improvement to productivity. Although they pose major problems in terms of resource management and sustainability, they are not considered here because of their negligible capacity to contribute to the future demands for animal protein.

MRA systems support 10% of the world's human population with the great majority of this 10% located in Asia. These systems support large ruminants, mainly cattle, in cropping areas and an increasing proportion of Asia's sheep and goats. MRH systems include the rice–buffalo associations, mainly in South-East Asia, and are relevant to about 14% of the world's human population. MIH systems are arguably the most important to South-East Asia since they include the irrigated rice–buffalo smallholders of the region. They are relevant to 990 million people, 97% of whom are in Asia. The MIA systems are most prevalent in South Asia; they support 500 million people in Asia generally and predominate in the production of milk and meat from small and large ruminants. Although the major livestock species associated with each of these systems can be nominated, to do so misses the importance of the mixture of species to the functioning of these systems and the wellbeing of the smallholders.

Within each of these classifications there are also differences associated with the scale of the operation involved which, in relation to possible improvements and the R&D opportunities, need to be recognised. There are the village-based 'backyard' operators where the livestock are local breeds which essentially scavenge around the village, inputs are very low and productivity (growth and reproductive rates) are also low. There are also village-based smallholder systems where there is evidence of some specialisation and the use of improved technology in terms of genotypes, health care and husbandry. There is a greater orientation towards marketing, particularly in close proximity to major urban areas, e.g. peri-urban dairy systems. These systems are probably the

best target for any new developments in R&D because they are systems in transition from traditional practices to improved methods and production levels. Finally there are the commercial type, large-scale operations that are already accessing the latest technology, are well financed and managed. These are not a priority for publicly funded R&D efforts.

Environmental impacts

The FAO/multi-donor study on ‘Interactions between Livestock Production Systems and the Environment—Global Perspectives and Prospects’ has summarised the present situation along the following lines: *Livestock production systems have evolved and developed in response to agroecological opportunities and the demand for livestock products. In many cases, a fully sustainable equilibrium has been established. Furthermore, in many of these environmentally balanced systems, the livestock element is often clearly interwoven with crop production, as in the rice–buffalo or cereal–cattle production systems of Asia. Animal manure is often the essential element in maintaining soil fertility. In other cases, such as the semi-nomadic pastoral systems of many of the world’s natural grassland regions, environmentally stable balances of human society, animal population and vegetative biomass have existed for centuries* (Sere et al 1995).

This study has identified eight ‘impact domains’ which provide useful guidelines for any environmental evaluation of livestock production systems. Briefly, the ‘domains’ (not in any order of priority) are as follows:

- encroachment of crop–livestock (and other) systems into forested areas
- integration of crop–livestock production for sustainability
- diversion of animal manure from fertiliser to fuel
- waste products from processing of meat, leather and other by-products
- reducing methane emissions
- potential loss of genetic diversity
- protection of marginal lands from cropping, especially for feed grains
- sustainable grazing in variable rainfall environments.

An integral part of these ‘impact domains’ for the environment is the energetic efficiency of agricultural practices associated with different production systems, i.e. the production of food energy relative to the energy inputs.

Some of these ‘domains’ are obviously of greater relevance to South and South-East Asia than others, e.g. the first six above, but collectively they form a useful framework to assess the sustainability of present and evolving livestock systems and management practices in relation to the environment.

Asian agriculture can make a major contribution to protecting the environment and promoting sustainability. Asian countries will do this individually and collectively by participating in a variety of ways in the global and regional teams that:

- assess the synergies in the development of integrated livestock–crop systems in robust and fragile environments
- evaluate the use of manure compared to chemical fertilisers in nutrient recycling and its relative value as fuel
- identify the potential benefits of regional genetic diversity in livestock
- conduct research into the environmental impact of waste processing and the production of by-products associated with post-harvest technologies
- develop technologies and systems that minimise methane emissions
- develop more efficient systems to minimise the use of expensive feed resources
- develop and monitor the indicators of overgrazing and long-term sustainability of grazing
- enhance the efficiency of draft animal power.

Livestock species

In Section 2, the projected increases in per capita consumption of various livestock products by country, in the next decade or so, demonstrated the large increase in milk consumption anticipated in parts of South Asia and the marked increases in all types of livestock products in South-East Asia. Beef and sheep meat consumption will double, pork and poultry meat and eggs will also double but, in contrast to South Asia, milk consumption in South-East Asia shows only a relatively small increase. On past performance, Thailand and Indonesia are notable exceptions.

Small ruminants

Small ruminants are kept primarily for meat; only in Bangladesh and Indonesia are goats an important supplier of milk. In these countries they supply about 55 and 28% of the domestic demand, respectively, with Indonesia's production at a much lower baseline (see Section 2). The bulk of the Asian sheep and goat population is in South Asia, most notably India and Pakistan, with a small but nevertheless significant number in Bangladesh. Goats out-number sheep in Bangladesh by 10 to 1, in India by 2 to 1 and in Pakistan the numbers of sheep and goats are about equal. The population increases are higher for the goat populations than for the sheep, perhaps indicating that the resource base is declining. ILRI's consultations in South Asia suggest that a substantial proportion of the sheep and goat populations are in the nomadic and transhumant systems where the opportunities for substantial increases in productivity are not great (de Boer 1992). However, some are kept in small herds as part of crop-livestock MRA systems. In South-East Asia, only Indonesia has significant sheep and goat populations while the Philippines has a small population of sheep relative to goats.

Small ruminants have several roles; the provision of meat and milk, fibre for clothing and rugs in South Asia, religious ceremonies in Islamic countries and entertainment/leisure, e.g. fighting and racing, in South-East Asia. They form the basis of the transhumant and crop-livestock systems in South Asia, producing milk, meat, carpets, apparel and shelter, much of which is bartered or traded. They are also prevalent in plantation agriculture, e.g. in the border regions of Thailand with Malaysia and parts of Indonesia, where they are frequently kept in raised, slatted-floored housing overnight and taken to plantations during the day time. They are kept for meat, religious festivals and other ceremonies, and are traded for cash.

The attractiveness of small ruminants lies in their relatively short generation interval and their ability to utilise low quality roughage. The scope for improvement of the productivity of small ruminants lies in the ability to intensify the production systems, possibly through an integration with appropriate plantation agriculture.

