ISSN 1327-8231

ECONOMICS, ECOLOGY AND THE ENVIRONMENT

Working Paper No. 25

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August 1998

THE UNIVERSITY OF QUEENSLAND

ISSN 1327-8231
WORKING PAPERS ON
ECONOMICS, ECOLOGY AND THE ENVIRONMENT

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WORKING PAPERS IN THE SERIES, *Economics, Ecology and the Environment* are published by the School of Economics, University of Queensland, 4072, Australia, as follow up to the Australian Centre for International Agricultural Research Project 40 of which Professor Clem Tisdell was the Project Leader. Views expressed in these working papers are those of their authors and not necessarily of any of the organisations associated with the Project. They should not be reproduced in whole or in part without the written permission of the Project Leader. It is planned to publish contributions to this series over the next few years.

Research for ACIAR project 40, *Economic Impact and Rural Adjustments to Nature Conservation (Biodiversity) Programmes: A Case Study of Xishuangbanna Dai Autonomous Prefecture, Yunnan, China* was sponsored by the Australian Centre for International Agricultural Research (ACIAR), GPO Box 1571, Canberra, ACT, 2601, Australia.

The research for ACIAR project 40 has led in part, to the research being carried out in this current series.

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ASIA'S (ESPECIALLY CHINA'S) LIVESTOCK INDUSTRIES: CHANGES AND ENVIRONMENTAL CONSEQUENCES

Abstract

Asia's livestock populations and production of edible livestock products have risen substantially in recent years. Asia has increased its global share of livestock and livestock products. Furthermore, it has greatly increased its involvement in world trade in edible livestock products, e.g., exports of poultry meat and pig meat and imports of bovine meat and milk products. This article highlights these changes focussing on China, considers the reasons for these and their possible consequences for the environment. Future possible threats to Asia's export of livestock products are also discussed, such as environmental and animal welfare concerns.

1. Introduction

Livestock industries in Asia, particularly East Asia, and especially China, have been undergoing significant change in recent years with livestock numbers showing tremendous increases. In many Asian countries, such growth is associated with rising human population; increasing per capita incomes, changing technologies, availability of new techniques such as urea additions to roughage and straw to increase its digestibility by ruminants e.g., cattle, and altering tastes as a result of international contacts. The purpose of this paper is to highlight features of these developments, focussing in particular on China. What are the main changes? Why have they occurred? What are, or are likely to be their environmental consequences? What are some of the possible implications for international trade?

As Templeton and Scherr (1997, p. 22) state, 'relationships between human and animal population growth, production methods, and land quality are complex'. In low income countries, there is a tendency for livestock numbers to increase with human population but at a slower rate. Harrison (1992) for example, found that in developing countries between 1961 and 1985, human population increased at 2.3 per cent per annum and livestock numbers at 1.3 per cent per annum.

Templeton and Scherr (1997, p. 22) maintain that as human population rises from low to medium-high density (75-100/km^2), animal densities on ranges and pastures increase too, along with the total livestock population. However, when human population exceeds these densities, these trends in livestock population are reversed. In the earlier stage involving higher stocking densities, natural environmental quality is claimed to decline. However, they suggest that environmental quality in some cases could improve when human population levels become high (Templeton and Scherr, 1997, p. 24; Cf. Scherr and Hazell, 1994) due to changing methods of animal husbandry and reduced stocking densities. Nevertheless, it is very difficult to generalise in the way that Templeton and Scherr have. For example, the Netherlands, a country with a very high density of human population, has experienced

considerable environmental problems from livestock which have been stocked at high densities.

In Asia, industrial livestock production is increasing as incomes and populations rise, even though the recent Asian financial crisis will check this growth. East Asia has been one of the main recent sources of global growth in livestock production, an increasing proportion of which is being accounted for by poultry and pigs which lend themselves to industrial production. Steinfeld et al. (1996, p 10) notes:

> "Livestock productions is becoming separated from its land base, urbanized, and is beginning to assume the features of industrial production. In recent years, industrial livestock production grew at twice the rate (4.3 per cent) of that in mixed farming systems (2.2 per cent), and more than six times the grazing system production growth (0.7 per cent) (Seré and Steinfeld, 1996). This trend has accelerated in the past five years."

