Meat and milk self-sufficiency in Asia: forecast trends and implications

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Abstract

Recent structural changes in dietary patterns in Asia resulting from economic development are placing increasing pressure on the existing production systems in the region—particularly those systems producing ruminant meat, non-ruminant meat and milk. This has significant policy implications for the countries in the region in terms of self-sufficiency goals in these commodities and the associated inter- and intra-regional trade opportunities in the future. Forecasts of ruminant meat, non-ruminant meat and milk production and consumption for selected Asian countries between the years 2000 and 2010 revealed the following: China, Pakistan and Viet Nam are likely to be self-sufficient with respect to ruminant meat; Malaysia is likely to continue to be a net importer of ruminant meat; India and Malaysia will be more than self-sufficient with respect to non-ruminant meat with the converse being true for Pakistan; and India, Laos and Pakistan will be self-sufficient with respect to milk production with the possibility of Indonesia, Thailand and Cambodia becoming self-sufficient if the current trends continue. Structural changes in the early 1980s generally resulted in higher average annual growth rates of production—particularly in non-ruminant meat production. Thus forecasts of ruminant meat production and consumption by 2000 using the medium-term average annual growth rates for production present a more favourable outcome in terms of self-sufficiency for countries such as Bangladesh, the Philippines and Viet Nam but a less favourable outcome for countries such as Indonesia, Malaysia, Laos and India. Similar forecasts for non-ruminant meat indicated an improvement in the long-term non-ruminant self-sufficiency estimates for most cases—particularly for Bangladesh, China and Cambodia. Intensification and commercialisation of meat production systems have increased meat self-sufficiency in a number of countries but often at the expense of grain self-sufficiency. Given these trends, the impact of trade liberalisation measures on livestock production in the region and inter- and intra-regional trade of livestock commodities and grain is likely to be significant. © 1999 Elsevier Science B.V. All rights reserved.

1. Introduction

Current meat and milk self-sufficiency in selected Asian countries is dependent on the balance between domestic consumption and production of these commodities. In the future, meat and milk self-sufficiency will depend upon the trends in production and consumption which in turn are affected by the individual country's political environment.

1.1. Consumption trends

The consumption of livestock products in South and Southeast Asia—particularly meat and milk—has

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generally increased with strong potential for further growth in the next century. Increasing trends in the consumption of livestock products on a per person basis is predominantly the consequence of economic development and associated changes in dietary patterns in Asia. These trends together with relatively large initial populations, sizeable population growth rates and expanding urbanisation in a number of Asian countries has led to large increases in Asia's total demand for food generally, and livestock products, in particular (Chantalakhana, 1996). The majority 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 the following stages related to increases in 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 meat, eggs, milk and milk products in addition to fish (Yuize, 1978; Garnaut and Ma, 1992). The latter is likely to be at the expense of traditional sources of lower quality protein (such as cereals) rather than the sources of traditional higher quality protein (such as

fish in Japan) (Longworth, 1983). The transition from a diet dominated by a starch staple to one including substantial amounts of animal products is a general feature sometimes referred to as Bennett's Law. Traditionally, per person consumption of non-ruminant meat (i.e. meat from pigs and chickens) in Southeast Asia has generally been higher than that of ruminant meat (i.e. meat from cattle, buffalo, sheep and goats) with the converse being true in South Asia—a feature which is generally accepted as a reflection of the greater availability and lower relative prices of the dominant meat-type consumed (Table 1). For example, ruminant livestock species (particularly cattle and buffalo) are the largest contributors to meat production in South Asia—the converse generally being true for Southeast Asia (Table 2).

In Indonesia prior to 1977, ruminant meat (mainly beef and veal) was the dominant contributor to total meat consumption with pork being the second largest contributor, followed by chicken meat. Rapid increases in non-ruminant meat consumption (particularly chicken meat consumption) since then have led to the dominance of non-ruminant meats (mainly chicken meat and pork in equal proportions) in total consumption. These consumption trends reflect historical changes in relative world import prices for ruminant and non-ruminant meat which in turn reflect structural changes and related productivity increases in the non-ruminant sector in particular. For example, the average nominal world import price for beef and chicken meat increased from US$ 560 to US$ 2870 and US$ 640 to US$ 1640, respectively, from 1961 to

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	9.4	2.3	7.2
Laos	10.8	3.0	7.8
Malaysia	48.0	4.1	43.9
Pakistan	12.5	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
Viet Nam	16.6	2.5	14.1

Table 2
Livestock species contribution to meat production in selected Asian countries, 1993

Country	Beef and veal (%)	Buffalo meat (%)	Pig meat (%)	Mutton and l amb (%)	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
Viet Nam	7.9	8.5	66.9	–	0.6	16.1

Source: FAO (1994).

1992 and since 1971, the relative world import price of chicken meat with respect to beef has declined by 0.65% annually. Zhao and Williams (1996) estimated that the cross-price elasticities of demand for beef with respect to chicken meat were approximately 1.2 and attribute this and the significant decline in the relative price of chicken meat as the most likely explanation for the decline in the share of beef in total meat consumption in Indonesia. Their study also revealed that beef consumption was far less sensitive to changes in the prices of pigmeat as a result of an estimated cross-price elasticity of 0.2.

1.2. Production trends

Meat production systems in South and Southeast Asia can be divided into two categories—commercial production systems (including highly intensive confined feeding operations including feedlot and more extensive 'ranching' systems) and backyard or small land holder (smallholder) production systems. Meat production in the region is dominated by the latter production system—particularly in the lower income Southeast Asian countries.

Coinciding with increasing consumption of livestock products in South and Southeast Asia is increasing pressure on the existing production systems in the region to help meet these demands. However, in much of South and Southeast Asia, meat production, particularly beef production, is typically constrained by

one or more of the following factors (Simpson and Farris, 1982; Piggot et al., 1993):

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

Availability of land, or more particularly the availability of land of a suitable quality capable of producing meat and feed at an economically viable level, is an important factor in domestic meat production. The lack of this resource in most Asian countries acts as a constraint to meat production—particularly extensive ruminant meat production (FAO, 1996). Where increases in permanent cropping and permanent pastureland have been observed, in particular in Southeast and South Asian countries, this is usually counterbalanced by a reduction in the area of forest and woodland.

Beef productivity in the small-holder meat sector is typically low as a result of a lack of animal husbandry skills resulting in inadequate nutrition (giving rise to slow growth rates and low rates of fertility), greater disease problems and low use of production technology (Manzo and Tanguin, 1992; Jayawardhana, 1993). Poor annual growth performances, particularly in ranch-type farming, have also been attributed to a lack of managerial experience (particularly with respect to breeding). For whilst cattle raising is a traditional part of the rural scene, cattle breeding is not something to which great attention has been traditionally given—placing long-run constraints on the quality of cattle (Piggot et al., 1993). The relatively long production time lags in beef production normally mean that the producer must rely on alternative sources of income between income received from beef—reflecting the mixed nature of small-holder farming. Apart from raising the cost of inputs, high capital costs also limit beef production by restricting the provision of infrastructure required in beef production.

