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Asian Livestock to the Year 2000 and beyond

prepared by

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The author, Dr. Denis Hoffmann is the Senior Animal Production and Health Officer, FAO RAP, Bangkok. The current publication is part of a Working Paper Series produced by the FAO Regional Office. Also in this Working Paper Series on Food and Agriculture-Perspectives Beyond 2000:

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This is an unedited version. Your comments and suggestions are welcome.

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Foreword

After two decades of rapid economic growth, five of the most economically dynamic countries namely South Korea, Thailand, Philippines, Indonesia and Malaysia of East and Southeast Asia entered a period of serious economic and financial crisis in 1997.

This recent crisis has further emphasized the critical role of agriculture on the road to economic recovery. There is an increased pressure on domestic food production and supply to meet the needs of a growing population. Our current and achievable challenge, therefore, is to build upon and accelerate the progress registered in the region to ensure safe, secure and nutritious food for the future.

This publication was prepared to enhance Asian prospects for achieving nutritional security beyond 2000 by serving as a catalyst for further and sustained actions. It is part of a series of publications being prepared by FAO Regional Office staff for dissemination to planners, policy makers, concerned professionals and others citizens with a view to enhance the focus and effectiveness of information and communication related to the overall mandate and programme priorities of FAO in the Asia-Pacific region.

Looking at the long-term and in a broader regional context, the demand-driven Livestock Revolution in Asia is fueled by population growth, urbanization, and income growth. By 2020, these forces will dwarf the effects of the 1997 financial crisis in Asia. There are many reasons for being optimistic about future livestock demand in Asia.

Given that intensification of livestock production will continue, there is a need for the public sector to address the consequences. The role of the public sector is essentially to facilitate employment and income generating activities in an environmentally sound livestock industry producing safe quality products.

It is in this spirit that this Working Paper on "Asian Livestock to the year 2000 and beyond" is being produced. We realize that this is not the last word on the subject, and invite your valuable comments and observations on the Working Paper. These will encourage and guide the author to finalize the publication in due course. I trust the publication will prove to be a useful guide towards longer term, more sustainable policies and the means to optimize use of national resources.

Dr. Prem Nath
Assistant Director General
and Regional Representative
for Asia and the Pacific

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`I don't understand you,' said Alice. `It's dreadfully confusing!'

`That's the effect of living backwards,' the Queen said kindly:

`It always makes one a little giddy at first --

`Living backwards!' Alice repeated in great astonishment. `I never heard of such a thing!'

` -- but there's one great advantage in it, that one's memory works both ways.'

`I'm sure mine only works one way.' Alice remarked. `I can't remember things before they happen.'

`It's a poor sort of memory that only works backwards,' the Queen remarked.

Through the Looking Glass (And What Alice Found There)

by Lewis Carroll

INTRODUCTION

Livestock's economic importance goes beyond direct food production. Skins, fibers, manure (fertiliser or fuel), draught power, and capital are also livestock benefits. Livestock provides a lifeline for a large proportion of the 95 percent of the world's rural population that lives in the developing world and cultivates 64 percent of the world's arable land. People in developing countries have access to less than 20 percent of the industrial machinery and 40 percent of the chemical fertiliser produced in the world. The draught power and nutrient recycling inputs of their farm animals, which compensate for the lack of access to the modern inputs, help to maintain the economic viability and environmental integrity of their farms. Furthermore, livestock care is intricately interwoven with the social fabric of many societies, and in many situations, livestock constitute the main, if not the only, capital reserve of farming households, serving as a strategic reserve that reduces risk to the farmer and adds stability to the overall farming system.

Steinfeld (1998) considers that the livestock sector in Asia is under pressure to expand and to adapt. Under current conditions, this adaptation involves mainly functions and species, with the greatest change being the increase in the number of monogastrics and poultry. Livestock production is growing faster in the moister, more densely populated areas, and there is a general trend towards expansion and to vertical integration with the formation of product-specific, whole-production chains. This threatens the breakdown of traditional mixed farming and pastoral systems everywhere, as economic growth and/or demographic pressure provides the incentive for the industrial-type production. He observes that technological changes are creating modern, demand-driven and capital-intensive production chains for poultry meat, eggs, pork and dairy products, leaving the traditional, resource-driven and labour-intensive sector to smallholder farms. Smallholder farmers are therefore being excluded from the high-growth sector where economic returns are potentially high.

Contributions from the livestock sector to the economy have been largely underestimated in the past and although it is clear that the relative importance of the non-food benefits of livestock will decrease, nevertheless livestock provide for a wide range of human needs. The challenge now is to increase the productivity of livestock and the quality of livestock products and provide access to markets so as to assist in maintaining food security and relieving poverty, while maintaining the physical environment and protecting human health.

TRADITIONAL ROLE OF LIVESTOCK IN FOOD SECURITY

Ramsay and Andrews (1999) consider the role of livestock in food security involves not only the provision of food for the owners of the livestock but also a range of other products, which can be consumed or sold by the livestock owner to provide additional income, and/or traction and fuel. The major products of livestock are draught power, meat, milk, eggs, manure (as fertiliser or fuel), feathers, fibre, hides, and horn.

In addition to these products livestock act as an asset and provide a reserve that can be converted to cash in times of need.

By producing and selling livestock, poor rural families (in particular women) are able to enter the cash economy. Thus livestock production provides increased stability in income for the family without disrupting other food-producing activities.

The majority of the livestock in Asia is still kept by small holders; each producer usually owns a small number of animals. The livestock are fed on crop residues and are opportunistic feeders grazing and scavenging on common-and wasteland. In most cases therefore this does not involve the farmer in any expenditure. Small-scale producers do not use food that could be used for human consumption to feed their livestock.

In contrast to the small-scale producer, commercial production is generally intensive and based on the use of imported livestock feeds.

Livestock kept under the prevailing conditions of small-scale production in the region have a low level of productivity. This is in part because the diet is generally at or below maintenance levels and all of the food is partitioned to maintenance of the animal rather than to the production of livestock products. In most cases livestock are an integral part of the system of sustainable mixed farming. This system enables farmers to make maximum use of outputs such as crop residues and animal manure, which are often considered to be of low value but can represent a significant proportion of the value of keeping livestock. For example it is estimated that in Bangladesh 40% of the value of the animal is in the manure it produces and 20% is in the draught power it supplies. These outputs often never appear in the figures showing the value of livestock to a country.

CHANGING LIVESTOCK PRODUCTION SYSTEMS IN ASIA

In 1996 Sere and Steinfeld undertook a major study to provide a qualitative and quantitative description of world livestock production systems in order to assist in structuring global assessments of the interaction between livestock and the environment. Eleven categories of systems were defined, mainly on the basis of (a) agro-ecological zones (b) mixed (either rainfed or irrigated) or solely livestock and (c) landless (intensive) or grassland. This classification system was further simplified to three system types: pastoral, mixed farming and peri-urban/ landless (alternative names are extensive, mixed, and industrial).