Industrial livestock production can give rise to intensive pollution problems as well as issues involving animal welfare concerns.

This paper outlines major developments in Asia's livestock industries in recent years, reviews their environmental consequences, placing these in a broad context, and considers some of the international trade implications of livestock developments in Asia, including possible consequences for international trade of environmental and animal-welfare concerns.

2. Changes in Asia's Livestock Industries

Geographically and ethnically, Asia is a very diverse region. The FAO statistics for livestock in Asia cover countries from Asia Minor and Saudi Arabia in the west to Japan in the east and Indonesia in the south. Within this region, livestock are kept under varied conditions – some on rangeland as in Inner Mongolia or hand-fed as in parts of Thailand and China.

In the last 5 years, Asia has significantly increased its proportion of the world's stocks of major livestock species as can be seen from Table 1. It now contains almost all the world's buffalo, one-third of its cattle, almost half of its chickens, most of its ducks, about

two-thirds of its goats, almost a sixty per cent of its pigs, and over one-third of its sheep. In all these categories, except for buffalo where Asia's share was constant, noticeable increases in Asia's share of world stocks occurred between 1992 and 1997.

Table 1: Asia's Share of the World Stocks of some Selected Live Animals

Live Animals	Asia's % Share of the World Stocks	
	1992	**1997**
Buffaloes	96.61	96.61
Cattle	30.86	33.40
Chickens	45.37	48.97
Ducks	83.08	87.22
Goats	60.84	65.48
Pigs	52.66	59.02
Sheep	29.88	35.03

Source: Based on FAO statistics

Because world stocks of major livestock species have been increasing, it follows from the above that Asia experienced considerable growth in its animal stocks between 1992 and 1997. The percentage growth levels are indicated in Table 2. While stocks of all livestock grew, goats, chickens and pigs recorded the greatest growth.

Table 2: Percentage Change of Asia's Live Animals (1992-97)

Live Animals	% Change
Buffaloes	3.83
Cattle	11.47
Chickens	24.20
Ducks	18.26
Goats	28.12
Pigs	21.05
Sheep	10.00

Source: Based on FAO statistics

In the five-year period, 1992-97, Asia also significantly increased its share of most edible animal products as can be seen from Table 3. It recorded increases in all the edible

animal products listed in Table 4, and would have also recorded substantial increases for pork production, goat and sheepmeat output and for broiler output, not listed here. Beef and veal production increased by a massive 72 per cent and egg production by over 60 per cent, while cow milk production was up by more than one-eighth.

Table 3: Contribution of Selected Asia's Livestock Products to Total World Production

Livestock Products	Asia's Share of the Total World Production (%)	
	1992	**1997**
Beef and Veal	11.09	18.18
Butter and Ghee	27.08	35.48
Cheese (all kinds)	6.15	6.02
Cow milk (whole, fresh)	14.22	15.88
Eggs (primary)	47.28	59.30
Milk (total)	22.22	25.18

Source: Based on FAO statistics

Table 4: Percentage Change in Asia's Production of Selected Livestock Products (1992-97)

Livestock Products	% Change
Beef and Veal	72.40
Butter and Ghee	24.77
Cheese (all kinds)	5.27
Cow milk (whole, fresh)	12.52
Eggs (primary)	61.48
Milk (total)	16.57

Source: Based on FAO statistics

Growth in animal stocks has varied between Asian countries, but livestock populations in China have shown strong growth for all categories of livestock as can be seen from Table 5. While growth rates for most livestock populations for India are lower than for China, except for chickens, China started from a much lower base for cattle.

Table 5: Percentage Growth of Some Selected Animal Stocks in Some Major Asian Countries (1992-97)

Asian Countries	Percentage Growth of Animal Stocks						
	Sheep	Buffaloes	Cattle	Goats	Chickens	Ducks	Pigs
China	26.42	7.22	40.90	71.99	23.93	23.04	23.19
Indonesia	23.93	- 7.64	8.45	23.47	53.24	3.18	-2.19
India	2.80	2.28	2.10	3.15	26.67	-	18.61
Malaysia	-2.39	-18.86	0.22	-10.79	19.37	4.17	15.47
Thailand	-26.39	0.06	0.80	-51.43	-18.62	7.42	-9.59

Source: Based on FAO statistics

China's contribution to world stocks of most livestock is substantial as can be seen from Table 6, and in all categories it increased its share of world stocks between 1992 and 1997.