Structural changes are also occurring in livestock production systems as a result of attempts to increase production via the adoption of non-traditional production systems. The backyard production system dominates the ruminant meat sector where changes such as intensification and commercialisation of meat production systems have been slower than the more intensive pig and poultry industries where technology is more readily adapted (Longmire and Gardiner, 1984). For example, as a result of structural changes in Indonesia's livestock and poultry industry, from 1969 to 1993 (particularly the introduction of large-scale commercial production in the broiler industry in the early 1980s), the composition of Indonesia's total meat production changed rapidly as the contribution from beef dropped from 53 to 13%, buffalo meat from 16 to 3.5% whilst poultry meat increased from 13 to 37.2% (Directorate General of Livestock Services, 1992; FAO, 1996) (Table 2).

The nature of milk production in South and Southeast Asia too is varied. Overall, milk production per capita ranges widely from a wide range of sources (including cattle, buffalo, goats and sheep) which reflects the relative numbers of each livestock source. For example, the range in milk production in 1993 was from approximately 130 kg/capita in Pakistan

Table 3
Domestic milk as a percentage of total domestic milk consumption per capita, 1982–1992

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
Viet Nam	70.5	11.9

Source: FAO (1994).

(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). For countries where pasture and grazing land is scarce, the dairy industry is an important source of beef and veal production in addition to milk production (Reeves and Hayman, 1975). However, dairying is not a major industry in most developing Southeast and South Asian countries and therefore is unable to offer much in terms of milk (or ruminant meat self-sufficiency). For example, only India, Laos and Pakistan are totally or nearly self-sufficient with respect to milk requirements (Table 3).

For the majority of the countries studied, domestic milk production is supplemented with imported products to satisfy domestic consumption requirements—particularly in the Philippines, Malaysia and Thailand. Domestic milk production has increased significantly in Laos and Indonesia—via the importation of high quality breeding stock, improved management and artificial insemination (AI) programs. Whilst most of the traded product in the region is imported fresh and dry milk from countries such as Australia, New Zealand and the European Union, some intra-regional trade does occur. For example, Malaysia, Indonesia, China and Thailand export fresh and dry milk whilst India and Sri Lanka export dry milk—although all are net importers of milk.

1.3. Supporting industry trends

Maintaining and increasing meat self-sufficiency in a number of Asian countries may only occur at the expense of feed grain self-sufficiency—one of the major industries supporting the meat production industry in South and Southeast Asia. This follows as meat consumption increases with increasing incomes—encouraging domestic meat production. However, the traditional livestock and feed production techniques typically cannot adequately meet the growth in meat consumption. 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 (Longmire and Gardiner, 1984; Unnevehr, 1991). Where the necessary expansion of domestic feed grain production is constrained, as is the case in much of Asia, the reliance on imported feed grain increases (Hayami et al., 1976; Hooke, 1989). 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).

Dependence on feed grains for further increases in ruminant livestock production has been reduced in parts of Southeast Asia owing to the availability of agro-industrial by-products—supplementing feed grains, forage, pasture grasses and legumes, tree fodder and crop residues. Ruminant livestock feeding enterprises often develop around a food processing plant or oil mill to take advantage of available, often low cost, by-products. For example, locally available agro-industrial by-products (such as molasses, copra meal and bran, starch processing waste and brewers' dried grains) are available directly from mills in the Philippines. Feedlots in Malaysia also rely on palm kernel cake—a more expensive, higher protein by-product of the palm oil industry—and pineapple waste from pineapple plantations. However, the suitability of by-products as ruminant feed source is often limited by insufficient availability in the ruminant meat producing areas. 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. Also, 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. For example, copra meal and palm kernel cake can also be exported as livestock feed to Europe. 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 lack of development of industry support in terms of infrastructure (including cattle holding, cattle, beef and feed transportation and shipping, abattoirs and carcase processing facilities) and marketing expertise in a number of Asian countries is another factor which has limited the competitiveness of locally produced livestock products in these countries' markets (Lemcke, 1993). For example, in Indonesia, post-harvest losses are between 5 and 20% for meat, eggs and milk whilst mortality and loss of live weight during transportation have been estimated at between 1–3% and 7–10%, respectively (Directorate General of Livestock Services, 1992). This is particularly acute in the archipelagos of Asia where inadequate transportation and infrastructure results in a concentration of cattle in a particular province or island and a shortage of cattle in others (Mubyarto et al., 1973). The lack of infrastructure can be attributed to the high cost of finance that has, however, encouraged the development of joint venture feedlots with partners who can contribute capital. The marketing of livestock and livestock products in Asia's developing countries is often handicapped because of the dispersed nature of production and the associated need to assemble supplies from many small farm holdings, transport discontinuity between islands, inadequate transport infrastructure and refrigeration facilities, and a large number of market intermediaries (Unnevehr, 1991; Anderson, 1992; Rae et al., 1992).

1.4. Policy trends

Of particular relevance to the likely future self-sufficiency with respect to ruminant meat, non-ruminant meat and milk in South and Southeast Asia are the trends in the political environment of a number of these countries. For example, without domestic poli-

Table 4
Guide to live cattle and beef import policies in selected Asian countries, as in July 1993

Country	Live cattle import policies	Beef import policies
Japan	44,000 yen (A$600) tariff on cattle under 300 kg 75,000 yen (A$1000) tariff on cattle over 300 kg	50% tariff frozen beef 46.2% tariff chilled beef safeguard trigger frozen beef
Korea	Import ban	Government controlled tender and import quota system 42.8% tariff
Taiwan	No official trade restriction	NT$23.8/kg tariff on "Special Quality Beef" NT$30/kg tariff on other beef Import permit requirement
China	17% tariff and quota feeder and breeder cattle 37% tariff on slaughter cattle	67% tariff and product tax
Thailand	60% tariff on slaughter cattle	60% tariff
Indonesia	Import permits Quota 15% tariff on slaughter cattle	27.5% tariff and tax chilled beef 22.5% tariff and tax frozen beef Import licence requirement
Philippines	3% tariff on breeder cattle 3% tariff cattle under 330 kg 30% tariff cattle over 330 kg	Import licence requirement Quota 30% in quota tariff 60% above quota tariff
Brunei	No official trade restriction	No official trade restriction
Singapore	No official trade restriction	No official trade restriction
Malaysia	Import licence requirement	No official trade restriction

Source: Australian Meat and Livestock Corporation (1997).

cies directed at technological advances in livestock production to check the growth in the demand for feed, any growth in ruminant meat production and subsequent improvements in meat self-sufficiency in Asia is likely to lead to an increasing reliance on imported feed grain and a reduction of feed grain self-sufficiency.

Beef and live cattle are imported in order to balance domestic beef production and consumption such that Asia now contains some of the world's largest beef and live cattle importing countries. Current import restrictions are potentially adding to the burden on domestic feed grain supplies. For example, live cattle imports (particularly young cattle requiring finishing) are generally favoured over imports of beef via differential tariff and quota policies (Table 4). The main impetus behind such policies is the ability of live cattle to contribute more to domestic value-adding than beef in the case of cattle requiring further feeding and subsequent processing. Live cattle imports for subsequent beef production also overcome storage and distribution problems associated with the lack of refrigerated

transport as well as cultural requirements such as *halal* slaughtering. Smaller numbers of live cattle are also imported for breeding purposes to boost productivity in the domestic beef industry in the longer term.

