The role of grasslands in world food trade: projections of future trade policy reforms*

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Abstract

Consumption of livestock products has been increasing rapidly, especially in the developing world. Demand for non-ruminant meats has been increasing more rapidly than that for ruminant meats. This has been accompanied by rapid supply growth, especially in industrial grains-based livestock production systems. As a consequence, the importance of grasslands in livestock production and trade has been declining. Barriers to trade in livestock products are generally much higher for products that can be produced on grasslands (ie dairy products and ruminant meats) than for non-ruminant meats, despite the achievements of the Uruguay Round. A new WTO Round of agricultural trade negotiations began in March 2000, and this paper simulates outcomes of possible new trade agreements. Certain reductions in protection and trade barriers are projected to provide a boost to grasslands livestock farming and therefore to moderate the downward trend in grasslands' contribution to livestock production and trade.

Keywords grasslands; trade barriers; WTO reforms; projections; policy simulation; dairy; meat.

Suggested short title: Grasslands and trade policy reform

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INTRODUCTION

The way in which dietary patterns are changing as global economic growth and development proceeds is now well documented. Due to factors such as income growth, urbanisation and the modernisation of marketing infrastructures, consumption patterns in many developing countries are switching from an emphasis on traditional foods to value-added processed and high-protein foods such as those derived from animal products (Huang and David 1993, Huang and Bouis 1996, Rae 1997 and 1998, Delgado *et al*. 1999). Growth in consumption has generally been more rapid for poultry and pigmeat, than for dairy products and ruminant meats. Thus supply expansion has also been greater for the non-ruminant meats that increasingly rely on feedgrains and industrial production systems, than for the often-pasture-based cattle and sheep products. As a consequence, the share of grasslands in livestock farming has been declining.

For a variety of reasons, many countries have a comparative disadvantage in the production of livestock products. Such countries therefore may not have a natural ability to use their domestic resources to satisfy the growing demand for livestock products or to meet other objectives set for their livestock industries. Thus government assistance, including trade barriers, has been aimed at encouraging domestic production in many countries. Such assistance has in some cases led to the achievement of self-sufficiency or even the emergence of surpluses, but has also encouraged the rapid growth of feedstuffs imports as it became clear that demand for feedstuffs exceeded the ability to supply from domestic sources.

Due in part to the international transferability of modern industrial non-ruminant production systems, even land-scarce economies such as some in Asia are relatively efficient producers of

these livestock products. Hence government assistance tends to be aimed at ruminant meats and dairy production. *These also are the products that can be produced on grasslands*. The GATT/WTO Uruguay Round of trade negotiations (1986-95) was notable in that it was the first Round to have achieved substantive success in reducing barriers to trade in agricultural products. In summary, it agreed that non-tariff barriers would be replaced by their equivalent tariffs, that agricultural tariffs would be reduced by an average of 36%, that export subsidy payments would be reduced by 36% and the subsidised quantities by 21%, and that farm payments under domestic support policies would be reduced by 20%. These were to be completed over a 6-year implementation period (10 years for developing countries) commencing in 1995. The Uruguay Round Agreement on Agriculture also mandated that a new Round of agricultural talks begin before the end of 1999. In the event, these negotiations began in March 2000, and many WTO member countries have submitted reform proposals. Ample scope exists for these negotiations to make further inroads into the massive trade barriers that are hindering the further development of grasslands agriculture. Two possible trade reform scenarios are simulated in this paper.

DEVELOPMENTS IN LIVESTOCK PRODUCTS CONSUMPTION AND SUPPLY

Over the past 20 years there has been a steady increase in the share of the average diet contributed by animal food products in much of the developing world. Between 1983 and 1993, for example, the share of total calories provided by consumption of animal products increased from 8% to 15% in China, from 11% to 15% in the rest of East Asia, and from 9% to 11% on average for the developing world (Table 1 and Delgado *et al.*).

Average levels of per capita consumption of meats and dairy products in developing regions are also given in Table 1. While levels of per capita consumption are well below those in developed

countries (and especially so for milk products), the developing world has contributed nearly all of the growth in meat and milk consumption per person. In China and East Asia, meat consumption per person doubled over the 1983-93 period, and a substantial increase also occurred in Southeast Asia. Over the same period, milk consumption per person doubled in China (from a very low base), and substantial increases were also achieved in India and other parts of South Asia.