Large ruminants

Large ruminants are found mainly in rainfed and irrigated crop-livestock systems where their role is mainly to provide draft power, with manure and relatively small quantities of milk often forming useful by-products. Each farmer may own one or two buffalo or cattle; buffalo in the rice systems and cattle in the semi-arid and subhumid rainfed cropping systems. They may be either bullocks or cows and, in the case of the latter, they may produce a calf every 24 months or so. Surviving calves are sold before they are 12 months old, often earlier, or kept to replace the older animal. In many systems the calves represent a considerable extra burden on the farmer because of the impact on the working capacity of the dam, the timing relative to seasonal tasks and feed supply, and the additional labour required to care for it. At the end of their working life, draft animals provide meat.

Beef production may increase as a consequence of developments in the peri-urban dairy systems and perhaps by integrated activities in association with plantation agriculture.

There is a marked growth in the demand for dairy products, associated with the increases in the growth rate of per capita GDP. This demand is being met by the development of commercial dairy industries in urban and peri-urban areas. Although in 1987 the per capita consumption of buffalo milk in the region was slightly higher than that of cow milk, the growth rate in the consumption of cow milk more than doubled that of buffalo milk (3.6 versus 1.5%; de Boer 1992). The growth in the consumption of cow milk in the decade 1984-94, outstripped the growth in buffalo milk consumption in all countries of the region except Pakistan.

Pigs, poultry and minor species

The projected demand for livestock products in Asia generally shows (Section 2) the strong demand for poultry products and pig meat in regions in Asia (including China). Because of broad similarities in the intensive livestock systems and because there are essentially no pigs in Bangladesh and Pakistan, South and South-East Asia have been treated as a single region in this section. The role of these species in the mixed livestock–cropping systems of Asia in providing cash and spreading risk should not be underestimated.

Traditional systems for pigs are characterised by low inputs and low production and reproduction. They use traditional breeds, or sometimes their cross with improved breeds, given low-cost diets. The consequences are a slow-growing animal usually with excessive carcass fat but produced at low cost. Animals frequently scavenge out-of-doors during the day time and are often allowed to roam with a minimum of constraint and supervision. Pigs may gain only 100 g per day. Where improved genotypes are used in village systems, high cost and high quality feed supplements are often purchased for piglets and the lactating sow.

In traditional village poultry systems, inputs are also low and, although local breeds of hens are often capable of producing in excess of 150 eggs per year, their net production through brooding and wastage is often less than 50 eggs per bird per annum. Chickens kept for meat may reach 1–1.2 kg in 16 weeks or more.

For poultry production, there are sometimes small-size, semi-intensive units, which rely on improved genotypes that are offered either complete diets or diets with substantial amounts of agricultural by-products. These birds are usually confined in houses constructed mainly from local material. For laying hens, production is comparatively high with typical figures of 200 eggs in 300 days. The birds are managed at a high level with some disease prevention measures in place. Product quality is often a problem because of distance from, and lack of transport to, markets. Chickens are sold live.

Ducks are generally associated with wetland-rice farming and obtain significant quantities of feed through scavenging. Ducks are herded and production is low (<100 egg/year) and seasonal. Duck meat is often produced during the rice harvest. Ducks will scavenge in the fields for fallen rice and follow the harvest until ready for slaughter at three months of age when they may weigh about 2.5 kg.

In most countries in South and South-East Asia, less than 20% of non-ruminant livestock are kept under truly commercial conditions. Commercial production of non-ruminant animals is based on modern technology which varies little from country to country. Husbandry, housing, genotypes and disease prevention measures are standard. Intensive, commercial production is most common for laying hens, broiler chickens and to some extent pigs. Feed is often of insufficient quality to allow maximum production although some ingredients and invariably mineral and vitamin premixes are imported. Environmental factors, particularly high temperature and humidity, prevent broiler chickens from growing to their genetic potential. Disease problems are usually accentuated and vaccination against a wide range of avian diseases, including Newcastle disease, is needed. Performance is probably about 80% of that observed in similar genotypes housed and managed under optimum conditions.

Rabbits are raised in small numbers in South and South-East Asia. They are usually confined to the cooler areas of the country and there may be local breeds. Their advantages over other meat-producing livestock include low cost inputs, e.g. cut herbage supplemented with household waste and by-products, housing made from cheap local material. They are also easily managed. However, their meat is largely unknown and there may be cultural constraints.

Geese and Muscovy ducks are additional minor species. Geese are relatively common in China (230 million) where they scavenge in dry fields and can act as ‘watch dogs’. Muscovy ducks are different to farmed ducks and, although starting from low base population, are increasing their numbers in the drier areas where they feed on seeds and insects. Their meat competes with red meat in some markets.

Focus on products

Research and development programmes need to be driven by smallholder systems that have a capacity to deliver products for which the future demands are projected to be the greatest and which will be the most difficult to supply in an efficient, sustainable and equitable manner by smallholder systems. Within the region

there will be significant shortfalls in ruminant meat and some significant surpluses in non-ruminant meats arising particularly from those with high economic growth such as Malaysia, Thailand and Indonesia. Pakistan and India are likely to be self-sufficient in milk whilst Malaysia, the Philippines, Thailand, Sri Lanka and Vietnam are likely to be net importers.

The intensification required by this scenario is heavily dependent on the supplies of feed grains, only a part of which can come from sustainable production systems within the region. This conclusion can be substantiated by considering the current and future demands for compounded feeding stuffs in the selected countries. The current estimate of 44.3 million tonnes, or 119 million tonnes if South China is included, is expected to increase at approximately the same rate as that for the demand for poultry and pig products. Many countries in Asia are net importers of some (e.g. the Philippines, Vietnam, Thailand, Indonesia) or most (e.g. Malaysia) of their raw feed ingredients, at very high cost. The huge expansion in livestock production in China and the associated demand for raw materials, will have a major impact on world grain markets.

The rural smallholder, as the development towards intensification and specialisation continues, will become increasingly vulnerable to increases in feed prices and variations in product prices (Pingali and Rosegrant 1995).