The continuation of these policies is likely given the outcome of the recent rounds of the General Agreement on Trade and Tariffs (GATT). In general, 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 via the removal of import quotas and other quantitative restrictions or their conversion to tariffs; subsequent reduction of the level and dispersion of import tariff rates; compensatory devaluation of the national currency; and removal or reduction of export taxes. For many developing countries, these measures typically formed 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).

Table 5
World agricultural price changes resulting from partial and global multi-sectoral trade reform scenarios (percent increase in reference world prices from base simulation in 2002)

Commodity	GATT trade reform	Global trade reform
Sugar	8.0	46.6
Dairy products	5.1	40.9
Beef, veal and sheep meat	2.8	17.8
Wheat	3.5	16.9
Coarse grains	1.5	8.7
Vegetable oils	1.7	6.1
Tea	0.1	2.1
Cotton	0.9	1.6
Coffee	−8.2	−19.8
Cocoa	−5.7	−16.6
Rice	−5.0	−8.7
Wool	−0.1	−0.3

Source: Goldin et al. (1993).

Goldin et al. (1993) examined the implications of further trade liberalisation as envisaged under the Uruguay Round of the GATT—as well as the impact of complete global trade reform (Table 5). These results suggest modest increases in the price of beef, veal and sheep meat (2.8%) and dairy products (5.1%) as a result of the GATT trade reforms. Unfortunately non-ruminant meat was not one of the commodities studied. However, Tyers and Anderson (1992) estimated that the agricultural policies of all industrial market economies in 1990 depressed international prices of ruminant and non-ruminant meat by 33 and 8%, respectively—

indicating that the impact of policy changes on ruminant meat prices may be more significant than that on non-ruminant meat prices.

Price increases for beef could be reinforced in a number of Asian countries under GATT's provision for developing country status—allowing selected countries to significantly increase the tariffs on beef imports (Table 6). Conversely, the possibility that special bilateral or regional trading arrangements will evolve between developing countries in Asia and some of the larger OECD countries, thus offsetting these inflationary effects on prices, could significantly affect intra- and inter-regional trade in the region—particularly in meat and milk products (Hooke, 1989; Garnaut and Drysdale, 1994; Wu, 1995).

2. Forecasting methodology

2.1. Meat consumption patterns in South and Southeast Asia

Ruminant meat, non-ruminant meat and milk self-sufficiency forecasts in selected South and Southeast Asia countries—namely, Bangladesh, India, Pakistan and Sri Lanka in South Asia and China, Indo-China (i.e. Cambodia, Laos, Viet nam), Indonesia, Malaysia, the Philippines and Thailand—were estimated using forecasts of the likely future balances between domestic production and consumption of ruminant meat, non-ruminant meat and milk on a country-by-country basis. A number of estimates besides the base estimates were derived to allow for scenarios involving

Table 6
Change in beef import protection under GATT 1995–2000

Country	Summary comment
Thailand	Developing country status
	Maximum beef import tariff of 50% by 2004
Indonesia	Developing country status
	Maximum beef import tariff of 50% by 2004
	(Government plans to reduce tariffs to under 20% by 1998 and under 5% by 2003)
Philippines	Developing country status
	Maximum beef import tariff of 40% by 2004
Malaysia	Developing country status
	Maximum beef import tariff of 15% by 2004

Source: Australian Meat and Livestock Corporation (1997).

relative meat price changes as a result of structural and policy changes. Sensitivity analyses were also performed using ranges for a number of parameters involved in the forecasting methodology.

2.2. Consumption forecasts

Apparent ruminant meat and non-ruminant meat consumption (abbreviated to meat consumption per person for brevity) in selected South and Southeast Asian countries was projected for the years 2000 and 2010—using 1993 as the base year and applying an estimated average annual percentage change in consumption. Meat consumption in the base year was estimated from Food and Agriculture Trade and Production Yearbooks by adding net meat imports to meat production and dividing by the total population estimate for that year—assuming carryover stocks of meat did not change significantly from year to year. Consumption forecasts were made using the following extended version of the method described by Holtzman (1988) to allow for the effects of own and substitute commodity price changes:

$$C_i = P + (E_i \times Y) + (P_i \times OP_i) + (CP_{ij} \times CP_j)$$

where

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

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

E_i income elasticity of demand for commodity i

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

P_i own price elasticity of demand for commodity i

OP_i percentage change in own price for commodity i between t and $t + 1$

CP_{ij} cross-price elasticity of demand for commodity j with respect to commodity i, and

CP_j percentage increase in substitute commodity j between t and $t + 1$

Population growth is one of the most crucial determinants of food demand (Mitchell et al., 1997). 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 (World Bank, 1995; FAO, 1996). In the absence of consistent estimates of average annual growth rates in the population from 1989 to 2000 for Cambodia, an average annual growth rate of 3.0% was assumed based on an estimate by the FAO (1996) from 1991 to 1995.

The percentage change in real per capita income between 1993 and 2000 and 1993 and 2010 was estimated using GNP per capita and average annual growth rates in GNP per capita for 1980–1993 (World Bank, 1995). 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 Viet Nam, estimates were used. In addition, as a more representative estimate, 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 maintained at 2.3% to 2010. The positive average annual growth rate in GNP per capita for the Philippines for the period 1965–1990 of 1.6% was used in preference to the estimate of −0.6% for the period 1980–1993 to obtain a more representative forecast for this country.

Two estimates of ruminant and non-ruminant meat consumption were obtained by using two different income elasticities of demand for both ruminant and non-ruminant meat. The upper and lower demand elasticity estimates given in the literature for both meat-types in Asia were used in order to provide an appropriate range of forecasts (Table 7). Ideally, country-specific elasticity estimates would have been used but the relative lack of information of this type for the countries studied precluded this (Widjaja, 1978; Tomek and Robinson, 1981; Simpson and Farris, 1982; Longworth, 1983; Goddard, 1988; Costales, 1990; Harris et al., 1990; Gunasekera et al., 1991; Tyers and Anderson, 1992; Piggot et al., 1993; Trewin et al., 1995). 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 (Unnevehr, 1991). Thus, income elasticity of demand estimates used to forecast ruminant and non-ruminant meat consumption were taken as 0.6–1.2 and 0.7–1.4, respectively—representing the lower and higher limits of the most probable range of

Table 7
Average of elasticity estimates from some major empirical studies of the demand for ruminant meat and beef

Country	Income elasticity of demand	Own price elasticity of demand for beef	Cross-price elasticity of demand with pork
Australia	0.24	−0.78	
New Zealand	0.78	−0.84	
USA	0.49	−0.68	
Canada	0.31	−0.61	
Japan	1.06	−0.99	0.26
Korea	0.93	−0.95	0.24
Taiwan	1.22	−0.55	
China	1.00	−0.95	0.33
Indonesia	1.25	−1.00	0.30
Philippines	0.66	−0.80	0.13
Thailand	0.70	−1.20	0.25

Source: Widjaja (1978); Tomek and Robinson (1981); Simpson and Farris (1982); Longworth (1983); Goddard (1988); Costales (1990); Harris et al. (1990); Gunasekera et al. (1991); Tyers and Anderson (1992); Piggot et al. (1993); Trewin et al. (1995).

consumption estimates (Camoens, 1991; Ingco, 1991; de Boer, 1992).