The breakdown of per capita consumption to the various types of meat reveals that it is the white meats that have grown the fastest. In developed countries, poultry consumption grew at 3% per year from 1982 to 1994, exceeding the growth rates of 0.6% for pork and zero for beef. In developing countries over the same period, poultry consumption per person showed the strongest annual growth at 7.6%, closely followed by pork at 6.2%. Beef consumption grew at 3.2% per person per year. Thus it is the predominantly grain-fed non-ruminants that are supplying the strongest-growth market segments.

Livestock production is increasing most rapidly in the same regions where consumption is rapidly increasing. Thus meat and milk production is expanding 4 - 5 times more rapidly in developing regions than in the developed world. Among the livestock types, annual growth rates for pork and poultry of 6% - 8% in developing regions are about double those for beef and milk. The highest meat production growth rates are occurring in Asia, especially China (Delgado *et al.*).

These large differences in supply growth between developed and developing regions is also causing major shifts in the distribution of global livestock production. Between the mid-1980s and the mid-1990s, the developing countries' share of world meat and milk production increased from 36 to 47%, and 24 to 32%, respectively. While milk production is concentrated in developed

regions, India increased its share of global production from 8% to 12%. By 2020, Delgado *et al.* project that 60% of the world's meat, and 52% of global milk production will take place in developing countries.

While 75% of the world's cattle and two-thirds of the world's non-ruminants, sheep and goats live in developing countries, the latter regions produce less than half the world's meat and a third of the world's milk. Hence livestock productivity is much lower in developing countries than elsewhere. However, some developing regions, especially those in Asia, are catching-up on productivity levels in Europe and North America, especially for non-ruminant livestock (Delgado *et al.*1999, Rae and Hertel 2000).

What is the role of grassland systems in this supply expansion? While a quarter of the world's land is used for grazing, this land supplies just 10% of global meat output. Mixed livestock-crop production systems are the most common in developing countries, and produce half of the world's meat. However, given that production growth is fastest in non-ruminants in the land-scarce economies of Asia, it is not surprising that industrial grain-based livestock production grew globally at twice the rate of mixed-farming systems, and more than six times the rate of grazing systems over the decade since the mid-1980s. For most developing regions of the world, it is the industrial meat production systems that have shown the most rapid growth. And of all these regions, industrial system growth has been the highest in Asia. The use of grazing systems is declining absolutely in Asia. Only in West Asia and North Africa has there been any significant growth in grazing production systems but even there, this growth rate is still exceeded by that of industrial production systems (Degado *et al.*). Thus current trends are that *the share of grassland in*

global livestock production is falling and that of cropland in support of industrial livestock production is rising, so that grazing systems are rapidly diminishing in importance.

LEVELS OF PROTECTION IN LIVESTOCK PRODUCTION

Governments use a variety of instruments to provide protection to their livestock industries. These include support prices and deficiency payments, input subsidies, import tariffs, quantitative restrictions on imports, sanitary and food safety regulations that restrict imports, and export subsidies when domestic prices are supported above world prices and lead to production of surpluses.

The producer subsidy equivalent (PSE) is one way of measuring the extent of such protection The PSE measures the total funds transferred to farmers through agricultural policies as a percentage of farmers' revenue. While this measure excludes the impact of non-agricultural policies on farm production incentives, the PSE estimates made by the OECD comprise arguably the most comprehensive comparable collection of farm protection data. In 1999, total funds transferred to farmers through agricultural policies in all OECD countries amounted to US$283 billion. Of this, one-third was directed to livestock producers. Of the major livestock products, milk was by far the most heavily supported, this commodity alone accounting for 18% of total OECD support payments to agriculture. Beef accounted for 9% of the total transfers, while total spending on support of pig and poultry meat and eggs amounted to just 5% of total support (OECD 2000).

Averaged over all OECD countries, the level of livestock protection in 1999 was highest for dairy products, sheepmeat and beef (PSEs of 57%, 42% and 32% respectively), ie the products that in some countries are primarily raised on grassland. Grains-based livestock production, on the other

hand, received relatively low support (the average PSEs were 22% for pigmeat, 14% for poultry and 13% for eggs). Table 2 shows the PSEs for dairy and meat production for selected OECD members. Of these countries, dairy protection is highest by far in Japan and Korea with around 70-80% of farm revenue derived from support payments. This measure of dairy protection is around 50-60% in the European Union (EU) and North America, which is similar to the OECD average. Dairy protection is lowest in New Zealand, with zero transfers recorded in 1999. For beef production, protection is highest in Korea and the EU, followed by Japan. In contrast, the beef sectors of Australasia and North America receive very little government support. In other words, subsidies paid to beef and dairy farmers *tend to be highest in those countries that place relatively less importance on grasslands* in producing these commodities, and lowest in those countries that rely primarily on grassland.