As we move towards 2000 and beyond many developmental changes are predicted.

Steinfeld in 1998 published an article "Livestock production in the Asia and Pacific region – current status, issues and trends" in FAO's *World Animal Review* (No. 90, 1998/1). The rest of this section is an adaptation of that article, as it recently appeared in Agriculture 21, the FAO's AGA Departments Electronic Newsletter. These are Steinfeld's observations as presented in that paper.

The capital-intensive livestock sector that is developing in Asia generates little employment, threatens environmental degradation and challenges human and animal health.

The rapidly increasing demand for livestock products, together with changes in international trade, is placing pressure on Asia's livestock sector both to expand and adapt. This adaptation involves a shift in livestock functions and species, and a shift in agro-ecological and geographical zones, involving structural and technological changes.

The non-food functions of livestock are generally in decline and are being replaced by cheaper and more convenient substitutes. At the same time, the asset, petty cash, and insurance functions of livestock are being replaced by financial institutions as even remote rural areas enter the monetary economy. Except for some parts of South Asia, the use of animals for draught power is declining as more farmers mechanise, partly attracted by government subsidies. Manure continues to be important in mixed farming but its role in overall nutrient supply is diminishing because of the competitive price and ease of management of inorganic fertiliser. The same applies to animal fibers: although the demand for natural fibers is still high and in many places even increasing, there are a growing number of synthetic substitutes for wool and leather.

There is also an increasing tendency to greater selectivity as to the parts of the animal used for food. Traditionally, virtually the entire animal was utilised. Now the trend is towards lean meat for food and other products (such as offal, blood, and bone) for industrial use or recycled as feed. Thus, there is a trend from multi-purpose to single-purpose animals, with the production of animal protein the overriding objective. This is also reflected in the choice and manipulation of genotypes to favour specialisation over product diversity. Another trend is the growing importance of monogastrics as economic converters of concentrated feed.

Livestock production is growing faster in the moister parts of the region, and it is moving closer to urban settlements. It is the humid and sub-humid zones that still offer a large

potential for agricultural production. This is very problematic since these zones are the richest in natural resources and bio-diversity. Human populations are increasing dramatically in these areas while other zones, such as arid and highland areas, have reached a level of population density above which significant increases can no longer be sustained. The fact that the increase in livestock numbers coincides with increases in human population, to some extent, can be explained by a continued close integration of animals in mixed systems. More importantly, however, this phenomenon reflects the increasing "urbanization" of livestock production, influenced by urban demand, good market access, and adequate infrastructure.

This type of livestock production is largely independent of agro-ecological conditions and far outpaces other land-based systems, as shown in Table 1.

Table 1 Annual growth in meat production, 1985-1995

Annual growth in meat production, 1985-1995	
Arid and semi-arid zones	2.6%
Temperate and highland zones	5.1%
Humid and sub-humid tropics	7.2%
Industrial systems	17.2%

Source: FAO, WAICENT

This trend is in line with the observed shift to monogastric species and poultry. In some rural areas, the lack of infrastructure, economies of scale and insufficient marketing facilities limits success in competition, the result that livestock production becomes locked into subsistence level production activities. However urbanization is clearly not sustainable in the long term, mainly because of waste disposal and environmental problems as well as public health implications.

Two important structural changes apply across production systems: a general growth in scale and a trend from horizontal to vertical integration. Levels of livestock production and processing are increasing in response to technological development, market requirements, and insufficient returns to labour in traditional systems. Where alternative employment opportunities exist, such as in the rapidly industrializing countries of the region, traditional subsistence-orientated livestock farming is often abandoned, opening up market and expansion opportunities for other farmers or commercial entrepreneurs.

In particular, poultry production has often developed from a simple farm operation to a complex vertical operation of related industries and enterprises, including grain production for animal feeds, feed mills, slaughterhouses and processing plants, food chain stores and wholesale enterprises.

Further structural changes relate to the relative importance of different production systems. The growth potential for extensive grazing and roughage production is limited. In response to increased population pressure, good pastureland is being converted into cropland, leaving poorer land for grazing and mixed farming while industrial production of pigs and poultry is increasing relative to the reduction in production from grazing and mixed farming systems. Pork and broiler production will also increase relative to ruminant meat production. This is a direct result of the better conversion efficiencies of concentrate feed in pigs and poultry.

Faced with increasing resource constraints that stem from a small land base, imports of meat and other livestock products to satisfy the growing demand are increasing in Asian countries as evidenced by growing trade deficits in these products. The developing countries of Asia had a net trade deficit of 313,000 tons of ruminant meat and a net trade surplus of 409,000 tons of monogastric meat in 1997. While the region as a whole is self-sufficient in all livestock products, there are important differences between the sub-regions. Australia and New Zealand make up for the deficit of the other sub-regions, particularly for beef and milk.

It can be expected that many countries of the region will become permanent importers of livestock products. Indonesia, for example, imported 30,000 tons of red meat in 1997, and the country's Meat Importers Association estimates that imports of red meat will rise to 196,000 tons in 1999, and reach 346,000 tons in 2003. This situation is even more pronounced on the feed side. Taiwan, for example, in recent years has imports of more than 10 million tons of coarse grains and soybeans, equivalent to 95 percent of its concentrate feed utilization.

In line with the structural changes outlined above, the development, transfer, and adaptation of technologies will focus on improving the efficiency of feed utilization and increasing animal productivity. Feed requires land for production and this continues to be the limiting factor to the sector's expansion even if countries resort to feed imports. Continuing industrial development in the region will also make traditional livestock raising practices less competitive because of diminishing returns to labour, even though this process will be very gradual.

We are therefore witnessing a dualistic mode of development, with two conflicting components. First, a modern, demand-driven and capital-intensive sector, producing poultry meat, eggs, pork, and sometimes milk, increasingly uses state-of-the-art technologies. This sector utilises resources, in particular concentrate feed, efficiently-- with the notable exception of fossil fuel. It is rapidly expanding to meet urban demand but it is also susceptible to market upheavals; it generates little employment, threatens

great environmental degradation (because of the density of facilities in areas with good market access), and challenges human and veterinary public health. Technology uptake in the region has been fast, driven by commercial interests.

At the same time, a traditional, resource-driven and labour-intensive sector continues to provide a multitude of services to subsistence-oriented farms. While not efficient in terms of introduced inputs, this sector uses resources which have little or no alternative values, and for this reason, its potential to expand beyond moderate growth rates is constrained by low technology uptake, insufficient market facilities and infrastructure, and small economies of scale. Often, these systems are closed cycles of nutrients, farm labour, energy, etc. Unless these cycles are broken, technology uptake will remain constrained.

Grazing systems have limited scope for expansion. To some extent, in countries such as Laos and less densely populated areas of Indonesia, the Philippines, and China, these systems can intensify by incorporating new technologies, especially in the higher potential areas. To be sustainable, this needs to be facilitated by stronger institutions, local empowerment, and regulation of access to resources. Where this does not happen, and where population pressure persists, grazing systems are threatened with resource degradation through overgrazing.