Technical constraints to productivity improvement

Feed supply, both quantity and quality, has been identified in the ILRI consultations with NARS in South and South-East Asia as the major constraint to achieving the levels of production necessary to meet the predicted demands for animal products. Some of this deficit in feed supply will be alleviated by a shift in resources towards the growing of livestock feeds, as a consequence of rises in incomes, changes in consumer preferences, and a recognition of the financial benefits of value adding to coarse grains by converting them into animal products. Some of the deficit will be made good via increases in feed imports from inside and outside the region. Some increases will be forthcoming as a result of technological changes that identify and develop new feed resources from introduced crops or agro-industry by-products, improve crop (grain, vegetative and residue) yields, increase feed intake and/or digestibility of the diet, or increase the efficiency of utilisation of the feed by manipulating either the animal or the diet. The relative importance of these options in alleviating the fundamental problem of feed shortage is dependent on the end product, the species which produces it, the capacity of the region to absorb and apply new technology and the economic drivers of the particular production system.

A fundamental issue in relation to feed utilisation is the proportion of the feed that is used for maintenance as opposed to productive functions. There are important differences between species with the highest ratios of production to maintenance exhibited by non-ruminants (pigs and poultry) followed by rabbits and then small ruminants, with large ruminants that produce meat at the end of their use for draft purposes being the most inefficient way of producing meat. High efficiency of production to maintenance feed utilisation for meat, milk and eggs, includes a component that is highly related to reproductive rate.

Differences between species are confounded by the differences in feed resources required for production. Ruminants can utilise low-cost, low-quality feeds that cannot be used at all by the species with the capacity to be highly efficient. In some circumstances it is better to obtain some product from a low value resource, even at a relatively low efficiency, than nothing at all. The ability of ruminants to utilise crop residues, when coupled with the ability of pigs and poultry to utilise the grain components of the system, illustrates the potential for mixed livestock production in a variety of cropping systems.

Animal health issues are always present, often in relation to trade barriers to livestock and livestock products and also in relation to some specific diseases that decrease production, increase morbidity or increase production risks. However, in general, because of the nature of the production systems, there are no unmanageable issues.

Health issues that have local, regional and trade importance include the following. Fascioliasis is a major endoparasitic disease in the rice-based systems and a range of gastro-intestinal helminths (*Haemonchus*, *Oesophagostomum*, *Cooperia*, *Bunostomum*) and other infectious agents (*Toxacara*, coccidia) can cause poor growth and occasional deaths in young stock, especially if they are undernourished in more intensive

situations. *Boophilus*, and the associated tick-borne diseases (anaplasmosis and babesiosis), are present but create intermittent problems only in non-endemic areas. There are other tick species present including multi-host species in southern China and the vector of *Theileria annulata* in parts of South Asia. *Trypanosoma evansi* occurs in parts of South-East Asia but is not recognised as a major problem. Haemorrhagic septicaemia and other pasteurelloses cause problems in some situations but a number of countries produce vaccines for their own particular strains. Various bacterial and viral diseases cause problems from time to time, the major ones being foot-and-mouth disease, bluetongue, swine fever, ephemeral fever, infections of the gastrointestinal tract, and Newcastle disease.

A major question in relation to the current equilibrium between hosts and disease agents is the extent to which the level of intensification that will occur in the next decade with introduced genotypes, new feeding systems and developing management skills will create new disease-related problems of large economic impact. It will be important to match the higher risk with improved management and technologies.

Genotypes are both a constraint and a benefit to improved productivity, particularly in the rural-based village systems. Indigenous genotypes have resistance to the environmental stresses that operate in unmodified situations to which exotic genotypes are susceptible and cause productivity losses. Any programme for genetic improvement needs to identify the characteristics of the system and the product for which it is intended and look for the desired combination of traits in both local and exotic populations. It needs also to ensure that the necessary infrastructure to rapidly multiply and distribute superior genetic material is in place.

Other constraints

Other major constraints to the development of the livestock industries concern infrastructure, such as finance, transport, skilled labour, processing facilities, storage and marketing, and the delivery of advisory and health services. Hygienic processing of livestock products demands very high standards, with an adequate supply of high-quality water and a trained and highly skilled workforce. Product storage often requires a constant supply of electricity for refrigeration; this is costly and can rarely be guaranteed. Suitable transport for the product is uncommon and consequently the products often arrive at retail outlets in a poor or substandard state.

Since the vast majority of livestock are produced under traditional or semi-extensive systems, the marketing of animals is a major problem. Marketing chains are often poorly defined, complex and inefficient and not conducive to the delivery of livestock and livestock products in good condition. The consequences of government policies associated with interventions in the production and marketing chains to provide incentives, via subsidies or some other instruments, are frequently not as successful as they could be with unexpected and sometimes undesirable side effects for producers, marketers and consumers.

The ability of the small producer of livestock to improve output may be limited by the lack of adequate advisory and other (e.g. veterinary and training) services. The fundamental mechanisms required for successful technology transfer and uptake have to be strengthened if the impact of existing, and newly developed, technologies is to be realised. In the short term, a knowledge and control of animal numbers and movements will be invaluable to government planning for disease control and marketing.

Overcoming the constraints

The greatest challenge confronting the livestock systems of Asia is to increase the supply and quality (particularly protein content) of available feeds. There are two components to this; the first is to improve the supply of nutrients on a seasonal and annual basis and the second is to reduce the competition for the available feeds, i.e. by reducing the number of animals that are being kept on maintenance or near maintenance rations, so that the remainder can be fed at higher levels. The second component relies largely on government policy and incentives to increase markets and encourage the sale of animals at an earlier age. The first, increasing the supply of nutrients, can be approached in the following three ways:

- improving the local supply (by new crops and inter-cropping regimes, e.g. food/feed systems new by-products and identifying non-conventional feeds)

- improving the efficiency of utilisation (by supplements, treatment and processing of feeds and supplements, rumen manipulation and metabolic manipulations)
- increasing feed imports.

The first two approaches are high-priority research areas within the context of the product and the production system. Strategic research that underpins these areas includes evaluation of plant genetic resources, structural carbohydrate chemistry, anaerobic fermentation processes, physical and chemical aspects of hydrolysis, rumen ecology, and nutritional physiology and endocrinology.

Health and disease issues need to be anticipated and tackled in the context of the evolving systems. The economic impact of various common parasitic and other diseases on major production systems needs to be assessed along with the interactions amongst various diseases in mixed farming–livestock systems. Comparative studies on the epidemiology of important diseases in different systems may provide useful leads for control strategies. New vaccine technologies based on robust, one-shot and oral procedures are a high priority.