In many cases, much of the above protection is provided through import barriers, such as tariffs, that allow internal prices to rise above world prices. For example, unit returns to dairy farmers in Japan and Korea are five and three times the world price, respectively. In the EU and US, such returns are more than double world prices (OECD 2000). On average, the global agricultural tariff (17%) is four times as great as that on manufactured imports. Within agriculture, some of the highest tariffs are levied on livestock products. The average global tariffs on beef and dairy products, for example, are over 25% compared with 17% for non-ruminant meats. On a country basis, beef and dairy product tariffs are highest in the European Free Trade Area (EFTA) countries, the EU, Japan and South Korea, and some countries in Southeast Asia. In several of these countries, tariff-rate-quotas admit a certain volume of product at a relatively low tariff, with over-quota imports facing much higher tariffs. The latter can be so high as to completely prohibit

trade - examples include the equivalent of 1136% (Switzerland) and 657% (Japan) for butter, and 296% (Switzerland) and 174% (EU) for beef (OECD 1995).

MATERIALS AND METHODS

Trade model and database

We use a slightly modified version of the GTAP applied general equilibrium model (Hertel 1997) to project national and regional production, consumption and trade flows between 1995 and 2005. This is a relatively standard, multi-region model built on a complete set of economic accounts and detailed inter-industry linkages for each of the economies represented. The GTAP production system distinguishes sectors by their intensities in five primary production factors: land (agricultural sectors only), natural resources (extractive sectors only), capital, and skilled and unskilled labour. In our projections we will keep the total supply of agricultural land fixed. Thus any expansion of livestock production will be accompanied by either a transfer of land from other uses (eg cropland converted to grassland), and/or by an expansion of land sown in feedcrops. In trade, products are differentiated by country of origin, allowing bilateral trade to be modeled.

The 50 commodities in the version 4 GTAP database have been aggregated up to 15 commodity groups, of which 6 commodities (rice, wheat, other grains, oil crops, other crops and processed food) compete for use in the feedstuffs composite. We modify the model to incorporate feedstuff substitution into the livestock production functions. Livestock farming is represented by three aggregates: beef cattle (i.e. ruminant livestock), other livestock (primarily non-ruminants) and raw milk production. These farming sectors provide inputs to the beef processing (ruminant meat), other meat (non-ruminant meat) and dairy products industries in each region. All remaining production sectors are aggregated into manufactures, services, and other natural resource based

commodities. Details of the regional and commodity aggregations are to be found in Appendix Tables 1 and 2.

Some of the protection data in the GTAP version 4 database were modified to reflect improved estimates of agricultural protection. Import tariffs were modified for Korea (wheat, beef cattle, beef and dairy products), Southeast Asia (wheat, other grains, beef and dairy products), and the EU (beef and dairy products). Export subsidies on wheat, other grains, beef and dairy products were removed in Southeast Asia and Korea, that on other meats in Southeast Asia was reduced, and the export subsidy on dairy products in Australia was eliminated. Output subsidies were increased for dairy products in Australia, and for beef and dairy products in the EU. Following Hertel *et al.* (1999a) we also removed all export subsidies in China.

Macroeconomic projections

What will be happening in the world economy over the 1995-2005 projection period, that ought to be captured in the projections? The changes in population, resource endowments, productivity and tariffs that we model have implications on both the demand and supply side of each regional economy. Income growth, for example, will boost the demand for livestock products relative to grains, and in some regions there will be a shift away from food products altogether. In addition, accumulation of skilled labour and capital will tend to promote a shift in production away from agriculture in favour of manufacturing and services. This may perhaps be further encouraged by increased access to foreign markets for textiles, clothing and manufactures due to the Uruguay Round reforms whose implementation will be finalised over our projections period. Various sectors, including livestock farming, will be experiencing technological change and productivity levels in

developing countries could be converging on those of the developed world. These forces together will help shape the changes in regional trade and therefore the sectoral trade balances.

