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GLOBAL FOOD PRODUCTION AND CONSUMPTION: FUTURE TRENDS, OPPORTUNITIES AND CONSTRAINTS FOR LIVESTOCK PRODUCTS

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SUMMARY

Despite the increases in the world's population, the percentage of food insecure people has halved over the last 30 years. There are encouraging signs of a decline in the rate of increase in the population in several key countries e.g. China and India, but several hotspots remain, especially in the south Asia region and Sub-Saharan Africa. In the past decade there have been encouraging signs also of economic growth, one manifestation of which is a marked increase in the demand for animal products such as meat, milk and eggs. This new demand creates opportunities for trade in livestock products, technology and infrastructure, IT and management systems, for the production, transportation, processing, waste disposal, and marketing and distribution of animal products. It also creates potential threats because of the demand for feed grains, on which much of the increase in production will depend, and the environmental demands that increased crop production will place on natural resources. On balance, the opportunities outweigh the threats, but humanitarian values necessary to provide the aid that is required by the poorest countries, should not be forgotten in the chase for increased profits amongst those countries that are growing towards economic prosperity.

Keywords: food supply, demand, consumption, livestock production, trade, natural resources

INTRODUCTION

The record for predicting the future supply and demand for global food is notoriously bad. In 1968 Paul Ehrlich wrote in "The Population Bomb": "The battle to feed humanity is over. In the 1970s the world will undergo famines – hundreds of millions of people are going to starve to death". In 1973, Lester Brown of the World-watch Institute started predicting that population would soon outstrip food production and has been doing so regularly for the last almost 30 years, so far without being right. In fact, since 1961 the world's population has doubled but food production per capita has risen by over 20%, with the calorie consumption per capita in developing countries rising by 27% since 1963 (Ridley 2002).

Doom-sayers, not only those pronouncing on population and food, have been proven wrong on many fronts. Life expectancy is increasing, deaths from hunger are falling, medical treatment is improving, age-corrected cancer mortality is declining, air and water quality in most places is improving, rate of loss of tropical rainforest is falling rapidly, we have not yet run out of important metals or fossil fuels, the net loss of land to desert is being arrested, and energy use per unit of GDP is falling (Lomborg 2001; Ridley 2002).

Per Pinstrup-Andersen, Director-General of the International Food Policy Research Institute in Washington and winner of the World Food Prize in 2001, tells us that since 1970, the number of food insecure people in developing countries has declined by 17% to a current total of about 800 million and the food-insecure share of the population has halved from 37% to 18% (Paper presented at the Annual General Meeting of the CGIAR, Washington DC October 2001). But, as Pinstrup-Andersen points out, progress is uneven. East and Southeast Asia are experiencing major improvements but in South Asia the number of food-insecure people has increased slightly and in Sub-Saharan Africa, only one third of the countries experienced a reduction in the number of food-insecure people and more than half the countries experienced a deterioration.

Just because the food situation is improving in many parts of the world does not give us cause for complacency; the problem is far from solved. But, there are grounds for optimism, and with proper analysis, we can plan and more effectively target our agricultural production and technology, for humanitarian aid on the one hand and for increased trade and global prosperity on the other. While

some regions and countries provide a spur to do much better in our efforts to alleviate poverty and enhance food security, especially in relation to preschool children, in others the changes in the rate of population growth, the economic status and changing dietary preferences provide encouraging signs that the battle against food insecurity and poverty is being rapidly won. It is in these places in particular that the opportunities for livestock products are greatest, whether locally produced or traded.

This paper does not include fish in its coverage because comparable information, although being collected and analysed by IFPRI scientists, has not yet been published.

HOW FAST IS POPULATION GROWING?

United Nations statistics indicate that the world's population today is around 6.25 billion, the 6 billion mark being passed in 1999. By 2050 the population is estimated to be a little over 9 billion and by early in the next century, will be stabilised at a little less than 11 billion, and from then on it will slowly fall (UNDP 2001). The large growth in world population occurred from 1950 onwards and this was due largely to a fall in death rates. In the early 1950, women in developing countries gave birth, on average, to more than 6 children compared to around half that today. The decline in birth rates follows the decline in death rates. Now several developing countries are experiencing birth rates of around 3.1 children per family, similar to those seen in Scandinavia in the 1920s and the US and Australia in our baby-boomer years. In 1990 about 87 million were added to the population, in 2001 about 76 and in 2050 the estimate is around 43 million