Improving the genetic base of Asian livestock is a priority area especially when expensive, imported feed resources are a significant part of the nutritional base of the production system. However, this does not mean the substitution of local genotypes with the breeds favoured by the high input systems of the developed countries. It means the conservation and exploitation of the best features of the local genotypes in systematic evaluations using new molecular techniques and specially constructed genetic families to maximise the effectiveness of the techniques. Multiplication and distribution of superior genetic material will remain the responsibility of NARS for the foreseeable future. High fertility and resistance to environmental stresses in indigenous genotypes are attributes that could be exploited through trade, if markers and animals can be identified.

An integral part of genetic improvement programmes is an improvement in reproductive rate. New breeding technologies are required to enhance reproduction rate *per se*, and to enhance the rate of infusion of new genetic material into the national livestock.

The capacity to produce an increasing amount of human food for an increasing population from a decreasing land resource in a sustainable manner is arguably the greatest challenge to Asian agriculture. The maintenance of soil fertility, increasing forested areas, and improving water quality are three important goals that are not always easily reconciled with the urgent need to produce more low-cost food. It is a global issue that needs global solutions that involve policy and technological components. It will only be solved satisfactorily through national, regional and international co-operation.

There is a large variation between Asian countries in the quantity and quality of the infrastructure which supports livestock research. However, in general there is a substantial need to improve government extension services to the livestock producers in the region. Any improvements need to focus on the nature of the integrated farming systems, delivery of information through relevant services, and the education and training needs of the producers, if the best use is to be made of the information provided. With some notable exceptions, there is still a need to further strengthen the research capacity of the providers of R&D, whether government departments or universities, through both staff development and the upgrading of facilities and equipment. Associated with this is the additional need to train scientists in project management to ensure that resources are effectively utilised, that co-operative activities are maximised, and that duplication, but not complementarity of effort, is minimised.

ILRI's contribution to the R&D needs for livestock in Asia can be assessed against this background. ILRI's resources are limited and its mandate is strategic. It does not have the capacity to adequately service the full range of needs. It has special skills around which to build an R&D programme that will benefit Asia provided it can identify strong lead institutions in the NARS, develop co-operative joint ventures with them that include research institutions from developed countries and NGOs, and form productive and well-managed research, information and training networks in the region.

4. ILRI's role in Asia: strengthening livestock development

Philosophy and background

A rapidly expanding middle class in most Asian countries is demanding more animal protein: a demand most easily and cheaply met by poultry production. There, however, is a need for a more balanced approach to livestock development, particularly in relation to the pig sector, and to some extent the dairy and beef sector.

Acute awareness is needed of the benefits of integrated livestock–mixed systems to promote diverse, efficient and sustainable resource use, reduce overall risk, use biological and chemical energy more efficiently, reduce problems of waste management and pollution, and increase the economic and social stability of farm households.

Principles for ILRI operations in Asia

TAC (1992) has indicated that the activities of the CGIAR system must be research or research related, generating new knowledge or products. A second objective is information dissemination, training and collaborative programmes with NARS. Activities must be international in character, address problems in which the CGIAR centres have a comparative advantage, and target sustainability, food security and poverty alleviation. CGIAR centres should seek active partnerships with other institutions.

The following five important trends affecting the livestock sector world-wide have been identified:

- increases in production will come from intensification in mixed farming systems
- urbanisation of consumers will encourage specialisation of production and shifts to industrial-scale production, particularly for milk, eggs and poultry and pig meats
- in the foreseeable future almost all beef and small ruminant meat will come from smallholder systems
- there is limited scope for increased production from pastoral areas but a major challenge in terms of natural resource management
- new scientific developments will provide significant opportunities for improving productivity, particularly in plant varieties and in animal health interventions.

TAC has identified seven priority research areas for ILRI. Three are of global relevance (animal health, genetics and nutrition) from which general principles and generic technologies can be derived; and four are of ecoregional specificity (animal feed resources, production systems, natural resource management and socio-economic analysis) providing information of specific regional application.

This Discussion Paper embodies all of these principles.

Priority setting

Many methodologies exist for priority setting in research. These range from precedence approaches where research and development (R&D) investment reflects historical patterns of expenditure, through to detailed benefit-cost analysis or equilibrium displacement models. In Asia, ILRI is likely to use a pluralistic approach, using a mix of objective and consensus-based methods to reach agreement on the ultimate pattern of research investment. An important element of this process will be the active participation of the key players/stakeholders in the process of determining priorities. ILRI's position in relation to that of its partners in the region will be co-operative, complementary and strategic. Sound resource allocation will require a mature approach by all participants to ensure that research is targeted at achieving the greatest possible impacts.

What might ILRI do?

ILRI's probable portfolio in Asia and its links and associations with the NARS is summarised in Appendix II. It is likely to contain elements of the following:

- detailed studies and analyses of major livestock systems including marketing; household budgets of time, labour and other resources; social and technical constraints; possible incentives to better practices; use of advisory/extension services; capacity to absorb new technologies; resource utilisation and conservation; and finance and credit
- technology studies including techniques for technology transfer between the various players, application of research-proven technologies, penetration rates of new applied technologies and impact assessment of new technologies from social, economic and environmental perspectives.

It will also contain specific technical research areas such as:

- integrated research on the major crop–livestock systems (MRA, MRH, MIA and MIH) with particular emphasis on mixed livestock in these systems
- use of fodder trees and shrubs in cropping systems
- studies to increase the rate of transition of village pig and poultry systems towards greater commercialisation
- peri-urban dairy and associated beef development
- treatments of straws, and other crop residues either *in vivo*, i.e. after ingestion via rumen micro-organism manipulation, as well as *in vitro*, i.e. prior to ingestion
- characterisation of rare or unique genetic livestock using molecular and other gene-marker technologies, particularly in relation to parasite and disease resistance and high fertility
- increasing the rate of identification and dissemination of superior genetic material
- characterisation of existing indigenous plant resources
- innovative genetic improvement strategies for smallholder systems to accompany improvements in feeding and management.

In developing its portfolio, ILRI will identify the priority needs of the national governments of the region through their strategic plans, and within that framework prioritise its activities and linkages to maximise benefits to the region.

Institution building

The development of the livestock industries of Asia requires strong research, development, extension and education, and training (RDEET) institutions. These five elements and the way in which they are integrated are critical if successful development is to happen in a reasonable time frame. Proper involvement of clients and stakeholders (such as extension agencies, universities and other training bodies) through participatory processes, helps to ensure that R&D outcomes are relevant, useable and rapidly adopted.