Following the work of Gehlhar *et al*. (1994), projections are made through exogenous shocks to each region's endowments of physical capital, skilled and unskilled labour, population, and technology. Appendix Table 3 reports the shocks to population, endowments and productivity that we assume in this paper. Forecasts for population, investment (capital stock), and labour force are based on forecasts from the World Bank. Projected changes in skilled labour are based on expected increases in the stock of tertiary educated labour and are taken from Ahuja and Filmer (1995) for developing countries. Projections for the OECD countries are based on inputs developed for the World Bank's Global Economic Prospects (1997 and 1998). The stock of farmland in each region is held constant.

The projections also incorporate the trade policy reforms of the GATT/WTO Uruguay Round. Significant trade policy developments over the 1995-2005 projections period include completion of the manufacturing tariff cuts under the Uruguay Round, implementation of the Agreement on Textiles and Clothing (ATC) and the probable accession of China to the WTO. These changes are incorporated in our projection by using the results of Francois and Strutt (1999) to specify the remaining UR manufacturing tariff cuts to be made from our 1995 base period. It is assumed that the abolition of quotas under the ATC will have been completed by the year 2005 and that China, as a WTO member, will also benefit fully from these reforms. These were modelled by removing the implicit export taxes due to the quotas on textile and clothing exports from developing countries to the industrialised regions. China's WTO offer is based on the manufacturing tariff data in the US-China Bilateral Agreement. As regards agriculture, while reforms were negotiated during the

Uruguay Round, they were based on the late-1980s when prices were very low and hence measured protection was high. In contrast, our base year of 1995 was one of much higher world prices and hence lower protection. Because of this, and the extent of "dirty tariffication" in agriculture (Ingco 1996) we assume no change from 1995 protection in agriculture.

Productivity growth was forecast as follows. First, based on the work of Bernard and Jones (1996), we observe that productivity growth tends to be more rapid in agriculture than in manufacturing, which in turn has a higher productivity growth rate than services. Based on their averages for the OECD as a whole (Bernard and Jones, 1996, Table 1), we obtain the following multiples of the manufacturing productivity growth rate for the other sectors: (non-livestock) agriculture = 1.4 * manufactures, services = 0.5 * manufactures, and mining = 0 * manufactures. In this way, we are able to link productivity growth in each sector of the economy to a common metric - namely the rate of manufacture's productivity growth.

We then divide economies into four groups according to their overall rate of productivity growth: low, medium, high and very high. The assumed annual growth rates of productivity in manufacturing value-added for these groups are as follows: 0.25%, 0.75%, 1.25% and 1.75% per year (see Appendix Table 3). As a check on the plausibility of these assumptions, we compare our baseline cumulative GDP growth (second to last column) to that forecast by the World Bank, in the last column of Appendix Table 3. Apart from China and Korea, all of these GDP projections are reasonably close. In order to hit the World Bank targets for these regions, we would have to raise the very high growth category still further. In light of the current macro-economic uncertainty in that region, we opt for our more conservative projections.

There is mounting evidence that livestock productivity in some developing countries has been converging on that in developed countries (Rae and Hertel, 2000), which trends we seek to continue in the projections. Our livestock productivity projections have been updated from those reported in Hertel *et al*. (1999b). We apply these livestock productivity shocks in a way that maintains a constant ratio of feed use per animal. Provided these shocks are positive, feed consumption per unit of output (the feed conversion ratio) will decrease.

Trade reform simulations

Three computer simulations are performed. The first is a baseline projection, while the remaining two are specific trade reform scenarios. The objective of the *baseline* is to project the global economy to the year 2005, by which time the policy reforms of the Uruguay Round (OECD 1995) should be fully implemented. We then work from the projected 2005 data to examine how possible future trade reforms might impact on livestock trade and the role of grasslands.

One approach to future trade liberalisation in agriculture that has been put forward by some countries is to completely eliminate tariffs on particular goods (the so-called zero-for-zero approach). An advantage is that resistance to liberalization in 'politically-sensitive' sectors (such as dairy) need not hold up progress in the negotiations. A downside is that the politically-difficult sectors may never get addressed unless a framework were to be agreed that ensured no long-term exclusions. A *zero-for-zero agreement in grains and oilseeds* is one possibility, and is simulated in this paper. The US proposal to the current WTO agricultural negotiations supports sectoral initiatives including zero-for-zero agreements, and the Canadian proposal strongly supports zero-for-zero agreements for oilseeds, barley and malt. Such a grains and oilseeds

agreement is relevant to this paper, since those commodities are important ingredients in animal feeds and changes in their prices could affect the competitive position of grassland farming.