There is large variation in the population growth between countries. Currently, 7 of the 10 countries with the highest population growth are in Sub-Saharan Africa with rates of increase between 3.27 to 5.53 (Liberia) and 5 countries exceeding 4%. In contrast, China at 0.9 (excluding Hong Kong and Macao) is now matching many developed countries e.g. Australia (1.15), USA (1.05) but still some way to go to catch the European countries e.g. UK (0.27), Sweden (0.03), France (0.37), Germany (0.09). India (1.60), expected to be have a larger population than China by 2050 (1.57 billion vs 1.46 billion), Indonesia (1.41) and Vietnam (1.40) are making better headway than the Philippines (2.03), but the real problem areas are in Africa and to perhaps a slightly lesser extent, the Middle East and parts of South Asia.

Coupled with these changes in the total population are changes in the age structure and changes in the urban to rural dweller ratios. Population growth from now on will be in the cities. By about 2007, for the first time in history, over 50% of the population will live in cities.

Revising estimates

The figures quoted here are those termed the "median variant" by the UN. They are neither the most optimistic nor the most pessimistic, and the data from which they are derived are regularly updated and reviewed. The revisions have led always, so far, to reductions in the estimate of the plateau. This has been attributed to a number of factors, including rising incomes and falling death rates, but HIV/AIDS, which continues to wreak its dreadful havoc amongst rural and urban populations, especially on Africa, is emerging as a significant factor in future revisions.

Hope or despair?

The essential message is one of hope. The data by Pinstup-Andersen (2001), referred to above, and the IFPRI projections that indicate that the 800 million food insecure people will reduce to 680 million in the next decade, are all positive signs. Although still unacceptably high, these trends provide messages of hope. However hope must be tempered with caution when considering the future population and food scenarios for some countries and regions. The progress that has been made in arresting the population growth in many 'hotspots' and a stronger recognition of the driving forces, especially economic development and the fundamental role that agricultural development has in this, are all positive signs for humanity and humanitarian values, as well as for increased trade and prosperity.

WHAT WILL PEOPLE BE EATING IN 2020?

In the last 25 years the proportion of the calories coming from livestock products (meat, milk, and eggs) in developing countries has increased from 6 to 10%. In developed countries the proportion has remained constant at around 20%. By 2020, international research workers, led by the International

Food Policy Research Institute (IFPRI) in Washington D.C., predict that these changes will be more pronounced, as demonstrated in the following Tables that show data generated by the IFPRI “IMPACT” economic development model.

The IFPRI “IMPACT” model divides the world into 36 regions/countries and incorporates 22 commodities including 6 from livestock. The base data are those from FAO statistics 1996/98. The demand for the country groups is a function of prices, income and population growth and supply is determined by prices and productivity growth. Excess demand determines the net trade, and the sum of net trade that flows globally is minimised. The model determines annually – market clearing prices; consumption level by commodity and region; feed use level; area, yield and production levels by commodity and region; and net trade by commodity and region. The model has been updated and more finely “tuned” in 2001 from the 1998 version and the data I will be reporting, based on the model, are from the latest run of the model.

Table 1 indicates that by 2020, the consumption per capita of beef, pork, poultry, meat and milk will have increased substantially above their 1997 values. Naturally there are strong regional differences in total meat consumption and these are shown in Table 2.

Table 1. Per capita consumption (kg/year) of livestock products in developing countries 1997 to 2020

Commodity	1997	2020	% Increase
Beef	6	9	50
Pork	10	13	30
Poultry	7	11	57
All Meat	25	35	40
Milk	43	61	42

Source: Delgado and Rosegrant (2001)

Table 2. Changes in total meat consumption (millions of tonnes, MT) by region, 1997 to 2020 and predicted annual growth rate in consumption

Region	1997	2020	Annual growth rate %
China	53	104	3.0
SE Asia	9	19	3.3
Latin America	26	45	1.8
Other developing	23	45	3.1
World	208	327	2.0

Source: Delgado and Rosegrant (2001)

The major features of these Tables are firstly the demonstration of the large increases in demand for all livestock products and especially for poultry, pork and milk, secondly the regional differences that there will be in demand, if these predictions are correct, noting particularly the huge impact of China on the overall equation and finally the fact that of the 119 MT difference in the amount of meat consumed per annum between 1997 and 2020, 102 MT of that will come from developing countries. Finally the types of meat that will contribute to the total increase in meat demand are estimated to be poultry 40%, pork 31%, beef 24% and sheep and goat meat 5%.