Table 6: China's Contribution of Some Selected Live Animals to the Asia's and World Stocks

Live Animals	% of Asia's Stocks		% of World Stocks	
	1992	1997	1992	1997
Buffaloes	15.46	15.97	14.94	15.43
Cattle	20.85	26.36	6.43	8.80
Chickens	46.02	45.93	20.88	22.49
Ducks	73.85	76.83	61.35	67.01
Goats	26.85	36.05	16.34	23.61
Pigs	82.95	84.42	43.68	49.82
Sheep	32.46	37.30	9.70	13.07

Source: Based on FAO statistics

Table 7 indicates China's contribution to selected edible livestock products in Asia. Between 1992 and 1997, China's contribution to Asian beef and veal production more than doubled. It is now Asia's major producer of beef and veal. It is Asia's major egg producer. It would also be Asia's major broiler producer and by far its major producer of pork. It is in fact the world's major pork producer.

Table 7: Contribution of China's Livestock Products to the Asia's Total Production

Livestock Products	China's Share of the Total Asia's Production	
	1992	**1997**
Beef and Veal	27.88	54.03
Butter and Ghee	3.71	3.17
Cheese (all kinds)	21.12	22.11
Cow Milk (whole, fresh)	7.96	8.87
Eggs (primary)	55.42	68.40
Milk (total)	6.87	7.23

Source: Based on FAO statistics

Substantial growth and changes have and are occurring in Asia's livestock industries. These are partially in response to rising populations (but the rate of growth of human populations are now relatively low in many Asian countries, e.g., China), rising per capita incomes, adoption of new livestock husbandry techniques and changing tastes due to increased contact with the Western world, e.g., increasing milk consumption in most East Asian countries. In the case of China, and other Asian countries in transition, market reforms, have also helped to stimulate livestock production. Before China's reforms, its planned economy placed great emphasis on grain production at the expense of production of other agricultural products such as meat production. Prices and profit incentives now play a major role in directing the composition of China's agricultural production. Rising incomes, especially the emergence of a high income class, has increased demand for edible animal products significantly.

In most Asian countries, dualistic methods of animal raising have evolved in recent years. For example, in Thailand, traditionally pig and poultry production was limited to the village sector. Now almost all pig production is undertaken in commercial piggeries. While village chickens still account for 30-40 per cent of Thailand's stock, most of Thailand's chickens are in its commercial sector, controlled by multinational companies, mostly with headquarters in Japan (Tisdell *et al*., 1998). Thailand has been a major exporter of broilers, but now it is facing considerable competition from China because China has lower costs of production. Several of the multinationals who have invested in the Thai broiler industry have switched their investment to China and this has created difficulties for Thailand's poultry industry. As can be seen from Table 5, Thailand's chicken stocks declined by more than 18 per cent between 1992 and 1997 due mainly to lack of stability in its commercial poultry sector due to variations in global competitiveness.

In Thailand, production of bovines remains essentially a sideline village activity with each village family having usually only two to four head of such stock (Murphy and Tisdell, 1996a). They form part of an integrated (mixed) agricultural system and are used for multiple purposes: a store of value, for utilizing farm 'wastes' such as straw, crop residues, grass from roadsides and levee banks in the rice fields. Sometimes they may be tethered and allowed to graze in communal places but often the grass is cut and brought to cattle and buffaloes. The growing of pasture for livestock is rare. In some villages one or two villagers specialise in the rearing of cattle, mostly yellow native cattle. These cattle are normally only in the village in the dry season. In the wet season, when rice is growing on the farms, they are taken to the forests or communal areas for grazing (Murphy and Tisdell, 1996b).

Dairying has developed in recent years in Thailand with government support, but dairy herds are very small by international standards. The industry appears to rely on trade protection for its survival (Kehren and Tisdell, 1998).