The institutional structures and management need to reflect a commitment to multidisciplinary, co-operative research. A sound systems philosophy must underpin training, development and operational practices of professional and para-professional support staff.

As resources devoted to agricultural R&D are finite (and in many instances diminishing), it is essential that resources are combined to solve particular problems. Forming co-operative joint ventures with appropriate institutions in Asia in conjunction with co-operative research and information networks in the region will enable a broad range of skills, expertise and resources to be harnessed. Institutional structures need to be sufficiently flexible to actively encourage staff exchanges at all levels and to facilitate co-operation across institutional and national boundaries. Because of its international standing, ILRI is ideally placed to facilitate the formation of

specific purpose, highly motivated teams which could contribute with great effect to the solving of regional problems.

Role of clients and stakeholders

Participation of clients and stakeholders in devising research strategies is critical. The most important of ILRI's clients are the NARS, national governments and funding agencies. ILRI has an excellent record of consultation and adoption of new processes by which it can identify key issues for research. This will continue as it establishes the priorities for its activities in the Asia region.

Areas for research activities (see Summary in Appendix II)

ILRI-sponsored consultations conducted recently in meetings held in Nairobi and at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the International Rice Research Institute (IRRI) have produced lists of priorities through a variety of methods of varying rigour and validity. Important generic issues have been identified. ILRI's strength lies in its integration of component research into production systems. This strength will be fully tested in the Asian region because of the diversity of crop–livestock systems in the region and the technical and socio-economic constraints to improving production, including the broad issues of high population densities and the associated reduction in the land available for agricultural purposes.

Generic research areas consistent with ILRI's global objectives and considered in a systems context include the maintenance of the diversity of animal and plant genetic resources, improved production and utilisation of feed resources, increases in the quality and rate of genetic improvement, improvements in the control of livestock diseases and wider aspects of animal welfare, protecting the environment, and livestock policy analysis.

An important role for ILRI will be to participate with other international agricultural research centres (IARCs) and regional and global agencies and groups in the analyses of the effects of current and planned livestock production systems on the environment and the assessment of their long-term environmental stability. ILRI activities in Asia will need to incorporate co-operative studies of the environmental impact of new technological interventions, and the continual need to protect natural resources.

Most importantly in the context of the comparative/competitive advantage of ILRI (and its networks) is the need to pursue strategic studies on the genetics of parasite and disease resistance. Bovine, ovine and caprine gene maps and markers will be important in this regard. There is still much to be learned about the immunology of livestock species; ILRI has a comparative advantage in this area especially for large ruminants. For Asian farmers, robust preparations, new delivery systems (one-shot and oral technologies) and improved distribution and health services are high priority.

ILRI is ideally situated to encourage and broker co-operation between NARS to maximise the efficiency of the long and expensive process of genetic evaluation, multiplication and distribution.

ILRI's role in environmental protection and system sustainability has already been detailed. Briefly, it is to participate with others in defining the potential impact of the evolving production systems on the 'impact domains' outlined by the FAO (1996) consultancy.

ILRI's major comparative advantage is in its systems approach and the skills it has in systems research backed by strong component research skills in key areas. One of the major roles of ILRI in Asia will be to participate with Asian NARS in the definition and analysis of major systems with a view to identifying key constraints that are capable of responding to interventions with new technologies. The location of ILRI's Asian systems group and the speed with which it can identify and analyse the key systems and their ability to increase production are key factors to the success of ILRI in Asia.

Linkages with extension and education and training

A strong relationship between the research scientist and the end user of research results is essential in the CGIAR system. This relationship is strengthened and made to function more effectively through participatory planning processes for, and co-operative execution of, R&D activities. Mutually beneficial and formally recognised co-operative arrangements, involving the strongest institutions in the NARS (possibly including extension, education and training partners), and R&D agencies from developed countries, is a recommended approach for ILRI to explore.

Technology transfer, adoption and impact

The advice of TAC to the CGIAR regarding its involvement in direct extension activities is acknowledged. This policy, however, emphasises the need for ILRI to be innovative and clever in the role it plays in the extension process. ILRI must be able to get the results of its work to those agencies who can make best use of it. Consequently ILRI, apart from working in a co-operative mode with the NARS, needs to be seeking novel ways of linking to, and communicating with, the government extension agencies and NGOs who are providing extension and information services to farmers. It is a part of the 'knowledge system' to which ILRI could apply its existing skills, and develop new ones, to ensure this interaction will be meaningful and effective. Furthermore, ILRI could work in conjunction with NARS and NGOs, perhaps in a consulting capacity, to monitor and measure the adoption and impact of new technological interventions in selected production systems.

Linkages of animal production with sustainable land use

The strategic and systems perspectives of livestock in ILRI allow it to play an important role in any studies concerned with sustainable land use and environmental protection. A co-operative effort through a joint venture with the IARCs, NARS and other government agencies in Asia, linked to the global groups with similar interests in environmental protection, could provide a rich and unique information source and forum to guide sustainable development of Asian livestock industries. ILRI's Asian based system studies group would provide the focus for this activity.

How might ILRI operate?

There are two basic, but not mutually exclusive, options as to how ILRI could operate in Asia. The first is to co-locate with existing IARCs in the region (IRRI, ICRISAT and the Center for International Forestry Research—CIFOR) and operate as a unit in each of those centres. The second option is for ILRI to identify for each priority activity in a particular region, an appropriate lead NARS institution (as a node) and network co-operators in each country who share the objective, and enter into joint ventures with the various parties on a programme-by-programme basis.

Option 1 offers convenience but relatively few advantages in terms of ILRI maximising the benefit from its investments in Asia. It would be likely subsumed into the culture of those institutions and would have difficulty in establishing and maintaining its own profile. It would also be sacrificing the benefits of direct links with its major client, the NARS. One of the few advantages would be in shared administration of its activities with another IARC and perhaps some direct interactions with crop scientists. However this could be achieved on a broader basis by other mechanisms.

Option 2 is the much-preferred option. It enables ILRI to capitalise on the skills and resources of its major clients, immediately brings close contact with the problems and current state of knowledge, it encourages local investment in a partnership model of R&D and adds considerable value to the ILRI dollar. It positions ILRI close to its primary clients and is likely to create a considerable multiplier effect on ILRI's input to the region. It gives ILRI considerable credibility in the region as a partner in the R&D and provides a focus for co-operation and strategic R&D alliances through the region. It is an option that is likely to be

attractive to donors. Such relationships must be flexible and managed in such a way that ILRI retains its international and regional focus.