The corresponding figures for milk consumption are shown in Table 3. The major feature in Table 3 is the very large predicted increases in milk consumption in all regions between 1997 and 2020, with the exception of Latin America where it will be a more moderate increase. However it should be noted that even in Latin America the predicted increase will still be above the world average. It should also be noted that of the world increase of 244MT, approximately 70 percent would come from the developing countries and regions listed. Some of this increase will be driven by increases in population but, as Table 1 shows, a high proportion, even in the case of India, will be due to higher per capita consumption.

The changes in dietary preferences from starchy staples (rice, wheat, maize etc) to include a higher proportion of high-protein, livestock derived products, has two immediate effects: firstly, more starchy staples are available for human consumption amongst the poorest of the poor and secondly, because the increase in livestock products will come mainly from intensive production systems, more grains will be

needed to feed animals. For example, in China's rural areas people consumed 200 kg of grain per capita compared to 130 kg per capita in the wealthier urban areas. As income increases, this pattern is repeated – animal products supplant starchy foods and the proportion of food derived from starchy staples declines (Huang and Bouis, 1996, cited by Delgado *et al.* 1999).

Table 3. Changes in total milk consumption (MT) by region, 1997 to 2020 and predicted annual percentage growth rate in consumption

Region	1997	2020	Annual growth rate %
China	10	23	3.5
India	60	132	3.2
Other South Asia	21	42	3.0
WANA*/Africa	42	77	2.7
Latin America	54	82	1.8
World	412	654	1.5

*West Asia and North Africa

Source: Delgado and Rosegrant (2001)

The world will be a happier and a healthier place if all this happens. Not only will people have more to eat but, as Delgado *et al.* (1999) point out, the increase in the consumption of livestock products will impact directly on the health of poor people, and particularly on pregnant women and children, because of the higher intake of protein, vitamins and minerals. The growth areas, in terms of the quantity of food consumed, will come from the developing economies, and while most of the world's population will be seeking quantity, the trends in the industrialised countries towards "health" foods, and issues of quality, purity and production methods, will continue.

However, the increases in the amounts of livestock feed required by the IFPRI analyses of the future needs, raises some hard questions about the potential consequences on natural resources and trade.

FROM WHERE WILL THE FEED FOR LIVESTOCK COME?

What is required?

If the above scenario for livestock products is to be met then there will have to be large increases in feeds, especially for pigs, poultry and dairy cattle, but also one could expect that some of the beef increase will be derived from grain-finishing production systems. Based on the trends during the 1980s and 90s, "IMPACT" estimates that from 1997 to 2020 the total cereal use as livestock feed will increase by 40%, from 660 MT to 925 MT. This is shown in Table 4.

Table 4 highlights the enormous demand for livestock feed from China in 2020, amounting to almost 25% of the global demand. Almost 80% of the total increase in demand from 1997 to 2020 will come from developing countries (207 MT of 265 MT).

Table 4. Total cereal use as livestock feed (MT) 1997 and 2020, by region

Region	1997	2020
China	111	221
Southeast Asia	15	27
WANA	36	59
Latin America	58	98
Developing Countries*	201	408
Developed Countries*	459	517
World	660	925

*Estimated from Delgado *et al.* (1999)

Source: Delgado and Rosegrant (2001)

Where will it come from?

It is predicted that the demand for grains for livestock and humans will be met by:

- Bringing new/idle land into production, especially arable land in South and North America, Sub-Saharan Africa, and areas of eastern Europe that have been under-utilised or managed poorly,
- Increased yields per hectare, particularly in developing countries where the use of fertilisers and improved management practices will have a major impact, and
- Increases in feed efficiency as efficient and more highly productive genotypes and management practices are introduced into the intensive production systems in developing countries.

There is no doubt that high-yielding land in several industrialised countries for which farmers are currently paid to keep out of production, will, if conditions are right, be able to contribute to an increase in supply of feed grains. We can add to this the sizeable contribution that the former Soviet Union can make, as its agricultural sector restructures and revitalises. Yields in developing countries have increased dramatically since 1960 and the trend continues. Since 1960 the yield in tonnes per hectare has increased from 0.8 to 2.7 for wheat, 1.1 to 2.9 for maize and from 1.0 to 2.6 for rice. These increases are attributed to new varieties, enhanced water use – including irrigation, fertilisers and pest control. The impact of increasing efficiency of feed used by livestock is evident from the following examples. Per head production of dairy cows in the USA increased by approximately 65% between 1960 to the 1990s. The USA now produces more milk from fewer than half the cows that were present at the end of World War II and the efficiency of feed conversion is twice as high as those in places like Mexico, Kenya and Egypt. The global average (including developed and developing countries) for milk production is 1150 kg/cow, only about 10% of that of the world's highest producing herds (CAST, 1999). Another example can be found in broiler chickens: improved strains grew 3-4 times faster and required about 68% less feed per unit of gain than a random breeding population based on 1957 stock (CAST, 1999).