3. The Environment, Livestock and Asia's Changing Livestock Situation particularly China's.

Increasing livestock populations and changes in animal husbandry can have a variety of environmental impacts. These include:

(1) nitrate and plant-nutrient emissions from manure;

(2) release of greenhouse and ozone-depletion gases from ruminants ;

(3) contributions to acid rains;

(4) where extensive grazing is practised, accelerated soil erosion if stocking rates are high;

(5) loss of natural vegetation and induced changes in the composition of botanical species;

(6) increased competition with wildlife for food and water, and

(7) loss of biodiversity (Cf. Preston, 1995).

There is a potential for Asia to experience all of these impacts. Currently, however, official emphasis in Asia appears to be on the positive environmental consequences of measures to increase livestock populations as later discussion of Chinese developments indicate.

Livestock-environment interactions are much more complex than the above list of points may suggest, and vary with the types of livestock systems adopted, e.g. grazing extensive, mixed farming and industrial intensive, as well as with stocking rates and husbandry practices. In industrial systems, account must be taken of their offsite consequences, e.g. need to grow crops to provide feed concentrates to livestock and the environmental consequences of this.

In several parts of the world, overgrazing by lost livestock adversely affects biodiversity, adds to soil erosion, and reduces the economic benefit from keeping livestock. This can sometimes be a consequence of the occurrence of inadequate socio-economic mechanisms for livestock management. For example, due to the erosion of local community, controls on grazing may be undermined and common land may become virtually open-access land with occurrence of the well-known tragedy of the commons (Jodha, 1992,

discusses the Indian case). Conversely, enclosures of common land making it private property can have adverse environmental and economic consequences where weather patterns are variable and livestock need to be managed flexibly, and moved over long distances. Land enclosures in some of the East African states have had this consequence and similar dangers exist in relation to parts of Central Asia. Steinfeld *et al.* (1996, p.15) point out that "in the Middle East and Central Asia, state farms are being privatized and cut up, thereby impeding pastoralists' mobility."

Arid rangelands are especially at risk from livestock, and desertification can follow overgrazing. According to UNEP, hot spots for such degradation in Asia occur in the Middle East, in the neighbourhood of Baluchistan and Rajasthan, and in Central Asia (Steinfeld *et al*. 1996, p.14, p.50). Nevertheless, there is disputation about the seriousness of such degradation and the extent to which it is reversible. Steinfeld *et al.* (1996, p.14) claim that if irreversibility and declining productivity are taken to be the main indicators of land degradation, then the situation is better than is commonly believed. For example, although fluctuations have occurred since 1960, both the trend in production of meat per livestock unit and per hectare has been significantly upward in the Sahel.

There is also some disagreement about the impact of livestock on biodiversity. Steinfeld *et al.* (1996. p.16) maintain:

> "Complementarities can be observed between wildlife and livestock. There is increasing evidence that the combination of wildlife and livestock can result in greater biodiversity and a higher income for pastoralists and ranchers. Usually, livestock-wildlife combinations do not require significant reductions in livestock stocking rates. For example, a reduction of only 20 per cent of the cattle stocking rate is required to create the "niche" for most wildlife species to prosper (Weston, personal communication)".

However, this probably gives an overly optimistic view. For <u>some</u> wild species, complementarity exists between them and livestock grazing, e.g. in Australia cattle raising has had a positive impact on populations of the red and the grey kangaroo, but in some other

cases the situation is competitive. In fact, the disappearance of at least one small Australian marsupial, a hare-wallaby, has been attributed to cattle grazing.

To the extent that the requirements of livestock industries tend to create uniformity of habitats, they reduce global biodiversity. This is without doubt the overall effect. This can come about even though there may be greater local diversity because the local diversity may be similar everywhere, or at least show considerable similarity over a substantial geographical range.

Deforestation for cattle grazing can be part of the process of creating increased uniformity of environments. In South America, deforestation for livestock production is estimated to be the main reason for deforestation, accounting for about 44 per cent of such deforestation in South America overall, and up to 70 per cent in Brazil (Bruenig, 1991). In Asia, livestock development is a negligible cause overall of deforestation, but it has been of some significance in the Philippines and in Indonesia. The economic and environmental consequences of such forest clearing are most unsatisfactory and irreversibility occurs. "Weeds displace grasses, and artificial pastures can only be sustained for a period of up to ten years. More than 50 per cent of pasture areas in the Amazon region have now been abandoned in a degraded state. Natural regeneration of forests is quite difficult especially in large areas." (Steinfeld, 1996, p.17).