Historically, where agro-ecological conditions were favourable, grazing systems developed into mixed farming systems, which are now common throughout Asia. Mixed farming systems will intensify and grow in the coming decade with livestock production based on crop by-products and surplus. Some productivity gains will most likely be achieved by further enhancing nutrient and energy flows between the crop and livestock components. Involution of the mixed farming system may occur, such as in the Himalayan hills and Hindukush area, where the stability and sometimes very existence of mixed farming is threatened by the removal of livestock from the system, triggered by population pressure, fragmentation of arable land, poverty and lack of market access.

Under more favourable agro-ecological and market conditions, industrial systems have emerged, in parallel with, and sometimes supplanting, mixed farming systems. Because of generally poor infrastructure and institutions, these are usually established close to demand centers, resulting in excessive animal densities, nutrient surpluses and other environmental and human health problems that highlight an "urban trap": while profitable in the short run, these systems cannot be sustained in urban or peri-urban environments. Such considerations caused Singapore, for example, to abandon livestock production altogether. The answer is to have specialised commercial production operating on an area-wide basis where nutrient balances are maintained and the land's capacity to absorb animal waste is respected.

The evolutionary and significant trends described above must, if they are to be sustainable and progressive, take into account their impact on the public domain or public good. The four main issues are: the contribution of livestock to food security and food production; the protection of the environment in the face of increasingly intensive farming methods; the maintenance and generation of social equity which may be jeopardised by industrialisation and job loss; and the protection of human and animal health and welfare.

It is therefore essential that policy makers and planners responsible for livestock development define future strategies in the broad context of human development and the sustainable utilization of limited natural resources.

THE IMPLICATIONS OF THE ASIAN ECONOMIC CRISIS

The current Asian economic crisis threatens to wipe out the gains from recent years of economic growth, poverty alleviation, and human development in many developing Asian countries. It has significantly weakened the capacity of many East Asian countries to keep a sizeable proportion of their populations from falling into abject poverty and severe food deprivation.

During the past two decades, economic growth was the single, most important factor contributing to significant poverty reduction in East Asian countries, especially those in transition from centrally-planned to market economies. The sharp economic contraction in 1998 in some of these countries (particularly Indonesia and Thailand) has dealt a major blow to an otherwise good performance in poverty alleviation during the last quarter of the century.

If the crisis deepens in the economies of South Asia and Indochina, Asian household food insecurity could become an even more serious concern. India and China have the largest concentration of Asia's absolute poor, representing about 60% of the total population. Moreover, recession in this region could easily wipe out recent gains in poverty-reduction efforts, especially if agriculture, which the large majority of the poor are dependent on for income and livelihood, takes a disproportionate role in the subsequent economic adjustment. The step from poverty to sufficiency in these countries is still quite shallow, largely because economic growth has not been as rapid and sustained as that in North East Asian countries.

Between mid-1997 and 1998, the currencies of South Korea, Indonesia, Malaysia, the Philippines, and Thailand fell by 40-80 percent against the U.S. dollar, precipitating a financial and economic crisis, the long-term effects of which are uncertain. The expected growth rates of gross domestic product in the region's economies have been revised sharply downward, into negative territory in most cases. Declining growth rates and depreciating exchange rates may significantly alter the levels of malnutrition, nature of domestic food demand and patterns of trade in the region and throughout the developing world.

In theory, the currency depreciation that occurred should help the agriculture sector. All other things being equal, depreciation raises the domestic prices of tradable goods relative to those of non-tradable goods, thereby enhancing the incentives for sectors producing tradable goods. While this may be true for agriculture in general it is not true for those countries which have developed a livestock sector based on imports, such as has

occurred in the livestock poultry sector in Indonesia. Since 70 percent of the inputs for intensive poultry production is feed, the industry will collapse if feed costs rise above a level where profit can be made. As most of the inputs into industrial livestock production are not available domestically and are essentially tradable goods, the depreciation is expected to decrease the capacity of industrial livestock production to contribute to foreign exchange generation and hence to economic recovery. Also, since industrial livestock production is not labor-intensive it does little to ease the adverse impact of the economic downturn in urban areas, not withstanding the reverse flow of labor, mainly unskilled and semi-skilled, from urban to rural areas as urban wages are significantly depressed.

In addition, cuts in government spending can significantly reduce the provision of public goods to services for both urban and rural populations.

Even in rural areas where most of the poor are dependent on agriculture for incomes, the poorest tend to be net buyers of food staples. Thus, the sharp rise in food prices for many of the crisis-affected countries is a serious threat to household food security and to the gains in poverty alleviation during the last quarter of the twentieth century.

CRISIS ASSESSMENT

Rosegrant and Ringler (1998) assessed the Asian economic crisis and how it would affect cereal and livestock demand, food security and nutrition, trade and poverty to the year 2020.

They said that after more than a decade of rapid economic growth, many East and Southeast Asian countries face the prospect of a long economic slump, and the poor in these countries face a reversal of their halting climb out of poverty. Exports from the developed world will be affected as well.

Although the long-term effects of the crisis on income growth and real exchange-rate depreciation are unclear at this point, making it difficult to assess long-term changes in global food markets and food security, the crisis is likely to have some persistent negative effects. The potential impact on agriculture and nutrition can be gauged by using IFPRI's recently updated global food model, which covers world food production and consumption for 18 agricultural commodities, to compare three scenarios through 2020.

The baseline scenario reflects the economic trends prevailing before the onset of the crisis. In the severe scenario, the short-term effects seen so far in Asia are assumed to worsen significantly. Income growth rates drop to half of pre-crisis levels and domestic agricultural prices rise by 10-30 percent as a result of currency devaluation. In the moderate scenario agricultural commodity prices rise to half the severe-scenario levels and income growth rates almost recover to pre-crisis levels.

Delgado et al (1999) consider livestock as a major economic sector in Asia, the relative importance of which increased greatly prior to the onset of the Asian economic crisis in July 1997, largely due to rapid increases in urban demand. While meat is frequently exported, the share of exports in total production is low (20 percent in the extreme case of Thai poultry). On the other hand, production has rapidly become industrialized, using large amounts of imported cereals and soybeans as feeds.

The Asian economic crisis has been most prominent in Thailand, South Korea, Indonesia, Malaysia, and the Philippines, associated with income compression of the order of 6 to 13 percent, and exchange rate depreciation of the order of 30 percent to date. It began at the start of the second quarter of 1997, and saw rapid economic deterioration through the first quarter of 1998 and some recovery thereafter.

They consider the Asian economic crisis had a major depressing effect on livestock production incentives in the short run. In Thailand, this was manifested through a 28 percent decline in the ratio of domestic meat prices to feed costs from the third quarter of 1997 through the first quarter of 1998. Since March 1998, a gradual recovery has been

underway in livestock production incentives. In Thailand, the ratio of domestic meat to feed prices had fully recovered its decline by the end of the first quarter of 1999.