There is still debate about the extent of the competition between animals and humans for human-edible grains. Steinfeld *et al.* (1997) calculated that worldwide, animals consumed 74 MT of human-edible protein and in return produced 54 MT of animal protein for human food. The 1.4:1 input:output ratio is acceptable, given that the relative biological values of plant and animal protein are also of this magnitude. The contributors to the CAST study have included a detailed analysis of the competition between humans and livestock for grains and highlighted the conversion ratios (grain per unit of final product) for different species in developed and developing countries (Box 5 page 42). Apart from demonstrating that ruminants are not as inefficient users of human edible grain as has been promulgated previously (because a high proportion of their final weight has been achieved on forage), they conclude that this is not an issue of great concern and in any event is best tackled through appropriate policy settings.

We can be certain that a lot of grain will be traded. The predicted major net importers of grain in 2020 are shown in Table 5.

Table 5. Net imports of cereals (MT) 1997 and 2020

Region	1997	2020
China	7.8	47.6
Southeast Asia	5.7	8.6
WANA	45.2	73.1
Latin America	15.4	3.5
Developing	104.1	202.1

* Source: Delgado and Rosegrant (2001)

What will grains cost?

The "IMPACT" model projects that there will be little impact on the costs of grain associated with this large increase in demand for livestock products. The historical rate of decrease of real food prices in the last 25 years or so suggests that the rate of decline of food prices during the next 25 years will be weaker and the reasons for this, proposed by Delgado *et al.* (1999), is the reserve capacity for additional cereal production. The large exporters of grains such as Australia, Canada and the USA, have the ability to bring large amounts of land into production that may not be used for grain production when other commodity prices are higher. Average wheat yields in Britain and other European countries are higher than in the major exporting countries, which suggests that there is further reserve capacity to increase yields amongst the major exporters. When measured in constant 1996/98 US\$ projections suggest that the real price in 2020 for maize will be US\$97 per tonne, up 3% on the 1996/98 baseline, and that for soybean will be US\$248 per tonne, no change, in real terms, from the 1996/98 baseline.

Thus it appears that there will be sufficient feed to support the projected increase in production generated by the increased demand for livestock products, but the increased production will not all

come from an increase in domestic production, associated with the drive for self sufficiency amongst those countries where the demand is greatest. There will be major effects on the trading of livestock products and the raw materials that generate those products.

CHANGES IN TRADE IN LIVESTOCK PRODUCTS AND FEED

There is no way in which the countries that have the greatest demand for livestock products can meet the demand internally. They will have to import. They will import the products, the raw material from which those products are made (livestock and feed), and they will import the manufacturing and processing technology, as well as much of the technological and physical infrastructure required to support the new food industries.

Table 6 shows a part of the trade picture for meat and milk a few years ago, and the predictions of what it will probably be in the next two decades. These figures demonstrate a continuation of what we know to be already occurring; live sheep and cattle into Asia and the middle East, milk and milk products streaming into Southeast Asia, and excellent trade opportunities for Australia and New Zealand in these areas of maximum market growth. Over the next two decades the nature of the trade is likely to change.

Table 6. Net imports of meat (MT) and milk (MT) from selected countries in 1997 and 2020

Region	Meat		Milk	
	1997	2020	1997	2020
China	0.0	4.0	1.4	2.9
India	na	na	0.0	0.5
Southeast Asia	0.0	0.4	4.7	8.8
WANA	0.9	1.7	4.9	7.9
Latin America	-0.3	-2.5	5.8	4.5
Developing	0.9	5.7	20.0	33.7

Source: Delgado and Rosegrant (2001)

As the infrastructure and capacity for transport and cold storage increases, the trade in processed product will increase relative to the live animal trade. The present situation in Southeast Asia, where live animal exports from Australia support the “wet-market” systems, is changing rapidly. More cold-chains are being installed and improved transport and handling methods are being introduced. Furthermore, many Governments in East and Southeast Asia have active policies for the genetic improvement of their national flocks and herds, so the flows of breeding stock to these countries from other places will strengthen, along with the movements of stock for feeding and subsequent slaughter.

