The global feed market: Asian perspectives

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Abstract. Global demand for feed, especially cereal feed, is expected to increase in the decades to come. At the global level, demand for cereal feed will be met by the supply. There are, however, disparities between regions. As a result of strong livestock industry development, the Asian region as a whole will have a shortage of cereal feed and will become a major cereal feed importer. This paper examines existing projections of feed demand and supply in the Asian region. It also sheds light on the implications of the feed demand and the livestock industry development in the Asian region for the Australian rural industries.

Keywords: feed market, demand and supply, Asia

Introduction

Globally, the next three decades will see a strong increase in demand for feed, especially cereal feed. At the global level, demand for cereal feed will be met by the supply. There are, however, disparities between regions. The Asian region as a whole will have a shortage of feedgrains. Within the Asian region, the shortage of feedgrains in South Asian countries is likely to be small, whereas countries in East Asia and the Near East are likely to experience major shortages and will be major feedgrain importers.

This paper examines existing projections of global feed demand and supply with a focus on the perspectives in the Asian region. In the next section, the paper first provides an overview of the global trends in feed demand and supply. Then in Section 3 it highlights the likely future feed demand and supply in Asia with particular attention to the East Asian region. Given that China is a major feed producer and consumer in the East Asian region and that China has been experiencing rapid livestock production expansion, China's feed demand and supply will be discussed in Section 4 as a special case. Section 5 concludes the paper.

The global trends

The next three decades will see a strong increase in global demand for feed, especially cereal feed. The increasing demand for feed is driven by the increasing demand for animal products, especially in developing countries. The increase in consumption of animal products in developing countries has been most impressive in the past three decades. According to the Food and Agriculture Organisation of the United Nations, between 1964-66 and 1997-99, per capita meat consumption in developing countries rose by 150% and that of milk and dairy products by 60% (FAO 2002, p. 5).

Increase in animal product consumption is projected to continue. By 2030, per capita meat consumption in developing countries will rise by a further 45% (from 25.5 kg in 1997/99 to 37 kg in 2030), compared to an increase of 14% in industrial countries (from 88 kg to 100 kg for the same time period). Per capita consumption of milk and dairy products will rise from 45 kg to 66 kg in developing countries, and from 212 to 221 kg in industrial countries. Per capita egg consumption will grow from 6.5 kg to 8.9 kg in developing countries and from 13.5 to 13.8 kg in industrial

countries (FAO 2002, p. 5; Bruinsma 2003, p. 159).

The increased consumption of animal products will pose significant challenges for future farming for it has to produce enough feed to raise additional animals. However, pasture has only limited potential as a source of additional feed in the future. Mixed crop-livestock production systems will be constrained in their use of some feeds (such as restaurant and household food scraps, common in many developing countries) due to difficulties in exporting products of animals that are fed with such feed. Further, more farmers may give up small-scale traditional animal raising because of increasing opportunity costs (Zhou et al. 2003). Thus mixed farming systems will also have limited potential for increasing animal products.

An increasing share of livestock production will come from intensive industrial livestock production systems.

In recent years, production from these systems has grown twice as fast as that from traditional mixed farming systems, and more than six times faster than from grazing systems (Bruinsma 2003, pp. 164-66). Increased intensification will require more feed cereals and the demand for cereal feed will be strong.

The FAO report suggests that, by 2030, global aggregate consumption of all cereals will reach 2.83 billion tonnes, an increase by about one billion tonnes from the 1.86 billion tonnes of 1997/99. Of this increment, about one half (491 million tonnes) will be used for feed, 42% (403 million tonnes) for food, and the remainder for other uses (e.g. seed, industrial non-food and waste) (see Table 1). Thus, feed will be the most dynamic element driving the world cereal economy and will account for an ever-growing share in aggregate demand for cereals.