The Uruguay Round Agreement on Agriculture included the commitment to reduce agricultural tariffs by an average of 36%. Another approach in the current negotiations, then, would be to agree *a further 36% cut in all agricultural tariffs* and this is mimicked in our third simulation. In this scenario, trade barriers are reduced for all agricultural commodities, not just grains and oilseeds. In several regions, including the EU, North America and Northeast and Southeast Asia, the tariffs on imports of some livestock products are substantial. Reductions in these tariffs will reduce domestic prices and increase the import demand for such commodities. Export subsidies on several products, including dairy products and beef, are also very high such as in the EU and (for dairy products) North America. Cuts in these export subsidies will discourage domestic production of the affected commodities and will therefore reduce the volume of export surpluses. Hence the impact of simultaneous cuts to tariffs and export subsidies on global trade volumes and prices is unclear.

RESULTS

The baseline projection: 1995-2005

Livestock productivity growth was projected to be most rapid (at least in the meat sectors) in China, and the results suggest around 80% growth in livestock outputs over the projection period. Even so, China's positive trade balance in livestock products deteriorates somewhat since domestic demand for such products is also projected to increase substantially. Further, China's manufacturing and service sectors are projected to increase output by over 100% compared with their 1995 base. Other regions to experience relatively rapid manufacturing and services growth

(although by half the rate projected for China) are the developing regions of Southeast Asia and Korea, as well as North America.

Although the manufactures sectors are not the focus of this paper, their sheer size in most regions means that policy reforms in these sectors can have a major impact on the rest of the economy including agriculture. Over the 10-year projection period, assisted by the completion of the UR manufacturing tariff cuts plus those that result from China's assumed accession to the WTO, China's trade surplus in manufactures more than doubles. Korea's manufacturing trade surplus is projected to double, while the EU trade surplus is reduced and North America's trade deficit in this sector worsens.

Turning to the livestock products, base-period beef trade surpluses in Australia, New Zealand and South America all increase, while that for North America is reduced (Table 5). The EU is projected to shift from a net importer to a net exporter of beef, and China's small 1995 trade surplus is projected to increase. China has been a not insubstantial exporter of non-ruminant meats in the past, and this trade surplus is projected to be cut by a third. Other traditional non-ruminant exporters such as the EU, North America and Southeast Asia all increase their net non-ruminant exports. The traditional dairy exporters - Australasia, North America and the EU - are all projected to increase their trade surpluses, whereas the deficits of Northeast and Southeast Asia are projected to worsen. In the case of China, the small base trade deficit worsens substantially.

Changes in the size of the livestock sectors in each region also contribute to the projected changes in the net trade situation with respect to grains and oilseeds. We project that China's 1995 trade deficit in these commodities of US$2.5 billion will expand to $7.5 billion by 2005, and Southeast

Asia's deficit worsens by 50%. North America's trade surplus in grains and oilseeds increases substantially.

Simulation of a 'zero-for-zero' agreement in grains and oilseeds

The removal of all tariffs and export subsidies on wheat, other grains and oilseeds in 2005 boosts world prices of these commodities by 3-5% for grains and by 3% for oilseeds. Volumes traded globally expand by over 40% for other grains and by 20% for oilseeds, but global trade in livestock products contracts. For those regions with high tariffs on grains and oilseeds, such as Japan and Korea, the liberalisation results in a substantial fall in their domestic prices. As a result Northeast Asian livestock sectors expand while their grains outputs decline significantly to be replaced with imported grain (Table 4). Both Japan and Korea decrease their net imports of livestock products (and both actually increase exports of meats, especially non-ruminants), and most world livestock product prices fall.

In many other regions, where grains tariffs are either very low or zero, domestic grains prices rise with world prices. Hence net exporters of grains such as Australia, North and South America expand international sales (Table 4), but this expansion draws resources out of livestock production. The impact of higher grains costs on livestock trade balances in the traditional exporting regions is interesting. Higher feeds costs reduce beef exports from North America (where grains are an important feedstuff) to about the same value of that region's beef imports, but beef exports from the primarily grass-fed industries of Australia and South America expand (Table 5).

Who would be the 'winners' should this reform be agreed? The welfare results of Table 3 clearly show that almost the entire global gain is shared by Japan, the EU and North America. In the cases of Japan and the EU, most of this gain in welfare comes from efficiency gains as the grains sectors are downsized and resources put to better use elsewhere in those economies. However, these efficiency gains are not as high as they would have been had not the highly-subsidised livestock sectors been encouraged to expand through lower feed costs. In contrast, North America benefits primarily from improved terms of trade, especially higher prices for grains exports. Welfare gains to other regions are either relatively small, or are negative.