Analysis shows that the main negative influence on incentives to livestock producers during the height of the Asian economic crisis was through the depreciation of the real exchange rate, which raised production costs much faster than returns. The five Asian countries most affected by the crisis have adjusted in the livestock sector through decreases in imports of meat and milk, and especially of feed grains, rather than through increased exports of meat.

Compression of domestic demand was only a secondary explanation of unfavorable incentives from the onset of the crisis until March 1998, although it likely has become more important in a relative sense as producers have adjusted to other feed sources and world prices have sagged. Full recovery for the livestock sector is likely in the next few years only if domestic demand recovers, which is unlikely for the foreseeable future in Indonesia, and may require a little more time in South Korea and Thailand.

Looking at the long-term and in a broader regional context, the demand-driven Livestock Revolution in Asia is fueled by population growth, urbanization, and income growth. By 2020, these forces will dwarf the effects of the 1997 financial crisis in Asia. There are at least as many reasons for being bullish about livestock demand in Asia as there are reasons for seeing lasting stagnation. Yet these projections are based largely on demand growth in Asia itself, so an important *caveat* in both the medium-run and long-run is that the health of the sector will require a prior resumption of income expansion in urban areas.

CEREAL AND LIVESTOCK DEMAND

Prior to 1998 indications were that world cereal demand would have grown from 1,773 to 2,511 million tons between 1993 and 2020 (a 42 percent increase) and that demand for cereals consumed by humans would have grown by 354 million tons, a 39 percent

increase. As a result of the Asian economic crisis, however, cereal demand will fall in comparison with the baseline scenario, but by relatively small amounts. Total world cereal demand in 2020 is expected to decline by 74 million tons (3 percent) in the severe-crisis scenario and by 19 million tons (0.8 percent) in the moderate scenario. In Asia, the contraction will be slightly larger: 4.1 percent and 0.9 percent respectively. Falling rates of income growth will increase the demand for food cereal in China and other East Asian countries but decrease this demand in South and Southeast Asia. Larger changes are likely for feed cereal demand, which will decline by 60 and 17 million tons in the severe and moderate scenarios respectively. All developing Asian countries will decrease their feed demand in the severe scenario except for Malaysia and South Korea. In these two countries higher prices for livestock resulting from currency depreciation will drive up livestock production more than decreasing income growth will push it down. The Asian crisis will have far larger repercussions on the global supply, demand, and markets for livestock products, which are more price- and income-sensitive. In the pre-crisis baseline scenario, global meat demand was expected to increase by 64 percent, with Asian demand accounting for 61percent of this increase, and Chinese demand alone accounting for 42 percent. But if a severe-crisis scenario unfolds, world meat demand will be 8 percent below the baseline trend (2 percent below in the moderate scenario) and developing countries in Asia will be hit hardest. Demand for meat in China, for example, will plunge by 23 percent, and the Chinese share of the increase in global meat demand will drop 10 percent. Indonesian and Philippine meat demand will decrease by almost one-third. The biggest drop in livestock demand in developing countries will be for pig meat (19 percent), followed by poultry and beef, 13 and 8 percent, respectively. Although the contraction in the demand for meat in Asia could be large, it will not threaten the region's increasingly important role in global food markets. Asia's share of global meat demand will fall by 7 percent, to 35 percent, under the severe scenario, and by only 2 percent under the moderate scenario. Global meat demand will still be dominated by developing countries. They will account for 59 percent of the demand for meat even in the severe scenario.

TRADE

In the pre-crisis baseline, global net trade in cereals rises by 75 percent and trade in livestock products nearly doubles by 2020, with increased Asian imports accounting for much of this growth, and U.S. and European exports expanding rapidly. Some of the shifts in demand are dramatic: in developing countries. Asia, for example, increases in cereal imports will be almost 350 percent, while eastern Europe and the former Soviet Union become large net exporters instead of large importers by 2020.

But if the crisis continues to be severe, global net cereal trade will decline by 20 million tons (6 million if the crisis turns out to be moderate) and net imports by developing countries will decline by 13 million tons (3 million if the crisis is moderate) compared with the baseline projections. Asia would reduce its imports the most; its net imports of cereals would be 21 percent below pre-crisis levels. Within Asia, Southeast Asian net cereal imports would contract by 55 percent.

How the Asian economic crisis plays out will also have a decisive impact on the direction and magnitude of global livestock trade and export earnings of developed countries. Under the severe crisis scenario, China and several Southeast Asian countries will shift from import to export positions in livestock, virtually eliminating growth in developed-country livestock exports. The sharp reductions in meat exports and smaller cutbacks in other agricultural exports, combined with lower world commodity prices, would result in large reductions in the agricultural export earnings of developed countries. The USA, for example, would lose US$12 billion annually in exports of cereals, meat and dairy products, soybeans, oils, oil cakes, and roots and tubers while western Europe and other developed countries would earn US$10 billion less in exports of these commodities.

FOOD SECURITY AND NUTRITION

Pre-crisis trends indicated that per capita food availability would increase by about 10 percent between 1993 and 2020 with daily calorie consumption per person rising from 2,684 to 2,945. Although per capita food availability would improve in all major regions,

the level of improvement would be small in some regions. The most devastating impact of a severe crisis, however, would be on the food security of Asian countries. Energy intake would drop by about 140 calories per person per day in developing countries, with Southeast Asian consumption dropping by 291 calories to 2,647. Small-scale farmers and the rural and urban poor in developing Asia would be hit hardest by declines in income levels. But in some regions e.g. Latin America, Sub-Saharan Africa, and West Asia/North Africa-calorie availability would actually improve slightly because of price-induced increases in food consumption. If pre-crisis trends had continued, the number of malnourished children under the age of five would have decreased by 23 percent in developing countries. But as a result of the Asian economic crisis, the number of malnourished children could rise substantially in comparison with the baseline projection. In the severe-crisis scenario the number of malnourished children in developing countries will increase by 15 million (from 143 to 158 million) by 2020. In the moderate scenario, the human cost would still be an additional 3 million children without adequate food. In the severe crisis scenario, the number of malnourished children will increase by 11 million in South Asia, by almost 3 million in China, and by 2 million in Southeast Asia. They end by saying the number of malnourished children will decline slightly in developing regions outside Asia as a result of lower food prices.

SOME SOCIAL/POLITICAL/ECONOMIC ISSUES THAT HAVE INFLUENCED OR WILL INFLUENCE LIVESTOCK PRODUCTION IN ASIA TOWARDS 2000 AND BEYOND

URBANISATION

Animal production in Asia is concentrating around the major population centers. Reithmuller (1998) outlines several reasons for this: most high income earners, who consume the largest share of livestock products, live in the cities; the transportation of animal products requires more advanced technology than the transport of animal feeds; some Government regulations have discouraged investment in transport technologies; Government regulations often make it difficult to transport livestock products between regions; the cost of carrying animal feeds to meet the requirements of animals in

intensive production facilities is high since these are high bulk, low value commodities compared to meat or milk; land zoning regulations and environmental regulations are often lax and have not prevented the establishment of animal feed and animal processing facilities in heavily populated areas; roads in rural areas may not be of sufficient standard to provide year-round access to markets (this problem is most likely to arise during the wet season) and agro-industrial processing industries are often located near the major population centers (so as to be near the potential workforce and market) and because their byproducts are often used as livestock feed, feedlot and intensive livestock farms are likely to be located near to them.