Table 1. Projections of global cereal demand and supply

	Per Capita Demand (kg)		Total Demand (m t)			Production (m t)	Net Trade (m t)	SSR [a] (%)
	Food	All uses	Food	Feed	All Uses			
World								
1997/99	171	317	1003	657	1864	1889	9	101
2015	171	332	1227	911	2380	2387	8	100
2030	171	344	1406	1148	2830	2838	8	100
Developing Countries [b]								
1997/99	173	247	790	222	1129	1026	-103	91
2015	173	265	1007	397	1544	1354	-190	88
2030	172	279	1185	573	1917	1652	-265	86
Industrial Countries [b]								
1997/99	159	588	142	331	525	652	111	124
2015	158	630	150	387	600	785	187	131
2030	159	667	155	425	652	900	247	138
Transition Countries [b]								
1997/99	173	510	72	105	211	210	1	100
2015	176	596	70	127	237	247	10	104
2030	173	685	66	149	262	287	25	110

[a] SSR: Self-sufficiency rate = production/demand.
[b] In the FAO report, all countries are placed into three country groups: 'Developing Countries', 'Industrial Countries' and 'Transition Countries'. For further details about the country grouping, see Appendix 1: Countries and Commodities in Bruinsma (2003, pp. 375-77).

Sources: FAO (2002, p. 90), Bruinsma (2003, p. 65).

At the global level, demand for cereal feed will be met by the supply. In 1997/99, global feedgrain demand was 657 million tonnes. This is projected to increase to 911 million tonnes in 2015 and 1148 million tonnes in 2030. In 2015 and 2030, total cereal demand will be 2379 and 2831 million tonnes, respectively. Total cereal supply will be 2387 and 2838 million tonnes, respectively. Hence, cereal demand will be met by the supply with a small surplus, implying that there will be sufficient cereals for feed use (see Table 1).

In both industrial and transition countries, overall cereal supply will be greater than demand (Table 1). The developing countries will experience a shortage of cereal supply. Feed use of cereals will more than double, increasing from 222 million tonnes in 1997/99 to 573 million tonnes in 2030. Food use will increase from 790 million tonnes in 1997/99 to 1185 million tonnes in 2030, an increase of 50%. There will be a deficit in cereal supply of 190 and 265 million tonnes in 2015 and 2030, respectively, an increase from 103 million tonnes in 1997/99 (Table 1).

Because of the faster increase in feed use of cereals, cereal feed shortage will be on the increase in developing countries. Table 2 provides a summary of net trade balances of wheat, coarse grains and rice. The shortage of coarse grains, primarily used for animal feed, will increase from 43 million tonnes in 1997/99 to 89 and 128 million tonnes in 2015 and 2030, respectively, in developing countries.

The Asian perspective

In the next three decades, Asia will become an increasingly important feedgrain user and a major feedgrain importer. In the FAO projections, Israel and Japan are treated as industrial countries and we will look into their feedgrain demand later. Here we first examine the likely feedgrain demand and supply and the import needs in developing countries in Asia.

By 2030, developing countries as a whole will become a major feedgrain user, accounting for about 50% of total world feedgrain use (573 million tonnes out of 1148 million tonnes, see Table 1).

Table 2. Net trade balances of wheat, coarse grains and rice (m t)

	1997/99	2015	2030
Developing Countries			
All Cereals	-102.5	-190	-265
Wheat	-61.8	-104	-141
Coarse Grains	-43.2	-89	-128
Rice (milled)	2.5	3	5
Industrial Countries			
All Cereals	110.7	187	247
Wheat	66.0	104	133
Coarse Grains	43.4	83	115
Rice (milled)	1.4	0	-1
Transition Countries			
All Cereals	0.9	10	25
Wheat	-0.3	4	12
Coarse Grains	2.1	8	15
Rice (milled)	-0.9	-1	-1

Source: Bruinsma (2003, p. 78)

On the other hand, a large portion of the 573 million tonnes of feedgrains will be consumed in developing countries in Asia. Thus, developing countries in Asia will be the major feedgrain users and major feedgrain importers. This can be predicted by examining the projections in Table 3. Countries in sub-Saharan Africa are unlikely to consume and import feed cereals to any great extent. Per capita cereal food consumption in this region is low and increasing. Coupled with the very high proportion of cereal food use, there will be hardly any major increase in the use of cereals for animal feed in the next couple of decades in sub-Saharan Africa. In Latin America and the Caribbean region, the proportion of cereal food use is the lowest, implying that a large portion of cereals is used for animal feed. However, while countries in this region together will consume a relatively large amount of feedgrains, they will not become major feedgrain importers. This is because cereal import needs are small and the self-sufficiency rate (SSR) in this region is likely to rise.