In the base simulation, it is assumed that prices remain constant over the time period. Under this scenario, the above estimation procedure reduces to that used by Holtzman (1988). The use of the upper and lower income elasticities of demand for both ruminant and non-ruminant meat provide an estimation of possible range of consumption per capita in both 2000 and 2010.

The effect of price changes in ruminant meat and possible competing non-ruminant meats uses ruminant own price and cross-price elasticity estimates for competing non-ruminant meats such as pork and chicken. Zhao and Williams (1996) estimated that the cross-price elasticity of demand between beef and chicken meat and beef and pork in Indonesia was approximately 1.2 and 0.4, respectively. In the absence of more country-specific information of this nature, forecasts based on relative price changes between beef and chicken meat is included in the analysis using this information as an appropriate representation for other countries in the region. However, the relatively low cross-price elasticity estimates for pork indicate that relatively large price increases in pork are required to increase the demand for ruminant meat significantly. Based on a lack of a priori reasoning to suggest that such large relative price changes could be expected, the cross-price effects for pork were not included in the forecasts. Ruminant meat consumption was estimated using an own-price elas-

ticity of demand of unity and a cross-price elasticity with chicken meat of 1.2. The use of these estimates reflects the findings of previous studies for China and selected Southeast Asian countries and presents conservative estimates in cases where the responses to own-price and cross-price changes are believed to be less elastic (Table 7).

A sensitivity analysis based on average annual changes in own-price only forecast a likely consumption range in 2000 and 2010 using the high and low income elasticities of ruminant meat demand discussed previously. Under this scenario, ruminant meat consumption based on average annual own-price changes of −5, −3, 3, 5 and 10% were simulated. Ruminant meat price increases could be expected as a result of trade liberalisation under GATT/WTO and increases in input prices such as feed grain or forage as a result of policy changes and/or a reduction in their availability. Conversely, ruminant meat prices in the selected countries may fall as a result of structural and productivity changes in the ruminant meat sector. Meat prices could also fall as a result of specialisation according to changing comparative advantages in the region with respect to ruminant meat production and intra-regional trade agreements.

Similarly, changes in cross-prices alone could have been examined. Non-ruminant meat price increases could be expected as a result of trade liberalisation and increases in feed grain prices. Conversely, non-ruminant meat prices in the selected countries may fall as a result of intra-regional trade

agreements and structural and productivity changes in both the non-ruminant meat sector and the feed grain sector (Mitchell et al., 1997). However, the range of ruminant meat consumption forecasts under this scenario would have been similar to the corresponding analysis under the previous scenario (i.e 5% increase in cross-price and 5% decrease in own-price) although with a slightly greater range due to the difference in own- and cross-price elasticities used. Relative price increases (falls) in ruminant meat of, say 10%, may arise as a result of increased (reduced) constraints on ruminant meat production, slower (faster) structural changes and productivity improvements and agricultural policy changes as discussed previously. The results obtained under both of these cases would reflect those obtained for own-price increases and cross-price falls of 10%, respectively—again with a slightly wider estimated range of ruminant meat consumption.

In addition to the forecast estimates of ruminant and non-ruminant meat consumption, milk consumption was also examined. Base milk consumption estimates for 1994 were derived in the same manner as base meat consumption estimates (i.e. the difference between net trade and production figures)—using the whole milk conversion factor of 8.2 to convert the weight of dry milk to fluid milk equivalents (Australian Dairy Corporation, 1996). However, in the absence of more specific information relating to milk consumption, a more simplified forecasting technique was used. Average annual milk consumption growth rates were used in conjunction with the base milk consumption estimate to forecast milk consumption in 2000 and 2010—assuming that the medium-term trend in growth rates estimated for the period between 1983 and 1994 continued. This period corresponds to the medium-term growth rates estimated for the corresponding period of greatest structural change in the meat industry.

In a less aggregated study, the following general features would also be considered: the estimated income elasticities of demand for ruminant meat are generally lower in the countries with higher per capita beef consumption levels; within a particular country, poorer consumers are likely to be more responsive to price changes than wealthier consumers—giving rise to differences between urban and rural estimates; and changes in average own-price elasticities over time as

a result of changes in incomes (Reeves and Hayman, 1975; Alderman, 1986).

2.3. Production trends

Ruminant and non-ruminant meat production per capita forecasts in 2000 and 2010 were also estimated. These estimates were based on ruminant and non-ruminant meat production per capita estimates for 1993 and two different average annual growth rates in production. The base forecast assumed that the long-term average annual production growth rates continued. Regressing ruminant and non-ruminant meat production estimates against time using a long-linear functional form for the period 1970–1994 estimated the long-term growth rates. A second set of forecasts was obtained by using estimated medium-term production growth rates. The medium-term growth rates were estimated in a similar manner to the long-term growth rates but the time period chosen was 1983–1994. Generally, increased growth rates in meat production for this time period (as opposed to the longer time period) provide a better indication of the impact of more recent structural changes in meat production in the early 1980s— particularly in the non-ruminant meat sector of the industry. Milk production forecasts were estimated using 1993 production estimates (using the whole milk conversion factor of 8.2 to convert the weight of dry milk to fluid milk equivalents) and medium-term (i.e. 1983–1994) average annual growth rates in milk production (Australian Dairy Corporation, 1996).

3. Results

3.1. Ruminant meat self-sufficiency forecasts

The forecast of ruminant meat production and consumption to 2000, using on the long-term average annual growth rates for production, indicate that domestic production will be unable to meet future ruminant meat consumption in most of the selected countries—with the exception of China, Pakistan and possibly Viet Nam (Table 8). For China, these results indicate a return to the position of being a net exporter of ruminant meat (as in the period 1988–1991). A

Table 8
Forecast ruminant and non-ruminant meat production and consumption per capita, 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[a]	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[a]	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
Viet Nam	2.7–2.9	2.7	15.8–17.2	16.0

[a]Note that 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.

relatively large imbalance is forecast between ruminant meat production and consumption in Malaysia—potentially placing an increasing reliance on ruminant meat imports to satisfy its domestic ruminant meat requirements. The Philippines and Indonesia have also been consistently increasing net importers of ruminant meat (with net imports of 36,000 and 5000 MT in 1994, respectively, compared to Malaysia's net imports of 61,000 MT in 1994) and the results indicate that this trend is likely to continue. Conversely, India has been a strong net exporter of ruminant meat (with net exports of 126,000 MT in 1994) (FAO, 1996).

However, the results indicate that India's position as a net exporter of ruminant meat will change to India being self-sufficient only—particularly, given the meat production and consumption forecast up to 2010 (Table 9). Widening gaps between domestic production and domestic consumption requirements are also particularly evident for Malaysia and Thailand with the converse being forecast for China in 2010.