As an initial move, ILRI might place four scientists in South-East Asia who, for the sake of minimising delays to the starting time, might be temporarily (say for 12 months) housed at IRRI. Project proposals, including longer term locations and housing, would be developed in conjunction with potential lead NARS. Funding for the proposal would then be solicited from the CGIAR and other donors from inside and outside the region. The ILRI team of four would probably contain scientists with the following expertise: livestock systems analysis, feed resources and nutrition, genetics with specific interests in parasite and disease resistance, and socio-economics with special interests in policy and trade.

A similar model and process could be also applied in South Asia.

Where might ILRI be?

There are many strong and potential lead centres in animal research throughout Asia in universities and government departments. These lead centres, which may be identified during the detailed country consultations, could be invited to 'express interest' in joining a joint venture with ILRI to pursue specified lines of R&D. The details of what an 'expression of interest' entails and the nature of the criteria by which joint venturers and network membership will be selected need to be developed.

When might ILRI begin?

It is desirable that the ILRI board moves swiftly to decide on its options and establish at least one, and preferably two, joint ventures by December 1997. Expectations in the region are already high and delays in establishing a significant presence could undermine the potential for strong co-operative links in the region.

Linkages and partnerships

ILRI will not only establish joint ventures and networks with institutions and organisations in South and South-East Asia, but will be in a position to also invite the participation of some of its bilateral donors, e.g. Japan, Australia, USA, Canada, New Zealand and the European Union, to participate. Given that some governments are channelling increasing funds through non-government organisations, ILRI needs to promulgate its Asian programme strategy widely amongst its donors and potential donors and begin exploring the selective participation of these groups.

Funding

For its activities in Asia, ILRI will seek additional funding, on a programme-by-programme basis, based on the content of each project/programme activity and the structure of the joint venture R&D partners. It will seek funds from its traditional donors in developed countries, e.g. USA, Japan, Australia and New Zealand, and will also solicit additional funds from new sources in the emerging economies of Asia, e.g. Korea, Malaysia, Thailand and Indonesia. Furthermore ILRI will expect to have cash inputs, as well as 'in-kind' contributions, from those countries in which it forms partnerships with leading NARS institutions for its programmes. We would expect to find that in the next three to five years there will be effective and generous consortia developing that will provide funds for specific activities and in which the members will have a say as to what occurs, where and how, in that activity. The opportunity for tapping funds from the large Asian corporations and financial houses in Asia should be explored.

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NOTE: All FAO Statistics quoted or used for any calculations in this report can be accessed and downloaded from “*Statistical Databases — Agriculture–Production–Livestock Primary*” at the following INTERNET address:

<http://www.fao.org>

Forecasting meat production and consumption—methodology

Assuming relative prices remain constant over the time period:

$C_i = P + (E_i \times Y)$, where

C_i = the percentage change in the consumption of commodity i between two time periods, t and $t+1$

P = the percentage change in population between t and $t+1$

E_i = the income elasticity of demand for commodity i and

Y = the percentage change in real per capita income between t and $t+1$

Population statistics for 1993 together with estimates of average annual growth rates in population from 1989 to 2000 were used to determine the percentage changes in population from 1993 to 2000 and 1993 to 2010 (Table 15)¹. The percentage change in real per capita income between 1993–2000 and 1993–2010 were estimated using GNP per capita and average annual growth rates in GNP per capita for 1980 to 1993 (Table 16).²

Based on the review of empirical studies of income elasticities of demand for ruminant meat and non-ruminant meat in selected Asian countries presented earlier, ruminant and non-ruminant meat demand were estimated under two scenarios of income elasticities of demand. Previous studies also indicated that the consumption of non-ruminant meat increases by more than the consumption of ruminant meat for the same increase in income as both coefficients were significant at the 1% level (Unnevehr 1991). This has important ramifications for predicting meat consumption patterns as a country develops.

The income elasticity of demand estimates used to forecast ruminant meat demand were conservatively estimated at 0.6 and 1.2 under low and high elasticity conditions, respectively. It could also be expected that the income elasticity of demand for meat would be higher for urban areas which would inflate the estimates, particularly for those countries with the larger proportion of the population in urban areas (Holtzman 1988). Similarly, two estimates of income elasticities of demand for non-ruminant meat, comparatively higher than those for ruminant meat, of 0.7 and 1.4 were utilised in the analysis. These estimates also compare with the income elasticity of demand of between 1 and 1.5 for selected ruminant meat types and between 1.6 and 2.4 for selected non-ruminant meat types by Camoens (1991) and de Boer (1992).

1 In the absence of consistent estimates of average annual growth rates in the population from 1989 to 2000, an average annual growth rate of 3.0 was assumed for Cambodia based on an estimate by FAO from 1991 to 1995.

2 Due to the absence of data on GNP per capita for Cambodia and average annual growth rates in GNP per capita for the same, Laos and Vietnam, estimates were used. In addition, the average annual growth rate in GNP per capita for China was reduced to the average for middle income countries of 2.3 by the year 2000 and then remained at 2.3 to 2010. The positive average annual growth rate in GNP per capita for the Philippines for the period 1965 to 1990 of 1.6 was used in preference to the estimate of -0.6 for the period 1980 to 1993 for forecasting purposes.

Summary statement

Asian and ILRI livestock research priorities

The following information is extracted from the main document and is based on the needs for Asian livestock industries as identified in the ILRI consultations conducted in both South and South-East Asia; ILRI's current strengths and competitive advantage in strategic research; and the perceptions of the Steering Committee as to how ILRI could operate effectively in the region. It recognises that, at least in the early stages, there are likely to be constraints on financial resources that will limit ILRI's capacity to co-locate with NARS and to build up its laboratory operations in Asia that may duplicate those that are currently African based.

The Steering Committee recognised that ILRI's concerns are primarily with ruminant animals but includes the consideration of the productivity of non-ruminants in the context of mixed livestock–cropping systems. ILRI combines strengths in component, biological research with a strong capacity to effectively integrate these outputs into livestock production systems and policy analysis. The application of ILRI's strategic research will have a different emphasis in South and South-East Asia because of the differences in eco-regional zones and variations in the components of the production systems.

Asian needs

Feed resources

Seasonal and annual variation in quantity and quality of feeds is the major constraint to improved productivity. Primary needs are to evaluate existing plant resources, investigate the scope to introduce new resources as part of crop (including plantation and fodder trees) rotations, and identify improved feed supplements, agro-industrial by-products and supplementation regimes, as well as unconventional feeds.