Simulation of a 36% cut in all agricultural and food tariffs and export subsidies

Our results reveal that while the volume of global trade in dairy products falls when all agricultural tariffs are reduced, that in most other agricultural commodities increases. A major factor in the dairy result is the impact of lower export subsidies on the EU's dairy export volumes which decline by more than 15%. Average export prices increase the most for dairy products, and meat export prices rise by not quite half that for dairy products.

Impacts on regional exports and imports can be summarised by changes in the trade balances. For ruminant livestock and meats (Table 5), the largest increases in trade balances occur from North and South America, but also from New Zealand and Australia. By far the greatest decrease occurs in the EU, which shifts from a projected net exporter to a net importer. Smaller trade balance deteriorations are projected in Japan, Korea and Southeast Asia. Changes in regional dairy trade (Table 6) are dominated by the improved trade balances of Australia, New Zealand and South America, although the latter region is projected to remain a net importer of dairy products. A smaller export increase occurs from North America. The EU decreases its dairy

export surplus substantially, and dairy trade balances of Japan and the rest of East Asia also deteriorate.

Some changes in regional grains trade balances are worth noting from Table 4. The current scenario leads to smaller deteriorations of the grains trade balances in Japan, Korea and the EU, compared with the grains zero-for-zero experiment. This is because the livestock sectors of these regions now generally decline due to reduced livestock protection, rather than expand when only grains protection was removed, with consequent reductions in feedstuffs demands. As a result, North America's trade surplus in grains is lower than under the former experiment.

Changes in regional welfare due to the cuts in all agricultural tariffs and export subsidies are quite different from those that result when reforms are limited to the grains and oilseeds sectors (Table 3). Globally, welfare rises by US$31 billion, well above the gain of $12 billion estimated to result from the zero-for-zero scenario. The largest welfare gain by far is enjoyed by the EU, primarily due to a more efficient use of domestic resources but also improved terms of trade. Japan receives the second highest welfare gain, due to improvements in resource use. North American welfare increases by less than when the grains sectors only were liberalised, and these gains arise mainly from improved terms of trade. The traditional livestock product exporters of Australia and South America, who gain little from the grains liberalisation, receive considerably enhanced welfare gains when liberalisation is spread across all of agriculture. Improved efficiency in resource use contributes to this result, but the major gains are due to higher export prices. The situation is somewhat different in New Zealand - although the terms of trade improve, expansion of the protected non-ruminant sector results in a less efficient use of resources. Finally, Southeast

Asia (which suffered a decline in welfare under the zero-for-zero scenario) now experiences an increase in welfare due mainly to improvements in the allocation of its resources.

DISCUSSION

The value of global exports of ruminant livestock and meats was projected to increase by 29% over the 1995-2005 period in the absence of further policy reforms. At the same time, global dairy exports were projected to increase by 16%. The contribution of grasslands to this growth in trade would appear to remain largely unchanged. Australia, New Zealand and South America may be considered among the major grassland producers of these commodities. Their projected combined share of global exports, however, remained much the same in 2005 as in 1995. While exports from each of these regions were projected to increase, so too were ruminants and dairy exports from the EU and North America where grains play a more important role in livestock feeds.

The WTO's current agricultural negotiations may agree further liberalisation of agricultural trade. Assuming such outcomes were to be implemented in 2005, what might be the consequences for the role of grasslands in trade? Under the grains and oilseeds zero-for-zero option, global exports of ruminants, dairy and non-ruminants all declined somewhat. A major reason for this outcome was that lowered grains prices in those regions that formerly protected grains production encouraged increased output from their livestock sectors. This occurred in regions such as Northeast Asia and the EU, where grain feeding dominates. Such an eventuality would appear to strengthen the existing trend of a declining role for grasslands in meat and milk production.

In contrast, when agricultural trade barriers are reduced 'across the board' grasslands does appear to increase its role in livestock products trade. Global trade in ruminants and dairy products

in 2005 could be increased by 7% and 2% respectively above our projected baseline due to the simulated 36% tariff and export subsidy reductions. In this case the combined share of Australia, New Zealand and South America in global exports rises from 30% to 43% in the case of ruminant products, and from 13% to 23% for dairy trade as each of these regions expands their predominantly grass-fed exports. At the same time, the reduced protection resulted in declines in the EU's ruminant and dairy exports as resources in that region were reallocated to more efficient uses.