The forecast of ruminant meat production and consumption up to 2000 and 2010, using the medium-term average annual growth rates for production,

Table 9
Forecast ruminant and non-ruminant meat production and consumption per capita, 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[a]	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[a]	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
Viet Nam	3.6–4.2	3.0	21.5–25.2	18.9

[a]Note that 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.
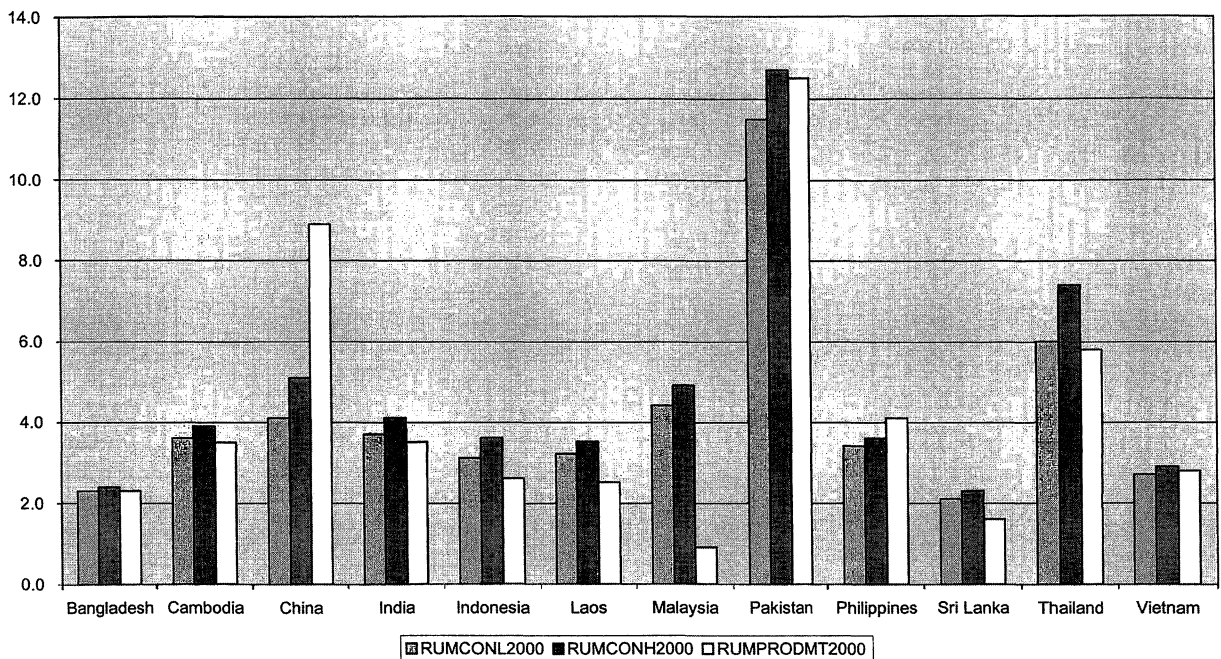
Fig. 1. Ruminant meat production (medium term trends) and consumption (low and high) forecasts, 2000.

present a more favourable outcome in terms of self-sufficiency for countries such as Bangladesh, the Philippines and Viet Nam with China consolidating its ruminant meat self-sufficiency (Figs. 1 and 2). However, for countries such as Indonesia and Malaysia, significant increases in their average annual production growth rates since the early 1980s are not reflected in greater ruminant meat self-sufficiency forecasts—indicating a significant effect of other factors including population and income increases. The medium-term average annual growth rates in ruminant meat production were slightly lower than the long-term average annual growth rates for Laos and India leading to a slightly less favourable ruminant meat self-sufficiency situation based on the medium-term growth rate scenario.

3.2. Non-ruminant meat self-sufficiency forecasts

Unlike the situation forecast for ruminant meat self-sufficiency using long-term average annual growth rates in production, non-ruminant production in most of the selected countries is forecast to meet consump-

tion requirements. In particular, countries such as Malaysia, Indonesia, the Philippines and Sri Lanka are forecast to be more than self-sufficient in 2000 with respect to non-ruminant meat if the long-term trends continue. This forecast is consistent with Malaysia having become a net exporter of non-ruminant meat since 1989 (with net exports of 5000 MT in 1994) (FAO, 1996). Pakistan is unusual in that it is forecast to experience a significant imbalance between non-ruminant meat consumption and production—indicating a potential for increased reliance on imports to satisfy domestic demands. China has been a strong net exporter of non-ruminant meat (with net exports of 370,000 MT in 1994—the majority being pigmeat exports) but this situation may not continue as China is forecast to be less than self-sufficient by 2010. Similarly, Thailand and Viet Nam have both been net exporters of non-ruminant meat (with net exports of 153,000 and 9000 MT, respectively, in 1994)—largely attributable to exports of chicken meat and pigmeat in the respective countries (FAO, 1996). However, the forecasts to 2010 indicate that the self-sufficiency of both countries will also decline (Table 7).
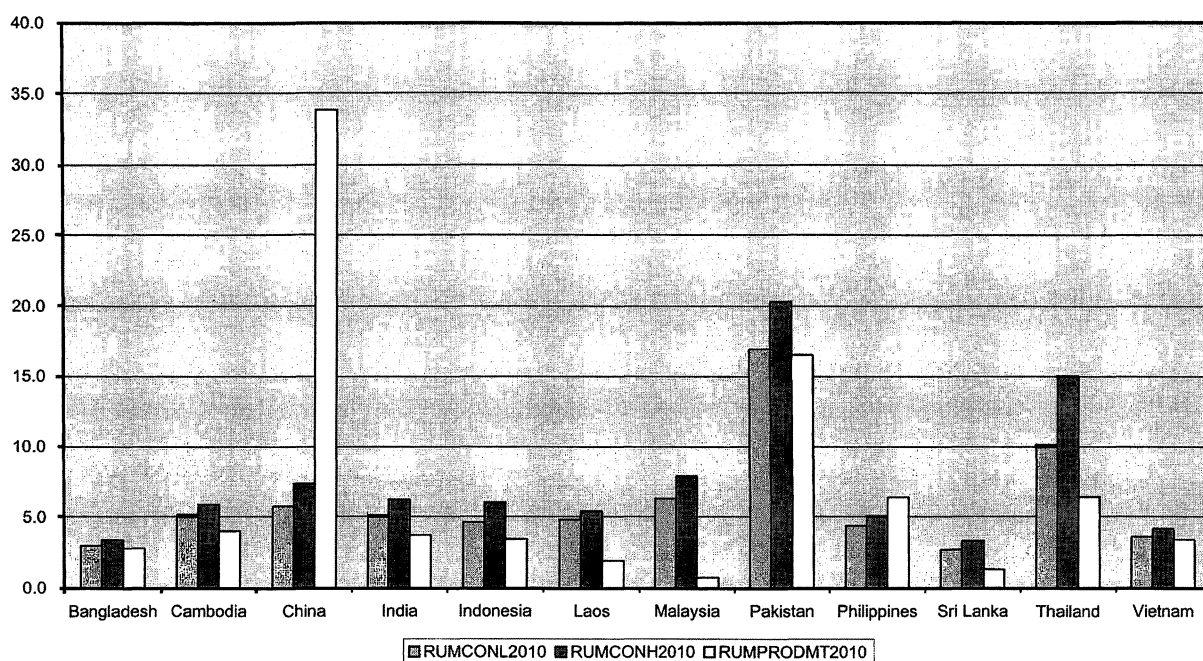
Fig. 2. Ruminant meat production (medium-term trends) and consumption (low and high) forecasts, 2010.