Strategic aspects of this research include plant chemistry, especially those elements concerned with structural carbohydrates and their hydrolysis, the manipulation of feeds to improve nutritive value either through pre-ingestion treatment or post-ingestion treatment via rumen biotechnology and ecology, and study of the regulation of the partitioning of nutrients for specific animal products, e.g. milk and/or meat.

Animal health

Major needs in this area are economic impact and risk analyses to establish those areas in which investment will have the greatest financial benefit, identification of resistant genotypes to minimise costs of control measures, epidemiology of economically important diseases and the associated diagnostic capacities, vaccine development for specific diseases, and improved delivery and distribution of health services.

Strategic aspects of this research area include the genetics of disease and parasite resistance involving skills in immunology, molecular genetics and biotechnology and their application to host–parasite–pathogen interactions.

Breeding and genetics

A major need in this area is to establish breeding objectives relevant to the required product, the feed, management and other resources, e.g. skilled labour, relevant information and extension, artificial insemination (AI) and veterinary services, and the environment in which the production will occur. Other important issues concern (i) the identification of superior local genotypes, especially in relation to parasite and disease resistance, coupled with the necessary conservation protocols where necessary, and (ii) the establishment of breeding programmes that will achieve the breeding objectives in the changing livestock production systems of Asia. Research into improved reproduction performance will be important to the successful and rapid infusion of superior genotypes as well as for its impact on improved productivity *per se*.

Strategic aspects of this area of research include molecular genetics and its application in ‘marker-assisted selection’ strategies, especially in relation to disease and parasite resistance and high fertility, the genetics of disease and parasite resistance, new breeding technologies to enhance the multiplication and distribution of superior genotypes, and physiological studies to enhance reproduction rate and augment fertility.

Environmental protection and sustainability

There are major issues for South and South-East Asia in this area which include land degradation, soil fertility, deforestation, water quality (fresh and estuarine), waste management and terrestrial and marine habitats.

Strategic aspects of this include technical aspects of sustainable livestock production and waste management, impact assessment, integration of the effort of the various international agencies and national departments with responsibilities for these different elements and the development of a shared vision of what needs to be done and a co-operative action plan as to how it might be achieved.

Livestock systems

The major need in this area is for reliable and comprehensive databases of the technological, environmental and socio-economic parameters of existing systems that can be analysed to produce a sound and rational basis for determining research priorities and policies for livestock development.

Strategic aspects of this area include the development of agreed methodologies employed for data collection and analysis, linkages to global GIS data banks, and co-ordination of national and regional efforts to maximise potential benefits.

Human resource and institutional development

Asia has a wealth of highly trained scientists and institutions, some of which are well equipped and resourced, including experimental field stations. However, there is marked variation in the standards of these facilities and in the level of academic training both between and within countries of the region and overall there is still a significant need for upgrading the skills of the scientific, technical, managerial and other support staff and the scientific equipment available to the research community.

Strategic aspects of this include an analysis of future needs for education, skills and training. Overhauling the education system to develop new structures and curriculae as well as to form co-operative joint activities with strong national and international institutions will be important, probable consequences.

Information services

A major need for the generation of improved productivity through new, sustainable agricultural practices in Asia is the provision and delivery of adequate information, and other extension services, to farmers.

Strategic aspects include investment in telecommunications and electronic technologies such as e-mail and the Internet.

ILRI’s activities and role

ILRI can contribute to each of these areas of need for Asian livestock. ILRI’s role is particularly in strategic research and development, capitalising on its existing strengths in component research and systems analysis and mindful that its major clients are the NARS whose needs therefore have to be satisfied. This will be achieved by the participation of NARS, as true partners, in the planning and execution of the research and development (R&D) and through their comprehensive knowledge of the significance, relevance and application of the results. ILRI’s activities will be mainly centred on the major livestock production systems in rainfed and irrigated conditions in semi-arid, subhumid and humid zones of Asia. Its strategic research will be applicable to specific problems of South and South-East Asia in these systems and zones.

Feed resources

Main aim

To support the alleviation of annual and seasonal shortages in the quantity and quality of feed supplies.

ILRI	NARS	Others
Component research	Feed utilisation	IARCs (ICRISAT, IRRI,
Rumen microbiology	Supplements and regimes	CIFOR, ICRAF, CIAT etc)
Plant chemistry and biochemistry	Evaluation of by-products and	ARIs
System research	unconventional feeds	
Integration and utilisation of new crops		

ILRI will conduct its contribution to the component research primarily from its African-based laboratories and its systems component in Asia, initially located in relevant sister IARCs, but moving quickly to co-locate with lead NARS. It will formally network both its component and its systems-work with relevant NARS with a lead NARS selected as the focus for each of South and South-East Asia. Potential lead and network NARS will be found in most countries of the regions, e.g. India, Pakistan, Sri Lanka and Bangladesh for South Asia, and Malaysia, Thailand, Indonesia, the Philippines, Vietnam and southern China for South-East Asia. Network co-ordinators, who may be located in a sister IARC or a NARS, may be either ILRI, or joint ILRI/network appointees.

Animal health

Main aim

To support the minimisation of the economic losses to production in livestock systems that are associated with parasitic and other diseases.

ILRI	NARS	Others
Component research	Identification of major disease	Regional and international
Genetics of parasite-disease resistance	constraints and specific disease	bodies, e.g. FAO, APHCA
Host-parasite interaction	problems	ARIs
Vaccine development	Diagnosis and epidemiology	
Immunology	Service and materials delivery	
Systems research		
Risk and economic impact assessment		
Epidemiology		

ILRI will make its contribution to component and the systems research initially from its African-based laboratories. Strong networks through lead NARS in each of the regions will impact on ILRI's research activities as well as ensure the capture of benefits arising from ILRI's presence in Asia by the Asian NARS. Network co-ordinators, located in the selected lead NARS, may be joint ILRI/network appointees. Lead NARS in South Asia are likely to be forthcoming from India, Pakistan or Sri Lanka, and from Malaysia, Thailand, Indonesia or the Philippines in South-East Asia.

Breeding and genetics

Main aim

To contribute to the characterisation of indigenous breeds and identifying molecular markers that will lead to their greater exploitation and/or conservation for the benefited of the region and the world.