Nutrient surpluses from keeping livestock have become a worldwide problem due to livestock being kept in high densities. Such surpluses occur in Asia, noticeably in Eastern China, South Korea, Japan and parts of South-East Asia, where they are often associated with peri-urban livestock production. Steinfeld *et al.* (1996, p.19) observe that "..... in most developing countries, in particular pig and poultry production in Asia, lack of regulations and weak infrastructure allowed a surge of peri-urban production. Industrial livestock production emerges when the demand for animal products increases too rapidly for land-based systems to respond" as has been the case in much of East Asia. In addition, wastes from processing animal products can create considerable environmental pollution. Consider wastes from abattoirs and tanneries, for example.

It is estimated that over 21 per cent of the world's land is used for producing concentrate livestock feed. Together, pigs and poultry use about one-third each of livestock concentrate with cattle consuming more than a quarter. To the extent that grain is used for this purpose, especially beef production, its use has been subject to criticism on the basis that it is an inefficient way of obtaining food for humans. Meat to grain conversion ratios are higher for poultry than for pigs, and lower than both of these for cattle (Tuan, 1987). But the position is complex (Tisdell and Harrison, 1997). Some of the grain fed to animals is unfit for direct human consumption. Cereals make up about 60 per cent of the overall composition of livestock concentrate, with brans and oilcakes and similar by-products accounting for the remainder. The latter by-products have few alternative uses. Nevertheless, there can be no doubt that grain production for livestock competes with alternative uses of arable land and promotes both the intensification and extension of cropping by raising the demand for cereals. To the extent that this land-conversion occurs, it is liable to reduce biodiversity significantly (Cf. Steinfeld, *et al.* 1996, p.21). With the expansion of poultry, pig, and dairy production in Asia, demand for feed concentrates is increasing.

Livestock contributes to "greenhouse warming" as discussed in some detail by Steinfeld *et al.* (1996). They point out (p.24):

> "Livestock and livestock wastes produce gases. Some are local, such as ammonia, whereas others, such as carbon dioxide (CO_2), methane (CH_4), ozone (O_3), nitrous oxide (N_20), and other trace gases (together forming greenhouse gases) affect the world's atmosphere, by contributing to global warming or global climate change. Livestock's contribution to that effect can be estimated as between 5 and 10 percent."

All livestock produce carbon dioxide, but ruminants have rather high emissions of methane due to their metabolic system. Livestock contribute about 16 per cent of animal methane emissions. Nitrous oxide, the most aggressive greenhouse gas, is produced by animal manure which is said to account for about 7 per cent of anthropogenic emissions (Steinfeld *et al.*, 1996 p.25). Nitrous oxide from such manure may also contribute to acid

rain. Thus it can be seen that livestock production, although not the major source of greenhouse gas emissions, is not an unimportant source of such emissions.

Not only has increasing livestock production contributed to a decline in diversity of wildlife overall, but modern developments are resulting in seriously declining domestic animal diversity as well. As pointed out by Steinfeld *et al.* (1996 p.26):

> "Increased intensification and industrialization of livestock production requires increasingly uniform genotypes and has caused the extinction of some, and the genetic erosion of other local livestock breeds. There are currently about 600 breeds at risk of extinction, representing about 20 per cent of the total global livestock breeds" (Hammond and Leitch, 1996).

Loss of such biodiversity has been quite noticeable in Asia, as it has become increasingly market-oriented and globalized. In many cases, introduced Western breeds of livestock are replacing domestic breeds. The number of pig breeds in China and of dairy cattle in India are in decline. Native breeds of draught animals and those used for beef are under threat, e.g. in Thailand.

Clearly, major environmental problems are arising from increased livestock production. In some cases, these effects have been exacerbated by government policies. No easy socio-economic solution is at hand, although there are some policies that can be adopted to counteract negative environmental effects of livestock production as pointed out by Steinfeld *et al.* (1996, Ch. 3) and by Mearns (1997). The rapid rate of growth of livestock production in Asia, pro-economic development sentiments, and required institutional strengthening, mean that in most cases, Asian countries have a considerable way to go to counteract the environmental impacts which are being generated. In China, there continues to be great emphasis on expanding livestock production with negative environmental impacts tending to be down-played.