The medium-term, average annual growth rates for non-ruminant meat production were generally higher than the long-term rates. These results indicated a strengthening of the long-term self-sufficiency estimates for most cases—particularly for Bangladesh and Cambodia which were forecast to become self-sufficient by 2000 and more than self-sufficient by 2010 as opposed to the deficit situation indicated using the long-term growth rates (Figs. 3 and 4). Similarly, the medium-term growth rate estimates indicated that China would be more than self-sufficient by 2010 as opposed to the deficit situation indicated by the estimates based on the long-term growth rates. A fall in the medium-term rates in Pakistan and Thailand reinforces the previous forecast of declining self-sufficiency up to 2010 (Fig. 4).

3.3. Milk self-sufficiency forecasts

Pakistan, India and Laos are likely to be self-sufficient with respect to milk in 2000 and 2010 (Figs. 5 and 6). However, based 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 and Thailand, Sri Lanka and Viet Nam. The gap between domestic milk consumption and production is forecast to increase in the Philippines, Viet Nam and also Cambodia but decrease in Thailand, Indonesia and Bangladesh—with the latter two countries becoming self-sufficient by 2010.

3.4. Price effects and ruminant meat self-sufficiency forecasts

Increases in ruminant meat prices led to a forecast reduction in ruminant meat consumption as expected for each of the countries studied (Fig. 7). An indication of the effect of price changes on consumption and possibly self-sufficiency is obtained by a comparison of estimated consumption and the generally more optimistic production forecasts in 2000 and 2010 based on the medium-term average annual growth rates. In the event of price increases, these generally more optimistic production forecasts will better represent the production response to increased prices—the converse being true for price falls. For countries forecast to be less than self-sufficient with respect
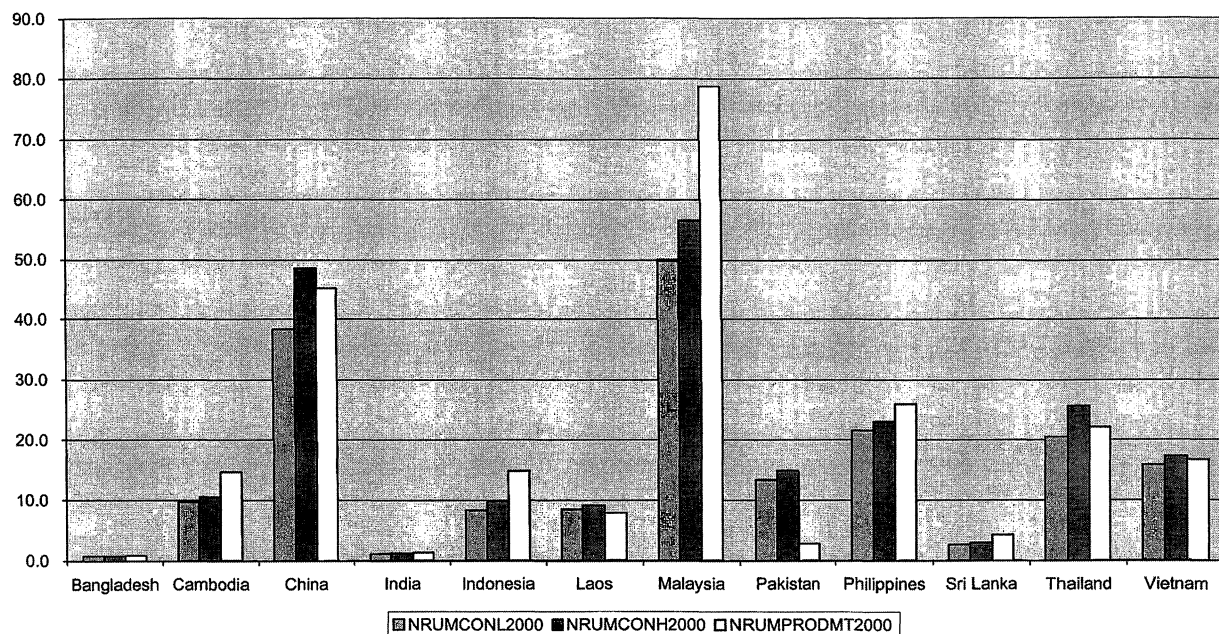
Fig. 3. Non-ruminant meat production (medium-term trends) and consumption (low and high) forecasts, 2000.
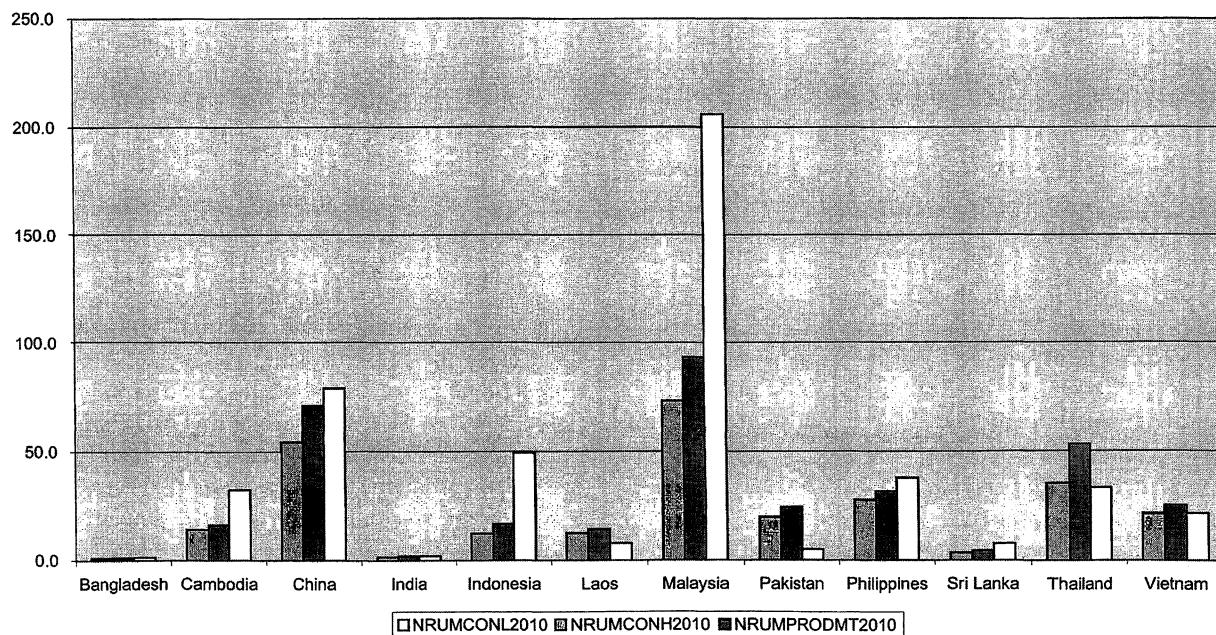