ENVIRONMENTAL DEGRADATION

It has been noted by de Haan et. al. (1997) and Steinfeld et. al. (1997) that land degradation of semi-arid lands in India is caused by a complex set of factors involving farmers and their stock, crop encroachment in marginal areas and fuel-wood collection. Land tenure, settlement, and incentive policies have undermined traditional land use practices and contributed to degradation through overgrazing, while the introduction of livestock to deforested land ultimately pushes ranching into the remaining rainforest frontiers. This also is the case, to a very limited extent, in South East Asia.

One of the consequences of deforestation is significant bio-diversity loss, and on the opposite side of the land-use mirror, in densely populated areas of Asia, animal waste production exceeds the absorptive capacity of land and water. Consequently, continuous nutrient importation results in over-saturation of nutrients with a series of negative implications on the environment, including, inevitably, bio-diversity losses along with groundwater contamination, and soil pollution. Nutrient surplus situations are a result of human population pressure and livestock density, access to markets, and feed and fertiliser incentive policies, aggravated by lack of regulatory response.

Land with low production potential includes unirrigated areas with arid and semi-arid climates, or unreliable rainfall areas with steep slopes or poor soil or a combination of

these features. Such areas tend to be ones where environmental degradation is most severe and the farming system has disintegrated. In the first step, livestock, often large ruminants, can no longer be maintained on the farm, so the nutrient and farm power balance runs into a widening deficit and finally disinvestment occurs as natural resources degrade.

Also in the developing countries, slaughterhouses release large amounts of waste into the environment, polluting land and surface waters as well as posing a serious human health risk. Because of weak infrastructure, slaughterhouses often operate in urban settings where the discharge of blood, offal, and other waste products is uncontrolled. Steinfeld et. al. conclude by saying they consider the move to vertical integration involving intensive production units may be due to several reasons not all of which are readily identified publicly by the society in which they develop.

Steane (pers.com.) considers the development of improved efficiency and the uptake of modern technology are crucial in the mixed farming systems if agriculture is to achieve any real semblance of sustainability, social equality, alleviation of poverty, and food security. This is not to say that industrial-type production should not be developed but simply that the *modus operandii* and the location need to be subject to much more responsible regulation than has been seen in Asia to date. There are examples of successful intensification by using groups of farmers to produce the livestock for a particular market outlet or company. The realisation of the need to involve local participation is a major step towards systems that provide benefits to all sectors and contribute to food security.

Also, de Haan et. al. (1997) and Steinfeld et. al. (1997) contends that although livestock production interacts mostly with the environment within the confines of a production system, in addition, livestock affect some global commons, which are essential parts of our support system. For example, bio diversity is affected indirectly through concentrate feed requirements and the resulting intensification and expansion of crop agriculture. Related environmental effects may be disguised because livestock production and feed

production are geographically separated and only linked through international trade. Furthermore, livestock and their waste products emit important quantities of greenhouse gases such as methane and nitrous oxide, contributing to the phenomenon of global warming. The major greenhouse gases include carbon dioxide, methane and nitrous oxide. Of these, livestock have the most significant effect on methane production. The global average methane concentration is increasing at about 0.8% per year and livestock and manure management contribute about 16% of total annual production. Methane omission by livestock results from the fermentation of grass by microorganisms in the stomachs of ruminants (cattle, sheep, and goats). Monogastric species, such as pigs and chickens, cannot digest cellulose and produce relatively low omissions. Methane production is greater per unit of ruminant (a) when animals are unproductive (so relatively more fodder is digested for maintenance of the animal rather than for production of milk or meat), and (b) when the diet consists of very low quality, fibrous foods such as straw. Low productivity and poor feed are typical in the farming systems in the project's sustainable development area. Stored liquid manure also produces methane, but this is a problem in factory farming systems such as large dairy or pig farms. Manure deposited by grazing animals or handled in dry form produces much less methane, and so this is not significant in the farming systems in the project area. In any case, about 80% of livestock methane production is produced by digestive fermentation. The production of methane is not, perhaps, a major factor influencing livestock development policy. However, as businesses and countries may be required to do environmental audits in future, policy makers should be aware of the issues. They also point out that livestock can also have beneficial effects on the environment e.g. by grazing, livestock improve species wealth, and the integration of livestock into mixed farming systems can improve water infiltration and the recharge of groundwater reserves. The biggest contribution of livestock to the environment, however, is to be seen in providing the main avenue for sustained intensification of mixed farming systems. This is bound to continue even when crop and livestock activities specialise into separate activities as they often do under developed market conditions. This resource-enhancement and resource-sparing effect continues to be underestimated because it is

indirect. Without this environmental function, intensification of agriculture could not have taken place and current populations could not be sustained.

Increased attention to livestock/environment interactions is therefore of critical importance in sustaining the world's resource base. These interactions have been the subject of much conjecture, often lacking objectivity and over-simplifying complex relationships. Such scarcity of informed decision-making has often exacerbated the negative effects. For example, the misperceptions regarding overgrazing in the arid areas led to measures which controlled stocking rates and movements, thereby causing more, rather than less, land degradation. A better understanding of the complimentarily of domesticated and wild animals would have led to greater species wealth and the improved wellbeing of local human populations.

In conclusion, de Haan et. al. (1997) stress that finding the balance between increased food production and the preservation of the world's natural resources remains a major challenge. It is clear that food will have to be produced at less cost to the natural resource base than at present.

The publications of Steinfeld et . al. (1997) and de Haan et. al. (1997) form an excellent consensus of outcomes from studies supported by a number of donors with global participation, thus providing a broad, densely analytical assessment of the interactions of livestock and the environment.

BIOTECHNOLOGY AND ITS IMPLICATIONS

Steane (pers. com.) considers that while biotechnology may offer many potential opportunities for major steps forward there is a clear tendency for developing countries to over emphasise the potential contribution of such technologies given the limitations which exist (and which may not be resolved prior to the attempt to exploit the biotechnology).

Countries need to ensure the proper evaluation of the different potential technologies. This is likely to be achieved by independent assessment, and yet such independence is becoming less available as science and scientists become ever closer involved with direct commercial exploitation of results.

Linking the needs of farmers, consumers, and other potential beneficiaries to an increasing array of biotechnology applications is a challenge to decision-makers in developing countries. To meet this challenge, information and discussion are required regarding identified national needs, wants, priorities and policies, estimations of financial requirements, integrating modern bio-technology methods with ongoing agricultural research, and the extent to which public- and private-sector agricultural research embraces biotechnology.