New developments in the treatment of crop residues, e.g., anaerobic fermentation prevention and treatment with urea have helped to boost China's beef production and that of mutton and the potential of this technique to increase production even further is considerable

(Tingshuang and Zhenhai, 1996). With their increasing adoption since 1990, these techniques have helped boost China's beef and mutton production. These measures help to economise on feed grain for livestock and have resulted in cropping areas replacing pastures. But the latter is not an unmixed blessing from an environmental point of view. Tingshuang and Zhenhai (1996) point out that extra cattle provide extra farmyard and manure and 'the extensive use of farmyard manure can reduce the cost of chemical fertilizer, thus not only lowering costs but also improving agricultural production'. They go on (p.3) to point to other environmental advantages of the crop-residue techniques:

'Many places along the Yantze River are schistosomiasis-endemic areas. Cattle grazing near the river (as well as lakes and water holes) become parasite hosts. Utilising ammoniated crop residue to feed cattle and moving from grazing to stall feeding, breaks the schistosome cycle and helps to control the spread of the disease. Also, utilising more crop residues helps to avoid atmospheric pollution from burning crop residue which is a problem in highly populated areas'.

The essay of Tingshuang and Zhenhai (1996) gives the impression that no environmental disadvantages are present from livestock systems based on the use of crop residues. In this respect, however, it paints an overly optimistic picture. For example, the technique may result in residues which were previously composted or directly ploughed into the soil being fed to ruminants. It is possible therefore that there could be some reduction in compost availability and materials for maintaining soil humus and structure. Nevertheless, in those cases where straw or residue is burnt, the alternative of feeding it to ruminants would be preferable.

As for farmyard manure, its environmental impact depends on how thinly it is spread and whether it is spread quickly. Groundwater contamination is likely to result from concentrations of farmyard manure. One of the most serious problems is the nutrient-enrichment of water bodies (particularly increased nitrogen and phosphorous availability in water) which encourages the growth of water weeds (both micro and macro) and can accelerate eutrophication. Deterioration in water quality can affect its suitability for

consumption by humans and livestock. Aquaculture and fisheries can also be affected adversely. China must consider seriously any possible adverse environmental impacts on its aquaculture because it has the largest aquaculture industry in the world and aquaculture provides a valuable source of animal protein for its people. Furthermore, the increased frequency of red tides in the China Sea which kill fish and/or render them unfit for human consumption has been attributed to increased levels of nutrients in waters flowing from China.

One way to reduce possible nutrient leakages from the local environmental system is by means of integrated farming systems which include aquaculture as a component with the livestock manure being used to fertilise aquaculture ponds, so as to promote the growth of aquatic plants which can be eaten by fish. However, there may be leakages of nutrients from ponds and the other problem is the organic content of livestock manure results in oxygen absorption from the water. While China has traditionally used mixed integrated farming systems, modern economic pressures are increasingly encouraging use of specialized agricultural production systems.

Large quantities of farmyard manure create considerable oxygen-demand and can reduce oxygen levels in ponds to levels where higher valued species of fish cannot be grown, or fish are stunted in their growth or in extreme cases, the growing of fish becomes impossible. Chan (1996) describes several methods for reducing the biochemical oxygen demand (BOD) of farmyard manure before releasing it to aquaculture ponds, namely:

(1) the use of digesters which involve holding the manure in airtight containers for a time (biogas can be obtained as a by-product), and

(2) oxidation of the digested fluid or washwater in shallow basins employing algae to supply oxygen naturally.

The economics of these methods need to be assessed along with other suggestions made by Chan (1996) for ecologically balanced Integrated Farming Systems.

Preston and Leng (1995) suggest that crop residues and straw digested partly using urea-based technology will, when fed to ruminants, reduce their methane emissions substantially. While this is so, account needs to be taken of any methane released in or following the digester process. Furthermore, even if methane emissions per beast are reduced if the technology permits a sufficient increase in numbers of ruminants, total methane emissions may rise. Preston and Leng (1995, p. 1) point out that 'Methane production appears to be a major issue although it only presently contributes 18% of the overall warming. It is accumulating at a fast rate and is apparently responsible for some of the depletion of the protective ozone layer. Methane arises largely from natural anaerobic ecosystems, rice paddies and ruminant animals'. Ruminants are believed to contribute about 18 per cent of methane emissions (Bolle *et al.,* 1986).