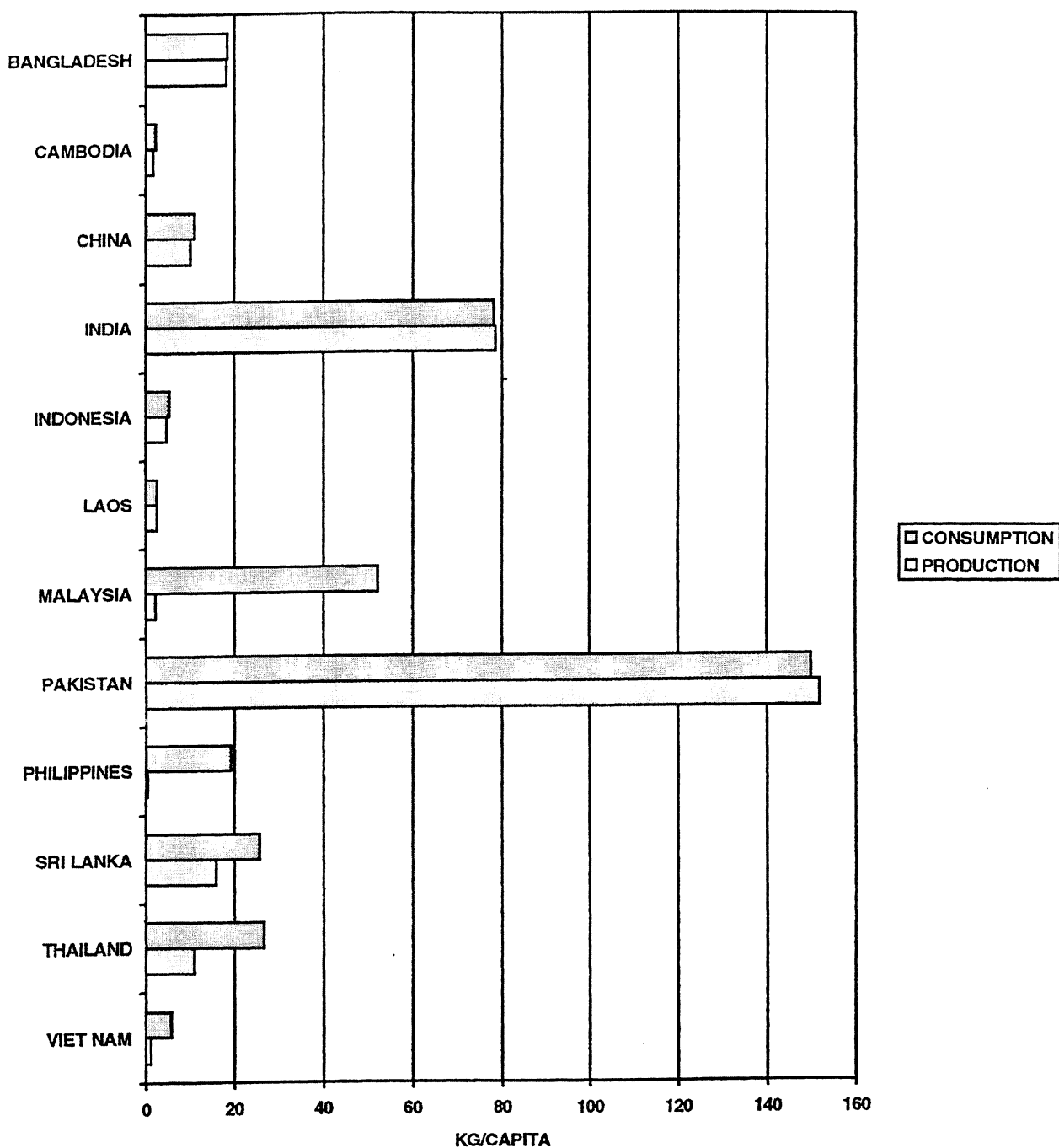Fig. 4. Non-ruminant meat production (medium-term trends) and consumption (low and high) forecasts, 2010.

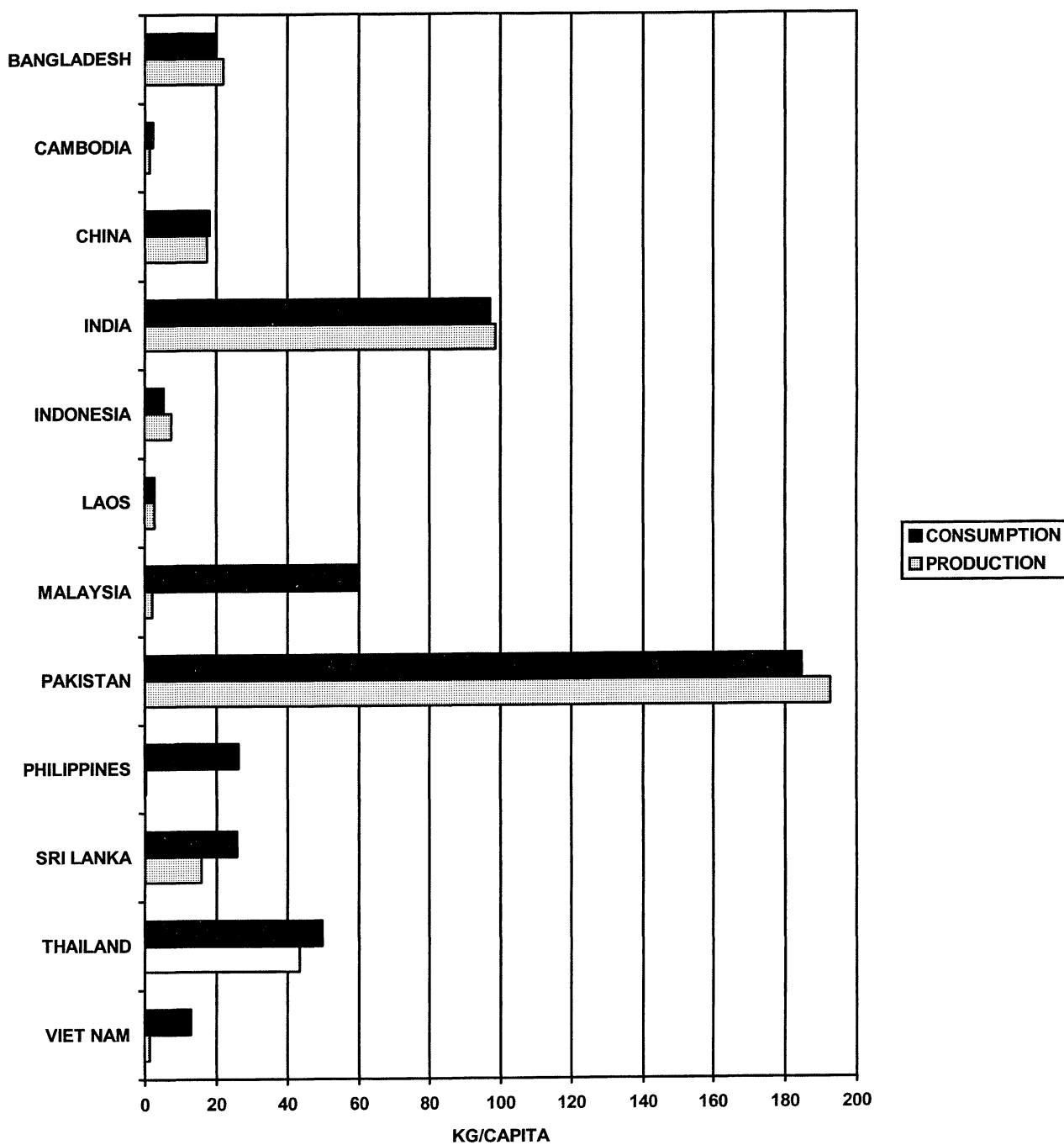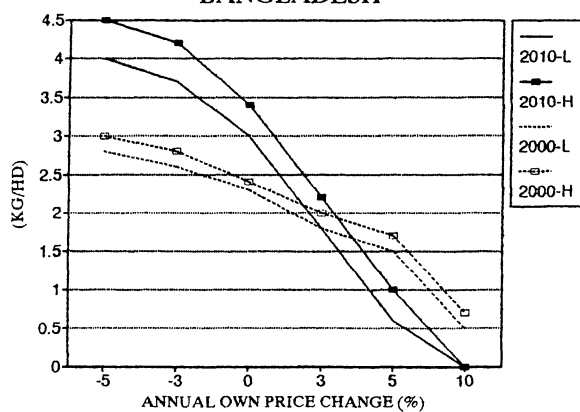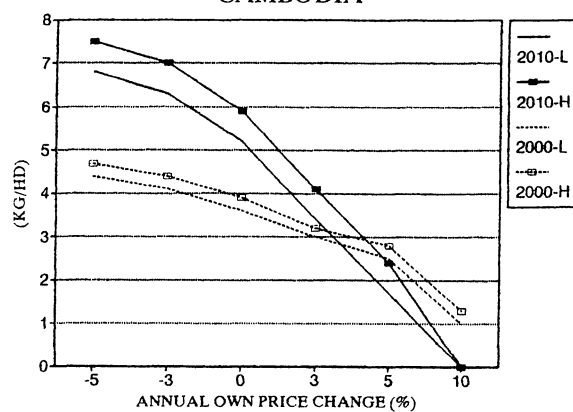Fig. 5. Milk production and consumption forecasts in selected Asian countries, 2000.