A growing number of countries are implementing national programs in agricultural biotechnology. It is to be hoped that these programmes adequately assess how the needs and priorities for biotechnology have been determined in relation to the overall agricultural objectives, whether the necessary guidelines are in place for the safe application of biotechnology, whether the national intellectual property rights laws are adequate to promote international collaboration and investment in this area, and the likely financial requirements for research in agricultural biotechnology.

TRADE AND THE WORLD TRADE ORGANISATION

Riethmuller (1998) considers that the continuing progress of increased integration of many Asian economies with the world economy means that regional and international developments will influence the performance of industries in these economies, including the livestock industries. Although there have been some changes in agricultural protection in high-income countries, there are still many tariff and non-tariff barriers to foreign produced commodities. Domestic political considerations in countries such as the USA and the European Union are likely to be given higher weight by policy makers than the effects of their policies on producers in other countries. The decision by the US

Government in May 1998 to reactivate its program of export subsidies on dairy products and poultry is an example of the type of policy measure that can affect international agricultural markets. Similarly, while bans such as that by the European Union on China's broiler meat exports may benefit other chicken meat exporters (such as Thailand), any removal of the ban could see that advantage disappear. Governments everywhere have always subsidised their farm sectors in many ways, including basic research and development, production and export. Subsidies may be transparent or hidden, direct or indirect. There is no indication that subsidies will be easy to handle even under the liberalised agreements proposed by the WTO. Determining fairness will be difficult, contentious, time consuming and labour intensive.

GENETIC DIVERSITY

The livestock industries in Asia, in particular Indonesia, the Philippines and Thailand, have become increasingly dependent upon imported breeds, often developed in countries such as the USA, Australia, New Zealand and the European Union. Their use has been associated with a displacement of native animals that are often better suited to the environment of these countries. The seriousness of this particular trend is illustrated by the projection reported by de Haan, Steinfeld, and Blackburn (1997) that by 2015, the US Holstein population could have an effective population (gene pool) size of 66 animals. In the Asia Pacific region, it has been estimated that 105 domestic animals (out of 996) are at risk. Breeds at risk are those with less than 1,000 breeding females or less than 20 males and for which there are no conservation programs in place. In the poultry industry of Indonesia, native chickens have become less important than introduced species.

The economic crisis reversed this trend as currency depreciations in Indonesia, the Philippines and Thailand increased the cost of rearing animals and also the purchase cost of imported animals, as well as increasing rural unemployment. However, this also provided an incentive for farmers to slaughter native animals, further reducing the population of these animals.

HUMAN HEALTH AND PRODUCT QUALITY

The drive in Southeast Asia to satisfy the increasing demand for animal protein has resulted in many changes to common agricultural practices. The intensification of some of the animal production industries, combined with urbanisation, global changes and the increasing ease of travel/transport has produced environments that have led to an increase in impact of formerly uncommon diseases or even the emergence of new diseases. Thought is now being given to the relocation of animal production systems away from where they have developed peri-urbanly to an area-wide integrated approach. These man-made relocations will significantly affect the disease determinants and can, if well understood, be used to significantly reduce the occurrence of disease in both animals and humans.

"Emerging" infectious diseases can be defined as infections that have newly appeared in a population or have existed but are rapidly increasing in incidence or geographic range. Specific factors precipitating disease emergence can be identified in virtually all cases. They include ecological, environmental, or demographic factors that place animals in increased contact with a previously unfamiliar microbe or its natural host, provide potential pathogens with a novel host, or favour increased dissemination. These factors are increasing in prevalence in Asia because of the rapid development of livestock industries in the region. This increase, together with the ongoing evolution of viral and microbial variants and selection for drug resistance, suggests that infections will not only continue to emerge but also that the rate and effect will probably increase.

Zoonoses are diseases transmissible from animals to man. There are over 150 recognised zoonoses worldwide. They are distributed widely and occasional infections occur with deadly consequence, for example the serious outbreak of Nipah virus that occurred in Malaysia in 1998-99.

These serious outbreaks can create a conflict of interest between the scientist who look for evidence that a disease agent exists in a country or region, where it is not expected to be, and the regulator who has to deal with the public health or economic consequences of

a newly revealed situation. It does not seem to matter whether it represents a new but spreading disease or one being recognised for the first time in a previously stable situation. The national and international reaction to the discovery of many agents in countries where they have not previously been noted all too often does not take cognisance of the fact that the actual risk to humans and/or domestic/productive animals may not be changed. Fear and overreaction are sure to be the result the risk is not quickly and correctly assessed especially when this is compounded by uniformed and sensational media coverage.

Globalisation of food supplies is affecting outbreaks of food-borne illness, and this is an increasing problem in human health. The organism responsible typically expresses several antibiotic-resistant genes. For example, recently a Vancomycin resistant Enterococcus has been detected in chicken meat imported into Japan from three different areas around the world. It is now possible to produce a food product in almost any part of the world, process it for distribution, and for it to be consumed far from its production locality. Thus, we can expect increasing numbers of outbreaks caused by organisms that were previously restricted to areas of endemicity.

The interaction of determinants (host, environment and agent) that bring about a disease situation in animals and man is a system that is continually changing. When we are faced with a complex system there is a tendency to want to summarise and break down the view of the system into parts that can be comfortably dealt with: however, we must be careful. As Lotfi Zadeh the father of Fuzzy Logic put it so nicely “If the only tool you have is a hammer everything starts to look like a nail.”

Epidemiologists try to assess complex situations by using probability theory using yes/no occurrences, ignorance of outcomes, and statistics. Probability estimates change with increasing information: they tell us whether something will happen. Possibility estimates tell us whether something can happen. Usually as you decrease the possibility of an event you will decrease the probability but the reverse is not necessarily true. Thus if an event

is impossible it will have zero probability. However, if an event is improbable it could still be 100% possible.

Recent disease outbreaks in Australia and Malaysia due to Hendra virus and Nipah virus are good examples of the doctrine of possibility. Both viruses have probably existed in fruit bats in the Australasian area for hundreds of years and yet only recently have they been detected in other species. It is possible that both viruses may have moved out of the host (fruit bat) to other species on previous occasions but never become established in the new host. One hypothetical reason would be that possible new hosts had lower population densities than they do today. However, we now know that it is possible: three times, to my knowledge, in Australia for Hendra virus (Brisbane 1994, Mackay 1995 and Cairns in 1999), horses were the new hosts. We now have evidence that Nipah virus related to Hendra virus has crossed into pigs in Malaysia and looks to be well established there in pigs. That is, pig-to-pig transmission has occurred on a grand scale.

To better respond to the changing situation of livestock keeping in Asia every country in the region must establish systems for disease surveillance and response. This would include four strategic objectives: surveillance, diagnostic tests, response and interdisciplinary research.