ILRI	NARS	Others
Component research	Genetic improvement programmes for smallholder systems	FAO/UNEP genotype conservation programmes
Molecular genetics	Identification and characterisation of important economic traits	ARIs
Marker-assisted selection	Field evaluation of marker-assisted selection protocols	
Genotype characterisation	Material for gene banks and maps	
Systems research		
Breeding objectives and genetic improvement strategies for mixed animal–crop systems		
Data banks		

ILRI will make its contribution to component and systems research initially from its African-based laboratories. Strong networks for both the component and systems research activities, through lead NARS in each of the regions, will impact on ILRI's research activities and ensure the capture of benefits arising from ILRI's presence in Asia by the Asian NARS. Co-ordinators, located in the selected lead NARS, may be joint ILRI/network appointees. Lead NARS in South Asia are likely to be in India or Pakistan and in South-East Asia in Malaysia, Thailand, Indonesia or Vietnam.

Environmental protection and sustainability

ILRI's contribution to environmental protection and sustainability will derive from its strategic and systems perspective of livestock production systems and focus on the 'impact domains' for livestock identified by FAO. It will play a significant role in Asia through joint ventures and co-operative activities with IARCs, NARS and other government and regional agencies. Its specific comparative advantage is its strength in environmental impact assessment of present and emerging livestock systems and their technologies in the short and long term. A collaborative study group of this nature will assist regional governments in the development of policies that encourage sustainable farming practices.

Livestock systems

Main aim

To assist in the analysis of major Asian smallholder livestock production systems in order to identify the major biological and socio-economic constraints to sustainable improvements to productivity, to assess the potential for greater output and to identify the impact of new technologies on the biological, ecological, and socio-economic elements of the system. Interact on policy issues for livestock development.

ILRI	NARS	Others
Methodologies and standards	National priorities	IARCs
Provision of existing data including GIS information	Data collection and national databases	NGOs
Co-ordination and training of the practices and practitioners in the region	Socio-economic detail, e.g. household budgets	
International databases	Policy implications for livestock development; natural resource management and utilisation; investment, marketing, incentive and gender issues	

ILRI will make its contribution to this research initially from its African-based laboratories but should move quickly to physically establish its contribution in Asia. Through its own staff, it will participate in collaborative networks with other IARCs, NARS and NGOs. The outcomes of these studies will impact on ILRI's future component and systems research in the region. Because of common interests and the possible sharing of existing networks and experimental sites with ICRISAT and IRRI, ILRI staff will initially be co-located with these institutions.

Human resource and institutional development

Main aim

To enhance the research capacity of the NARS in the region through joint research activities and specific training courses that increase the effectiveness of the regional networks associated with ILRI projects.

ILRI	NARS	Other
Strategic R&D projects meeting regional needs and providing training opportunities	Access to national resources Partnerships with ILRI and other regional groups	ARIs' participation providing enhanced training opportunities
Linkages to national and inter/multinational groups		

ILRI will facilitate the further strengthening of research institutes in South and South-East Asia by incorporating training components in its Asian projects which will be funded as an integral part of the project funding. In some cases these costs may be borne by the participating countries as part of their contributions to ILRI activities.

Technology transfer

ILRI's prime clients are the NARS. Some technology transfer will occur as part of the training processes but there also needs to be formal arrangements that recognise the importance of this element of ILRI's mandate. ILRI could facilitate the development of participatory management and associated benefits to technology transfer by the formation of consortia between IARCs in the region, NARS, NGOs and farmer organisations. This may require the development of some core capacity within ILRI to manage participatory processes. There is a need to identify researchable issues within the technology transfer complex that are especially relevant to the operation of IARCs in Asia. These issues can also be effectively tackled through the consortium concept.

Livestock policy

Part of ILRI's role in this area has been indicated under the livestock systems heading in this appendix. In addition to the broad systems approach to policy issues, ILRI can contribute its skills in the area of policy analysis to the Asian situation. The consortium approach, where goals, resources and costs are shared, has financial advantages and, more importantly, opportunities to strengthen regional institutions.

Information services

Information networks into which ILRI can feed its information exist for most NARS in the region as well as amongst development agencies, e.g. FAO, the Animal Production and Health Commission for Asia and the Pacific (APHCA) and some NGOs, but the quality, usefulness and accessibility is very variable. Most major countries in the region have, or will shortly have, e-mail and Internet access. There are good regional professional societies for the sharing of scientific information, e.g. the Asian Association for Animal Production (AAAP), the Asian Buffalo Association (ABA), and the Society for the Advancement of Breeding Research in Asia and Oceania (SABRAO). The Indian Council for Agricultural Research has information services (ARIS and NAPHIS) and the China Academy of Agricultural Sciences has a scientific document and information centre. ILRI will facilitate the linking of the various information services, improving the quality of information dissemination and encouraging greater investment in the area by national governments.

Management

The management structure of ILRI needs to reflect the global mandate and interests of ILRI and therefore needs to contain regional, as well as programme, interests at the most senior levels, e.g. Programme/Regional Manager.

The Steering Committee is mindful of the financial constraints on ILRI's activities in Asia and recognises that the following options for South and South-East Asia are conservative and could be modified or progressed more quickly if additional resources are forthcoming. The majority of the Steering Committee agreed that ILRI projects need to be networked in Asia and led either:

- (i) from an African base with a lead NARS institute in Asia providing the focus for the South and/or South-East Asian networks, or
- (ii) from a South and/or South-East Asian base, initially (and briefly) probably at ICRISAT and IRRI, and later at a lead NARS in one of the countries of the sub-regions.

Irrespective of the management structure adopted, senior management, including the project leaders, need to be highly mobile and active in maintaining project integrity and network identity. It is critical that several project leaders be based in Asia and that all relevant project leaders be represented in Asia to provide a regional point of contact for information and promotional activities.

Entry point to NARS

The Asia-Pacific Association of Agricultural Research Institutions (APAARI) is the primary entry point of ILRI to the NARS. It will be approached to form a livestock sub-committee which, under the APAARI umbrella, would become the main body with whom ILRI would negotiate operational aspects of its Asian activities, e.g. protocols for the identification of lead NARS, co-operative research and training activities and the formation of networks. Links to APHCA should also be explored.

Criteria for lead NARS

The Steering Committee has given preliminary consideration of the selection criteria for lead NARS which were discussed at the regional and sub-regional country consultations in May 1997.