The use of treated straw and residue for feeding ruminants has and is spreading rapidly in China as can be seen from Table 8. There are several reasons for this: urea is heavily subsidised, the method is quite profitable, little investment is required, scale is not an important constraint so farmers with few ruminants can adopt it and it can be tried incrementally. There has been considerable extension work undertaken since livestock production based on crop residues was included in the State Agriculture Comprehensive Development Project commencing in 1992. These techniques would also seem to have good prospects for adoption in other developing countries.

Table 8: Number of Chinese Farmers Treating Crop Residues (Straw) for feeding to Ruminants and Quality Treated, 1990-1995

Year	Farmers (millions)	Treated Straw (million tons)
1990	0.8	2.6
1991	1.2	3.7
1992	2.3	7.1
1993	3.8	11.7
1994	5.3	15.9
1995	7.1	21.5

Source: Tingshuang, Gao and Zhehei, Yang (1995) p. 3

Findlayson *et al.,* (1995) have examined the economics of utilising treated fibrous residues of crops for beef production in China. At present cost: price ratios, they find that this is quite profitable for cattle fattening in Henan and Hebei, (in the first case using urea and in the latter cases adding ammonia, [NH_3]), as a feed supplement. Using economic analysis, they provide estimates of profit and determine the most profitable quantity of fibrous supplement. Their results, however, do cover special cases.

China also has large pastoral regions in its western areas, where in some areas sheep and goats are important forms of livestock. In their study of such areas, Longworth and Williamson (1993, p. 301) found a close link between the trend in rural human population levels and herbivorous livestock numbers. In fact, they found that the correlation between values of these variables increased as both human population levels and livestock numbers rose. They came to the following conclusion:

'The increasing population pressure on the rangelands of China since 1949 can be traced to three basic policy initiatives of the central government: the expansion of cultivation in the pastoral region, the introduction of the household registration system; and the granting of family concessions to minorities. Taken together these three national policies have imposed major constraints on sustainable economic development in pastoral areas and, as a result, they have perpetuated regional poverty and attendant environmental decline' (Longworth and Williamson, 1993, p. 304).

The extent to which the environmental degradation of China's rangelands have been ameliorated since China began its economic reforms requires investigation. There are still strong pressures to extend cultivation in rangeland areas. Although more scope has been created for private agricultural initiatives since China's reforms, the extent to which these have impacted on pastoral areas is unclear. Furthermore, private economic incentives and higher prices for agricultural produce do not always result in more sustainable livestock practises or increased environmental conservation especially if property rights are ill-defined

or felt to be insecure or if grazing land is largely communal and its use by individuals is not carefully managed.

The above by no means exhausts possible environmental consequences of expansion in Asia's and China's livestock industries. For example, with improved communications in Asia, there is now the potential to spread livestock diseases rapidly. Control of livestock diseases is a growing issue and with increasing livestock populations, the cost of not controlling infectious livestock diseases is rising. With increasing populations of livestock and humans, the probability of diseases jumping between species increases, the so called chicken-flu seems to be an example, and it is believed that some new strains of flu originate in pigs and then subsequently infect humans. Increasing animal population densities (as with human population) are favourable to the occurrence of epidemics unless appropriate precautions are taken.

4. International Trade in Livestock Products in Relation to Asia, especially China, and the Environment

Asia has been more involved in international trade in livestock products in recent years than in earlier times. Both China and Thailand have, for example, become major exporters of poultry meat. China, for instance, increased its exports of poultry meat from 51,924 MT in 1990 to 308, 975 MT in 1995, almost a six-fold increase. Thailand expanded its exports of poultry meat from 143,689 MT to 193,732 MT in the same period, but has found it difficult to sustain its exports mainly because of competition from China which has had lower costs of production due to lower wage rates. Between 1990 and 1995, China's export of pigmeat increased by almost 50 per cent and the value of these exports almost doubled.