Delgado *et al.* (1999) predict that changes in feed efficiency by livestock will have a noticeable, and in some cases a pronounced effect on the trade picture, because of the impact on feed-grain usage. Higher feed efficiency encourages the use of cereals as feed and favour countries where cereal supply is relatively cheap and cereal feeding practices are well established. While changes in feed efficiency have virtually no effect on the consumption of livestock products, they do affect the way, and the locations, in which those products are produced. Thus, progressively lower feed efficiency can raise the price of cereals to the point where substitutes are cost effective, and countries such as Argentina and Australia, with a large capacity to produce beef off grass, can compete more easily with the more expensive lot-fed product. But, the responses in different countries to the changes in grain prices associated with changes in feed efficiency are different. For example, the IMPACT model predicts that an increase in feed efficiency produces an increase in net beef exports from India, and a decline of beef exports in China. This may reflect, at least in part, the relative preferences for beef, pork and poultry in the two countries and the relative feed efficiencies of these species. The price changes in cereals that are related to feed conversion efficiency indicate that a decrease in feed efficiency tends to increase net exports of cereals from developed countries, as well as India and Sub-Saharan Africa, and increase the net imports of cereals by China and Latin America. However, Delgado *et al.* (1999) warn that when the percentage of the total production and consumption of a product that is traded is small, the percentage trade responses observed in some cases can be relatively, perhaps disproportionately, large. The important point is that feed efficiency is an important determinant of grain prices and consequently the trade in them and the products that derive from them.

Interestingly, despite the increases in demand and enhanced trade, the “IMPACT” model does not predict major changes in prices for either livestock products or for feed, mentioned earlier. Price

projections (in 1996/98 US\$) for livestock products (per 100 kg) in 2020 are US\$1696 for beef, down 6% on 1996/98 prices; US\$2147 for pork, down 6% on 1996/98 prices; US\$700 for poultry, down 4%; and US\$277 for milk; down 12% on 1996/98 prices. The projections to 2020 for beef, maize and poultry are shown in Figure 1.

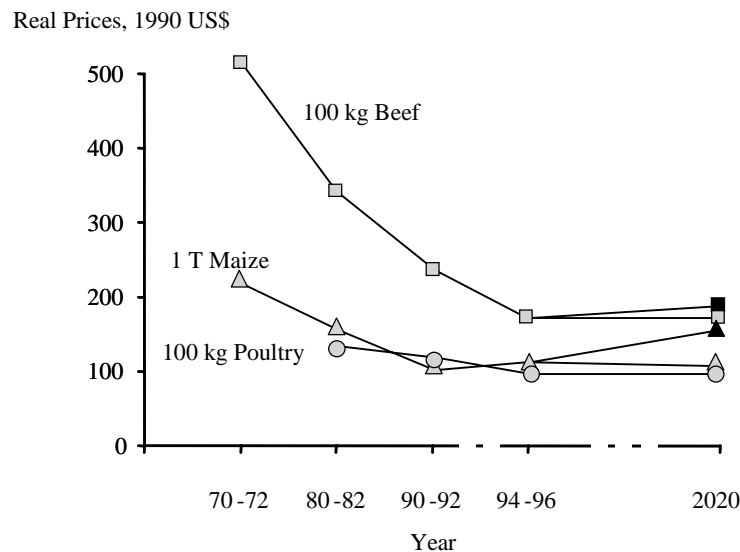


Figure 1. Projected 2020 prices in constant 1996/98 US\$ for beef, maize and poultry (Delgado and Rosegrant 2001)

Figure 1 shows the projected 2020 prices in constant 1996/98 US\$, relative to the historical trends, highlighting the significant changes that occurred in production efficiency since 1970, and emphasising the underlying changes in the terms of trade. The projections are shown for two scenarios of feed efficiency. Lower feed efficiency (closed symbols) increases the price of grain and beef, but the relative increase in the price of poultry is small.

CAN THE NATURAL RESOURCE BASE SUPPORT THE NEED?

This, of course, is the big question. Economic models such as “IMPACT” merely juggle the figures according to the equations that comprise them. The models make assumptions based on past trends and assume that these trends can continue. They know little about agro-ecological and other biological systems and the natural resources that are required to support them.