Fig. 6. Milk production and consumption forecasts in selected Asian countries, 2010.
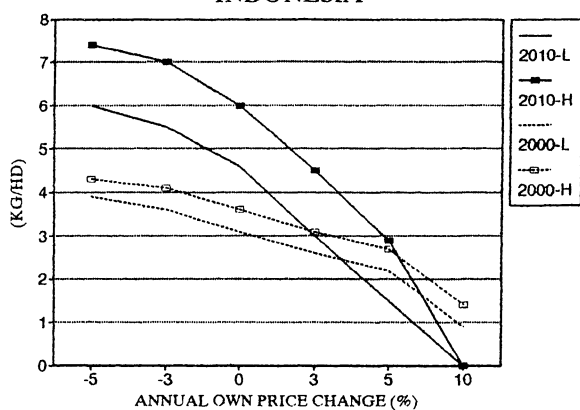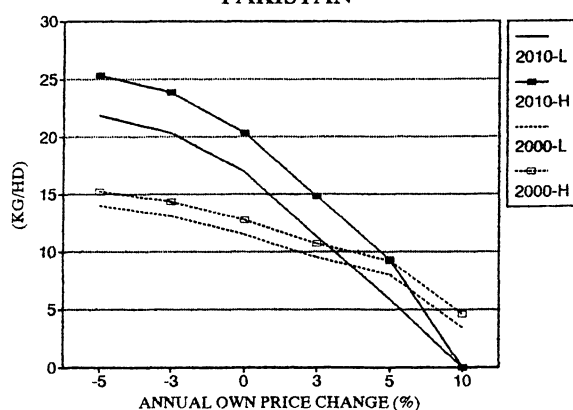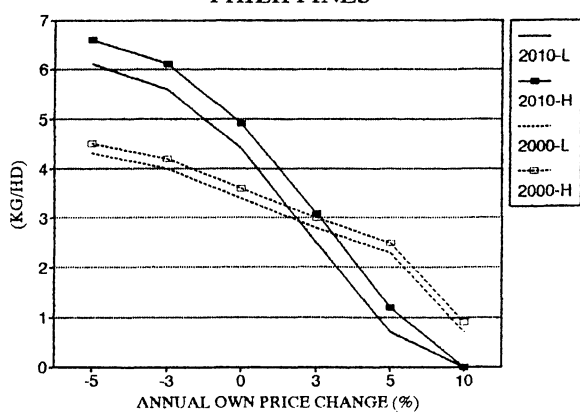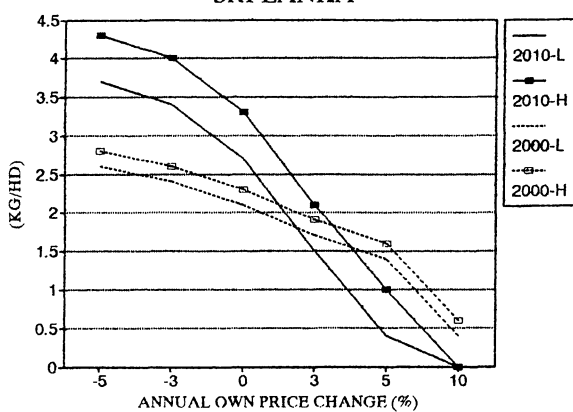
Fig. 7. Ruminant meat consumption and price changes in selected Asian countries, 2010.

to ruminant meat, the results revealed that relatively small increases in ruminant meat prices (i.e. 1–3%) would lead to falls in consumption that would closely align ruminant meat production and consumption by 2010 in Bangladesh, Cambodia and Viet Nam. Slightly larger increases in ruminant meat prices (3–5%) may lead to a similar situation in India, Indonesia, Laos and Sri Lanka. Only in the event of significant ruminant meat price increases (5–10%) would Malaysia and Thailand approach self-sufficiency. As China, the Philippines and Pakistan are forecast to be more than self-sufficient with respect to ruminant meat production, only comparatively large falls in ruminant meat prices relative to non-ruminant meat prices would reverse this situation.

4. Conclusion

In the future, the demand for meat is likely to continue to increase as a result of population growth, continued urbanisation and increases in real disposable income. Without rapid structural transformation and increases in productivity, the population pressures are likely to restrict profitable domestic ruminant meat, non-ruminant meat, milk and feed grain production—thereby further reducing ruminant meat, non-ruminant meat, milk and/or feed grain self-sufficiency in a number of countries. Estimates of consumption and production indicate that China, the Philippines and possibly Pakistan are forecast to be more than self-sufficient with respect to ruminant meat by 2010 and thus may be in a position to supply surrounding countries with ruminant meat. Similarly, forecasts based on long-term production trends indicate that Malaysia and Indonesia will have the potential to be net exporters of non-ruminant meat through to the year 2010—potentially meeting the shortfall of non-ruminant meat production that is forecast for individual countries in the region. This potential is further indicated by forecasts based on the 1983–1994 average annual growth rates in non-ruminant meat production with countries such as China and the Philippines also showing potential as exporters of non-ruminant meat. Milk self-sufficiency forecasts are similar to ruminant meat forecasts rather non-ruminant meat forecasts in that the majority of countries in the region selected for study are unlikely to be self-sufficient by 2010—the

exceptions being India, Pakistan and Laos. In addition, global trade reform and structural transformation are likely to alter production and trade patterns of these commodities in the region. In particular, relative price increases in ruminant meat as a result of global trade reform coupled with structural changes in ruminant meat production may result in domestic ruminant meat production and consumption becoming more aligned in a number of countries in the region. The probable exceptions to this situation are likely to be Malaysia and Thailand that would continue to rely on imports of ruminant meat from surrounding countries.

Acknowledgements

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