One the other hand, China's exports of bovine meat declined and its imports of bovine meat rose by more than 50 per cent, making China a substantial net importer of bovine meat in 1995. This reflects increasing consumption of beef in China. Although China's beef production has risen greatly, it is inadequate to meet rising demand. According to Cai *et al.*

(1998) Chinese demand for ruminant meet is more elastic, both for price variations, and income variations, than for poultry and pork. This is favourable to beef exporters such as Australia but from a global- greenhouse-gas point of view problematic. East Asia has been able to provide increasing market opportunities for Australia and New Zealand beef and dairy products and also for the US.

China's exports of dairy products (including eggs) declined slightly in the period 1990 to 1995 and its imports rose by more than one-third, making China a substantial importer of dairy products. Most East Asian countries have become major importers of dairy products (mostly milk-based products) and their imports have risen substantially.

Environmental concerns do not appear as yet to have become a reason for discriminating against exports from Asia of items like chicken-meat and pork, but environmental health considerations have the potential to disrupt seriously export of edible livestock products by Asian countries. For example, if chicken-flu, capable of being transmitted to humans, were to be found in China's or Thailand's chicken flocks, one could anticipate widespread bans on the importation of chicken products from those countries.

Another factor which could potentially affect Asian exports could be animal welfare concerns (Cf. Tisdell and Harrison, 1997). These have not achieved the degree of prominence in Asian countries as in higher income Western ones. However, it cannot be assumed that livestock are kept under worse conditions in Asian countries than in Western ones. From Table 9, it can be seen that broiler stocking densities in Thailand are lower than for The Netherlands and France. But of course, crowding is only one issue. Other issues include the risks to humans of the use of antibiotics, growth hormones and chemical additives to food used in rearing livestock.

Table 9: Comparisons for the Six Major Broiler Exporting Countries

Variable	Brazil	USA	China	Thailand	Netherlands	France
Stocking Density (bird/sq.m)	10-12	14	15-16	8-12	23	16-25
Mortality (%)	5.0	5.0	5.0	5.7	4.9	3.0 - 7.5
Feed Cost/ton (US$)	165	176	289	280	384	315
Wholesale Price (US cents/kg)	94	123	133	140	194	205

Source: Based on Anon (1996), p. 26.

5. Concluding Comments

Asia has experienced substantial growth in its livestock industries in recent years. The populations of all major livestock in Asia have multiplied in many cases by large amounts. Asia has both increased its share of world livestock populations and its share in world production of edible livestock products. Impressive growth has been recorded in developing East Asian countries, especially China, and these changes have been highlighted.

Dualism in livestock production has developed in many Asian countries and this is especially apparent in chicken and pig production. The development of commercial industrial-type livestock systems along Western lines can be expected to entail similar difficulties and environmental problems to those which have arisen in Western countries, e.g, similar problems in disposal of manure, similar animal welfare problems. The problems at the village level are rather different – it may be easier to utilise extra animal manure at this level without creating pollution problems, but on the other hand, increasing livestock numbers can be expected to result in more intensive land-use and can create ecological imbalance.

Despite increased animal production in Asia, supply of beef and milk products particularly in East Asia, has been unable to keep up with rising demand and this has created

export markets for countries like Australia, New Zealand and the USA. On the other hand, both China and Thailand have developed into major exporters of chicken meat and China is a major exporter of pork. This has changed the nature of international trade in livestock products. Such specialised trade is, however, extremely vulnerable to environmental health variations.

In conclusion, it might be noted that the development of livestock industries in different Asian countries is divergent in some aspects, due to variations in religious beliefs. For example, in parts of Asia dominated by followers of Islam, the husbandry of pigs is restricted by lack of demand for pork and restrictions on the keeping of pigs, whereas in India, Hinduism restricts the consumption of beef and in some instances, all meat and/or livestock products are avoided by some religious sects or groups. Although Islamic groups exist in China, the majority of East Asians (Chinese, Koreans and Japanese) have no religious restrictions on the eating of meat. Throughout Asia, both fish and poultry are widely accepted meats. Most Asians, however, like to consume some types of livestock products and rising incomes in this region until recently translated into rising populations of livestock. As we have observed, all types of livestock generate negative environmental effects and most Asian countries have not escaped such consequences. Once economic growth resumes again in Asia, concerns about such problems are likely to be renewed.

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