Fischer *et al.* (2001), in a major assessment of global agro-ecological requirements for agriculture in the next 100 years, conducted by the International Institute for Applied Systems Analysis in Laxenburg, Austria, and FAO, made the following findings:

- More than 75% of the global land surface is unsuitable for crop cultivation because this land is too cold (13%), too dry (27%), too steep (12%) or the soils are too infertile (40%) or combinations of these factors.
- Cultivable land in developing countries totals about 1.8 billion ha of which some 20% is only moderately suitable. At present about half of this 1.8 billion is under cultivation, compared with 595 million ha out of 756 million ha (80%) in developed countries.
- Over 80% of the potentially cultivable global land reserves are in either South America or Sub Saharan Africa. In Asia, most of the cultivable land is already in use and by 2050 the per capita allocation of this land will be below 0.1 ha, a value considered critical.
- In both the developed and developing worlds, some 1.4 billion ha are forest ecosystems of which 12% and 30% respectively, have good potential for crop cultivation, but to do so would result in severe environmental consequences.
- Intensification of agriculture will be the most likely means to meet the food needs of 9 billion people in 2050. The study asserts that enough food can be produced on currently cultivated land if sustainable management and adequate inputs are applied. This will require improvements in socio-economic conditions if inputs and technology are to be accessed by farmers in developing countries.

- The projected climate change will result in mixed and geographically varying impacts on crop production. In general, developed countries gain production potential while several developing countries lose.

The comprehensive assessment of Fischer *et al.* (2001) contributes substantially to the body of analysis and opinion that indicates that the growing world population will not only feed itself, but that the trends showing a decreasing number of food-insecure people and increasing numbers eating more and higher quality food can continue (see also earlier discussion). However the effects of climate change may vary the extent of the overall trend.

DOES AUSTRALIA HAVE A ROLE?

This question by now should be redundant! The opportunities for Australia lie in two major areas – each of them important, and interrelated over time. The first is in development assistance, and the second is trade.

In the “aid” area we work with such organisations and agencies as AusAID, ACIAR, and the sixteen CGIAR sponsored International Agricultural Research Centres, of which the International Livestock Research Institute (ILRI) is one. The opportunities that these bodies provide should be high on the list for activities by Australian livestock scientists and primary producers. At a recent Crawford Fund Parliamentary Seminar (“Food, Water and War: Security in a World of Conflict”, ACIAR 2000), Admiral Chris Barrie, in his keynote address, stated “*In affluent societies we take ready access to food and water for granted, but in their absence people are driven to do whatever it takes to get them.*” And added “*If the circumstances of life are precarious enough, it is easy for the bad guys to recruit young people to their cause for a uniform and some food, however squalid or ill-defined the particular cause might be.*” His talk highlighted the need to prevent poverty, the ideal breeding ground for discontent, and consequently the need for military intervention in the future. Afghanistan is a good lesson. Only now has a consortium of wealthy nations, including the USA, put together a fund, and a package of agricultural assistance, for delivery through the CGIAR and other groups. We can only ponder the consequences if this had been done 2 decades or more ago!

In the “trade” area we in Australia are fortunate. Many of the countries in our region have already made substantial socio-economic progress and have passed from the “aid” category to a “trade” status. And it is this region of the world that much of the action is occurring. We can underpin and strengthen the national relationships with institutional and personal partnerships, built on the exchange of information, technology, cooperative research activities, catchment, waste, and other land management practices (e.g. through community action and participatory producer groups), products, services, and infrastructure building and management.

In summary, given the large increases in the consumption of livestock products that is likely to occur over the next two decades, the Australian livestock industry (and I include our scientific and educational institutions and their staffs as vital parts of the industry) can participate in the future food production needs of the world, throughout the whole of the food production chain. In some circumstances we will produce and trade the raw materials for food production, in others the final processed product, in some our educational expertise, our technology and know how, and in others we will provide the infrastructure to support transport, marketing and distribution, and of course our IT to access new knowledge and practices. We will trade both our theoretical and practical knowledge and expertise, in ventures with our current and future partners in the developing world, who are the consumers of animal products in the future.

How we manage this and whether we succeed in meeting the challenge is entirely in our hands. It is up to us - as individuals, as academics, researchers and producers, and our institutions and organizations, to apply our own efforts and to exert our influence on our national leaders and policy makers. Let us seize the opportunity to make Australia and the world a better-fed and more peaceful place.

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