Trade barriers are much more formidable for ruminant meats and dairy products than they are for non-ruminant meats. While growth in consumption of the former products is slower than for poultry and pigmeat, these very high barriers to trade expansion do nothing to encourage further consumption. Such restrictive tariffs and quotas on dairy products and ruminant meats are often applied by countries that lack a comparative advantage in grasslands production systems and emphasise grain-fed intensive cattle production. Substantially lowering these barriers to increased trade has been shown to provide a boost to grasslands livestock production in regions such as South America and Australasia. Regions that are currently protective of their livestock sectors would replace to some extent their own high-cost grain-fed dairy and beef production with lower-cost imported product produced on grasslands. Hence a comprehensive liberalisation of agricultural trade in the current WTO agricultural trade negotiations is likely to make a significant contribution to arresting the decline in the role of grasslands in agricultural trade.

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Table 1 Consumption trends for livestock products

	Calories from animal products (%)		Per capita meat consumption (kg)			
	Per capita milk consumption (kg)					
	1982-4	1992-4	1983	1993	1983	1993
China	8	15	16	33	3	7
Other East Asia	11	15	22	44	15	16
India	6	7	4	4	46	58
Other South Asia	7	9	6	7	47	58
Southeast Asia	6	8	11	15	10	11
Latin America	17	18	40	46	93	100
WANA	11	9	20	20	86	62
Sub-Saharan Africa	7	7	10	9	32	23
Developing world	9	11	14	21	35	40
Developed world	28	27	74	76	195	192
World	15	16	30	34	76	75

Source: Delgado *et al.*

Note: WANA is West Asia and North Africa. Milk is all milk and products in liquid milk equivalents.

Table 2 Producer subsidy equivalents for dairy and beef: selected OECD countries

	1986-88	1991-93	1997-99
Dairy			
Japan	84	82	78
Korea	73	73	67
Australia	32	34	21
New Zealand	9	1	0
Canada	61	61	57
USA	60	52	54
EU	56	57	54
All OECD	58	56	54
Beef			
Japan	44	35	33
Korea	54	68	59
Australia	5	4	3
New Zealand	7	1	1
Canada	9	7	7
USA	6	5	4
EU	48	54	58
All OECD	30	30	32

Source: OECD (1999, 2000)

Table 3 Changes in welfare from trade policy reforms: 2005 (1995US$million)

Region	zero-for-zero	36% tariff cuts
AUS	61	651
CHN	-432	131
JPN	3279	4790
KOR	771	449
NZL	625	474
SEA	-169	1817
NAM	1791	1429
EU	3941	18881
SAM	211	1762
SSA	-73	36
ROW	1922	478
GLOBAL	11930	30897

Source: Author's calculations.

Table 4 Grains and oilseeds trade balances (1995US$million)

Region	1995 Base	2005 Base	Zero-for-zero	36% tariff cuts
AUS	1442	1949	2500	1924
CHN	-2551	-7477	-7045	-7294
JPN	-6360	-7166	-9137	-7746
KOR	-2599	-3274	-4790	-3744
NZL	-51	-72	997	-99
SEA	-3178	-4801	-5729	-4927
NAM	24736	34561	48513	37976
EU	-4242	-1496	-6934	-2612
SAM	-1465	-452	1412	-420
SSA	-595	-918	-1017	-1005
ROW	-8063	-14760	-23913	-16118

Source: Author's calculations.

Table 5 Ruminant livestock and meats trade balances (1995US$million)

Region	1995 Base	2005 Base	Zero-for-zero	36% tariff cuts
AUS	3121	3332	3406	3806
CHN	23	150	149	212
JPN	-4344	-4595	-4446	-5133
KOR	-746	-993	-987	-1083
NZL	1826	2239	2094	3320
SEA	-680	-1090	-1058	-1130
NAM	2251	900	-4	2277
EU	-1695	2034	2068	-3684
SAM	1791	4525	4811	9081
SSA	-12	-287	-283	-206
ROW	-3170	-8398	-7898	-9929

Source: Author's calculations.