Surveillance

There is a need to strengthen existing surveillance systems so that changes in the incidence of known diseases are routinely reported and information on the emergence of new or unusual diseases is readily available to the ministries in other nations.

Diagnostic Tests

There is a need to develop or adapt simpler, more cost-effective procedures to determine the causes of disease. Ideally, these procedures should be simple enough for use in the field when laboratory facilities are not available.

Response

There is a need to enhance the capabilities of Government agencies and existing disease-specific networks to respond to recognised outbreaks identified through improved surveillance.

Interdisciplinary Research

There is a need to support the capacity to undertake control and prevention strategies in the region.

These serious outbreaks can create a conflict of interest between the scientist who looks for evidence that a disease agent exists in a country or region, where it is not expected to be, and the regulator who has to deal with the public health or economic consequences of a newly revealed situation. It does not seem to matter whether it represents a new but spreading disease or one being recognised for the first time in a previously stable situation. The national and international reaction to the discovery of many agents in countries where they have not previously been noted all too often does not take cognisance of the fact that the actual risk to humans and/or domestic/productive animals may not be changed. Fear and overreaction are sure to be the result when the risk is not quickly and correctly assessed especially when this is compounded by uninformed and sensational media coverage.

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INFORMATION TECHNOLOGIES

Riethmuller (1998) considers that lack of information is a significant impediment to the efficient operation of an economy in the sense that it results in the economy failing to maximise its output. At the national level, despite the rapid growth in the livestock industries of Asia there is a dearth of reliable information on these industries.

Government statistics on livestock numbers, particularly for ruminants, are sometimes of dubious quality while statistics on animal slaughtering do not provide complete coverage since animals slaughtered for wet markets or outside registered slaughterhouses may not be included in the statistics or may be under-reported. Information on the ages and sex of large ruminants that have been processed in general seems not to be available. This increases the difficulty of arriving at consistent population estimates.

At the consumer level, estimates of demand elasticities are few and far between, making it difficult to arrive at forecasts or projections that can be used with any degree of confidence.

Information on technical parameters of livestock industries, with the exception of the intensive poultry or pig meat producing farms, is also extremely limited and often too old to be of use.

Information on feed resources is incomplete. Analysts therefore experience difficulties in arriving at informed judgements about the feed requirements of the livestock industries or the technical efficiency of the industry.

Information on the livestock sector is difficult to gather because livestock until quite recently have not been a particularly important part of the overall economy, although they have been important at the village level. Hence, governments have allocated few resources to monitoring these industries, as they considered that scarce resources provided a higher payoff in other parts of the economy. Riethmuller ended by saying that this problem could be compounded by there being a large number of government bodies

and non-government organizations that have an interest in livestock industries particularly at the village level.

LIVESTOCK DEVELOPMENT GUIDELINES AND POLICY ISSUES

There has been an explosive international growth in the extent of land allocated to the production of livestock feed. There have been changes in animal production techniques and a dynamic growth in consumer demand for safe, quality protein of animal origin. These changes mean that livestock production touches on a whole series of public policy issues as it directly affects smallholder farming, poverty, land tenure, equality, health, safety, the environment, to mention a few.

EXTERNALITIES

Externalities arise when in the course of producing or consuming a commodity, harmful or beneficial side effects arise that are not borne by the people who are directly involved in the production or consumption of the commodity. An example of a negative externality is the incorrect use of a chemical, which results in a mutation or counter-resistance to the targeted organism, which can ultimately threaten other populations. There are many other examples including the release of animal waste into natural waterways and the benefits gained by those who do not vaccinate against a disease from those who do vaccinate. A legalistic approach may be appropriate for specific problems due to externalities: however legal solutions consume time and economic resource hugely, and in some cases (for example in a developing country where the participants and/or non-participants have few resources) might not be practicable. Also legalisation that is unenforceable or not enforced can lead to well-developed corruption-driving mechanisms.

One approach to an externality problem would be for the parties to negotiate among themselves. In practice, the negotiated outcome might be difficult to achieve since it would in most situations require the agreement of many people. There may be a case, therefore, for the Government to legislate that all producers in the livestock industry participate in a specific program or for the Government to provide funding for the particular program.

NATURAL MONOPOLIES

A natural monopoly arises if a good or service can be provided at least cost by a single commercial entity. Under conditions of natural monopolies, unregulated markets are unlikely to yield satisfactory outcomes and governments often intervene. Entities may under-invest in certain areas and over-invest in other areas. Merger and acquisition activity in the USA and Europe has led to a relatively small number of large agricultural input and pharmaceutical firms coming to dominate research and technology in bio-technologies. On the one hand, this will allow huge expenditures on technology and its dissemination, but on the other hand it raises questions about access to the technology and the pricing practices used by the firms. Newly developed products such as vaccines can be protected from competition by patents, allowing the firms that produced the product to recoup its investment. The problem facing governments is how much to regulate the natural monopoly. The development of a new drug or vaccine may be highly risky and require a huge investment. Too much regulation will be a disincentive for firms to develop new drugs, while too little regulation could lead to a small number of firms (possibly colluding with one another) in the animal health industry charging prices that are too high. This latter trend is expected to increase as we move beyond 2000.

PUBLIC GOOD

Economics classifies goods and services as being either public or private. A public good has two characteristics. First, the consumption of a good or service by one individual does not reduce the amount available for others to consume. Second, once the public good is provided, it is impossible or prohibitively expensive to exclude others from consuming the good. Agricultural extension services are viewed by some as public goods, but examples of pure public goods are not easy to find. A free-rider problem arises with public goods since individuals believe the good will be provided whether or not they contribute to the cost of providing the good. If sufficient people behave this way, less than the optimal amount of the public good will be provided.

NUTRIENT BALANCE POLICY AND ENVIRONMENTAL ISSUES

Steane (per. com.) believes that the economic consequences of all aspects of animal production are not easily assessed. The long-term effect of the absence of animal fertiliser/humus on soil structure and soil fertility is not immediately obvious nor, indeed, are the effects of the use of farm mechanisation energy requirements or the environment. For example, the lack of animals to consume either waste products or by-products may well result in practices such as burning of rice straw, dumping of waste, or the use of costly waste disposal mechanisms. The reverse is also true. The feeding of waste to animals can and has caused problems. For example, feeding poultry manure to cattle has caused enormous losses due to botulism toxicity and feeding abattoir waste to cattle caused Bovine Spongiform Encephalopathy (BSE) or Mad Cow Disease. Very few studies have looked at the effects on health costs of changing agricultural practices.

Intensive livestock units can create major environmental and health problems. In a global context, the movement of feed for livestock is itself causing massive shifts in resources which, in the long-term, create serious problems in both areas i.e. the provider and the recipient suffering from nutrient deficit and surplus respectively. The producer fails to replenish land with manure while the recipient area suffers pollution problems seriously affecting crop production, water quality, etc. There is therefore a need to develop guidelines and legislation that aim to control the nutrient imbalances and the environmental consequences of industrial animal production (Sanchez 1998).