Table 6 Dairy products trade balances (1995US$million)

Region	1995 Base	2005 Base	Zero-for-zero	36% tariff cuts
AUS	1150	1695	1682	3433
CHN	-24	-237	-235	-239
JPN	-844	-898	-840	-1812
KOR	-203	-263	-252	-266
NZL	1974	1987	1594	3384
SEA	-1976	-2471	-2464	-2487
NAM	240	407	241	682
EU	2934	4946	5102	1816
SAM	-1709	-1924	-1909	-968
SSA	-495	-704	-702	-460
ROW	-3597	-5572	-5221	-6055

Source: Author's calculations.

Table 7 Exports a of dairy products (1995US$million): principal exporters

Region	1995 Base	2005 Base	Zero-for-zero	36% tariff cuts
AUS	1311	1867	1847	3604
NZL	1999	2019	1629	3421
NAM	1080	1386	1277	1787
EU b	23474	27194	27284	23688
SAM	470	645	656	1267

Note: a. Value of exports at world (fob) prices.

b. Includes intra-EU trade.

Source: Author's calculations.

Table 8 Exports of ruminant livestock and meats (1995US$million): principal exporters

Region	1995 Base	2005 Base	zero-for-zero	36% tariff cuts
AUS	3203	3490	3554	3968
NZL	1853	2267	2124	3353
NAM	6260	6628	6110	8246
EU	13963	19490	19516	14176
SAM	3105	5932	6198	10689

Source: Author's calculations.

Appendix Table 1 Regional aggregation

Region	(Acronym)	Description
Australia	(AUS)	
China	(CHN)	
Japan	(JPN)	
South Korea	(KOR)	
New Zealand	(NZL)	
Southeast Asia	(SEA)	Indonesia, Malaysia, Philippines, Thailand
North America	(NAM)	Canada, USA
EU	(EU)	EU15
South America	(SAM)	Mexico, Central and South America
Sub-Sahara Africa	(SSA)	South Africa, rest of Sub-Sahara and Southern Africa
Rest of the World	(ROW)	

Appendix Table 2 Sectoral aggregation

Region	(Acronym)	Description
Paddy rice	(rice)	
Wheat	(wheat)	
Other grains	(othergrains)	Cereal grains, nec
Oilseeds	(oils)	
Other crops	(othercrops)	Sugar cane/beet, plant-based fibres, fruit & vegetables, crops, nec
Beef cattle	(beefcattle)	Bovine cattle, sheep & goats, horses
Non-ruminant livestock	(otherlvstk)	Livestock and animal products nec
Milk	(milk)	Raw milk
Beef products	(beef)	Bovine cattle, sheep & goats, and horse meat
Non-ruminant meat	(othermeat)	Meat products nec
Dairy products	(dairyprod.)	
Processed food	(procfood)	Processed rice, sugar, food products nec
Other natural resource	(othnatres)	Wool, forestry, fishing, mining & minerals
Manufactures	(manufacture)	Beverages & tobacco, textiles & clothing, all other Manufacturing
Services	(services)	

Appendix Table 3 Annual growth rates of exogenous variables used in the projections and GDP growth

	Popu-lation			Endowments			Livestock	
productivity	Manufacture's productivity			Forecast GDP			World Bank forecast	
		Unskilled labour		Skilled labour		Capital	Beef cattle	
	Other livestock		Milk					
Australia	0.91	1.04	4.72	1.59	0.70	2.49	2.79	0.75
	3.0	2.9						
China	0.75	1.06	3.33	8.22	4.57	5.39	-0.29	1.75
	6.6	6.9						
Japan	0.18	-0.26	2.57	0.33	2.33	2.55	2.15	0.25
	0.8	0.9						
Korea	0.74	0.64	4.74	1.53	4.48	3.23	2.03	1.75
	2.9	3.4						
New Zealand	0.73	0.71	4.72	2.28	2.39	2.89	0.82	0.25
	2.4	2.3						
South East Asia		1.36	1.89	6.27	2.31	0.51	2.51	2.07
	0.25	2.6	2.6					
North America		0.78	0.89	3.02	3.04	0.86	2.37	2.17
	0.75	2.7	2.5					
E.U.	0.09	0.02	3.02	0.76	2.91	2.19	2.17	1.25
	1.9	2.3						
South America		1.37	1.94	5.50	0.96	3.15	2.91	2.79
	1.25	2.8	3.0					
Sub-Saharan Africa		2.55	2.84	5.97	1.05	-0.03	1.85	0.30
	0.75	3.1	3.3					
ROW	1.38	1.86	5.45	2.47	0.30	0.97	2.07	0.75
	3.3	3.2						

Source: Hertel *et al.* (1999b)