EQUITY, INCOME DISTRIBUTION ISSUES AND COORDINATION FAILURE

The generation of social inequities and marginalization of smallholders by large-scale producers may occur with industrial livestock production systems and governments need to address this problem.

Governments need also to be mindful of, and concerned about, and protect human health and be aware of the importance of livestock to food security and food production, particularly in low-income food-deficit countries where high land pressures emerge.

Traditional livestock keeping is important as it forms the principle, and sometimes only, means for raising household level purchasing power.

Other concerns are the protection of the environment, locally, domestically, and internationally. This includes land/livestock relationships, environmental standards, policies and regulations and trade conflicts.

The concept of Area Wide Integration (AWI) i.e. governments controlling where industries develop, does afford the opportunity to not only consider equity issues but to also consider the epidemiology and economics of diseases when designing the system. This allows a Government to ensure the rural poor are not marginalised and to contribute to and benefit from the potential to increase the production of saleable animal products. AWI needs to be undertaken with a sound knowledge of disease control (among other disciplines). This knowledge will influence the preferred siting of livestock production systems not only globally but also regionally, within a country, within a catchment and even within a farm. It will influence the type of livestock facility (housing, etc.) and how it is constructed, where and how waste is treated and disposed, where and how inputs are purchased and delivered, and where and how products are processed. It will especially influence broad management decisions e.g. “the all-in all-out system” which has revolutionised disease control in intensive poultry units. In many ways the impact that can be made on disease control afforded by such a planned system is enormous. For example if abattoirs can be sited near the production facilities, animal movements across the countryside can be reduced substantially and thus disease control in general is made much easier. AWI offers another tremendous advantage in those disease free zones (DFZ) become a possibility within a country where it may have been impossible to achieve this across a country. Since the biggest constraint to the free movement of livestock is disease control the DFZ concept would free up trade particularly if the economic advantages were great.

QUALITY ASSURANCE

Governments have a legitimate role, and many already play it, in insuring product safety. The control and monitoring of animal disease can move away from Government control when intensification increases and vertical integration occurs. The managers of very intensive systems often become secretive about diseases encountered and what measures are used to control them. One of the legitimate concerns of Government is to assure product quality and safety, and ways need to be developed to monitor food safety.

Applying concepts such as Hazard Analysis Critical Control Point (HACCP) may help as this is a structured attempt at quality control. However there is some debate about the appropriate type of legislation that can address some emerging quality control issues facing the livestock sector especially meat and milk production. For example the British Parliament is expected to approve a measure that would make British farmers directly liable for compensation for any illness caused by the food they produce. This means that a victim of food poisoning could sue a farmer if the source of the infection could be traced to a particular foodstuff and farm. A plaintiff would be required merely to establish a causal link but not to prove any fault or negligence on the part of the farmer. (Since the mid-1980s the principle of strict liability has applied to manufacturers but not to primary producers).

There are potentially serious difficulties in this decision, but nevertheless it shows a trend that will continue to grow up to and beyond 2000. Some of the difficulties are obvious when the produce of many different farmers is combined. It also does not seem reasonable to make farmers responsible for environmental hazards outside their control. It is perhaps unenforceable, and ignores that most food mishandling/poisoning comes from the consumer’s home, not the producer. It also fails to account for the role of processing plants, such as butchers and restaurant establishments.

CONCLUSION

Long-term scenarios for food supply, demand, and trade as predicted by the IMPACT model developed by IFPRI 1998 indicate that world cereal and livestock prices will decline much more slowly than in the past several decades, even if the crisis continues. The stronger price structure is the result of the continuing, gradual slowdown in the rate of growth in both production and consumption. The growth in cereal trade remains strong in all three scenarios, and Asia's role as a major player in cereal and livestock markets in the coming decades is not likely to be threatened by the current crisis. But at the same time the crisis is expected to have a devastating effect on Asian food security.

The extremely complex world we live in makes it near impossible to predict the future for a small but significant sector such as the livestock sector. However there are clear paths along which animal production should, and possibly may, move as surely as we move beyond 2000.

Among the signposts:

- Protection of the environment is critically important and the " I want it but not in my backyard " attitude is counterproductive. The true cost of production, including the environmental cost must be factored into the cost of production.

- Diversified research and development is vital. Local control and input is important as it encourages local ownership and respects diversity. As various technologies develop and are adapted to a variety of conditions local people are empowered to develop their own solutions locally.

- Progress can be expected in the integration of the industrial and mixed systems. Education and hard work over a long period of time are the essential ingredients.

- Information gathering and sharing will be vitally important. From a purely technical point of view systems must be developed for meaningful data collection leading us to understand what is happening and also understanding what might happen, putting us all in a better position to predict the future. Decisions are always better if based on good information. The Internet offers the opportunity for greater information sharing but accuracy and honesty issues must be attended to.

- There will be a need to encourage innovation, flexibility, and accountability and listening to the people working near the grass roots. Innovation is important, as solutions to existing problems will be found with yesterday's solutions in mind.

- Long-term views must prevail over the quest for short-term gains. There are some encouraging developments, for example in March 1998 the US Federal Drug Administration approved a spray containing 29 types of bacteria isolated from the gut of mature chickens. These are the bacteria that chicks normally receive from their mothers but that hatchery-born chicks lack. Not only does the spray of "good" bacteria protect the chicks from pathogenic bacteria, simply by occupying the niches where the pathogenic bacteria would otherwise lodge (competitive exclusion), but it discourages antibiotic use. This is a positive move in reversing one of the profit-driven mechanisms that threaten the livestock industry's future in the industrialised arena.

- There is a need to develop the concept of Area Wide integration. This is, in my opinion, an important and useful FAO initiative. AWI is a total concept involving issues such as: equity, economics, environmental controls, externalities, government policy, nutrient balance, sustainability, human and animal health, etc. The health issues are just a small but important element of the total AWI concept. The concept of Area Wide Integration (AWI) does afford the opportunity to consider the epidemiology and economics of diseases when designing the system. As mentioned earlier, Hendra and Nipah viruses are probably endemic in fruit bats and since fruit bats are migratory it is hard to imagine that AWI *per se* could have stopped the

expansion of this apparently chance occurrence of the bat virus and a pig. Although difficult to prove, until more information becomes available, it is possible that the concentration of large numbers of pigs in confined buildings and the uncontrolled movements of pigs, and even the controlled movement of pigs to distant abattoir in Singapore, contributed to its spread and ease of establishment in pigs. These conditions could have been more easily managed and controlled under the concept of AWI, as was mentioned before, but only if good surveillance and response procedures were firmly in place. This again exemplifies the need for an interdisciplinary or multidisciplinary approach to understanding and controlling disease. Even a simple procedure such as prohibiting the planting of fruit trees near pig production areas may have a tremendous effect on controlling the possibility of contact with the fruit bat population. There may be many other small initiatives that can have an equally desirable positive effect.

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