Table 3. Cereal balances by developing regions, all cereals
(wheat, rice [milled], coarse grains) *

	Per Capita Demand		Total Demand			Production (m t)	Net Trade (m t)	SSR (%)
	Food (kg)	All Uses (kg)	Food (m t)	All Uses (m t)	% of Food Use			
Sub-Saharan Africa								
1997/99	123	150	71	86	83	71	-14	82
2015	131	158	116	139	83	114	-25	82
2030	141	170	173	208	83	168	-40	81
Near East/North Africa								
1997/99	209	352	79	133	59	83	-49	63
2015	206	368	107	192	56	107	-85	56
2030	201	382	131	249	53	133	-116	54
South Asia								
1997/99	163	182	208	234	89	239	3	102
2015	177	200	295	335	88	323	-12	97
2030	183	211	360	416	87	393	-22	95
East Asia								
1997/99	199	290	366	534	69	507	-23	95
2015	190	317	404	675	60	622	-53	92
2030	183	342	422	787	54	714	-73	91
Latin America and the Caribbean								
1997/99	132	285	66	142	46	125	-14	88
2015	136	326	85	203	42	188	-16	92
2030	139	358	99	257	39	244	-13	95

* In the FAO report, 'Developing Countries' are further divided into five developing regions: Sub-Saharan Africa, Latin America and the Caribbean, Near East/North Africa, South Asia, and East Asia. The latter three are relevant for discussions in this paper regarding feed demand and supply in the Asian region. The Near East/North Africa group includes four North African countries: Algeria, Egypt, Morocco and Tunisia. In discussions in this paper, when necessary, adjustments are made to exclude the statistics of these four countries. It is also noted that South Korea was treated as a developing country and is placed in the 'East Asia' group. On the other hand, Israel and Japan are placed under the 'Industrial Countries' group.

Source: Bruinsma (2003, p. 68).

Major users and importers of feedgrains are therefore expected to be within Asia. Countries in East Asia and the Near East/North Africa are likely to be major users and importers of cereal feed. Cereal import needs are the largest in the Near East/North Africa region where SSR is the lowest among all the

developing regions and is forecast to decline. The share of cereal food use in East Asia is expected to decline at the fastest rate among all the developing regions and hence a major increase in cereal feed use is expected to occur in East Asia in the next couple of decades (see Table 3). On the other hand, countries in South Asia are unlikely to use a large amount of feedgrains. This is due to their dietary habits. People in these countries consume much less livestock product, except for milk. This has resulted in a very high proportion of cereal use for food. In addition, the SSR is high and import requirements are relatively small. The overall feedgrain demand in Asian developing countries will account for around 70% of total demand in developing countries, being about 270 million tonnes in 2015 and 400 million tonnes in 2030. [1]

Now, let us take the feedgrain demand in Israel and Japan into consideration. Feedgrain demand as shown in Figure 1 is based on USDA's database and includes several major feed cereals, namely, corn, sorghum, barley and feed wheat. [2] Feedgrain use in Japan peaked in the late 1980s and early 1990s and

has since declined. Israel's feedgrain use has been increasing steadily (see Figure 1). According to USDA projections, Japan's demand for feedgrain is likely to continue to decline (USDA 2003a). However, unless Japan significantly increases its imports of livestock products or its demand for livestock products drop dramatically, or both, the decrease in demand for feedgrain will be relatively small. Given that Israel's demand for feedgrain has been steadily increasing, let us simplistically assume that the total demand from these two countries will remain at the present level, i.e. about 18 million tonnes, for the next 30 years. Then, adding this to the total demand by developing Asian countries, total feedgrain demand in Asia will be around 290 and 420 million tonnes in 2015 and 2030, respectively. Thus, feedgrain demand in Asia alone will account for 32% and 37% of total world demand by 2015 and 2030, respectively.

Figure 1. Feedgrain use in Japan and Israel
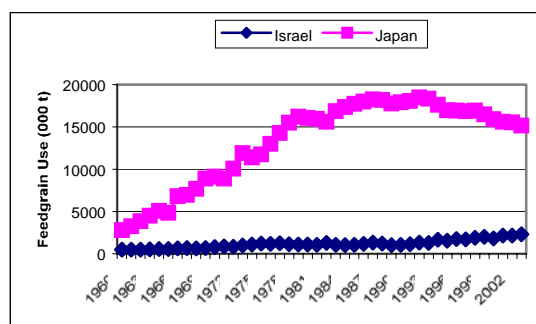
Source: Based on USDA (2003b).

Hence, feedgrain demand in Asia will remain strong in the next several decades. The key driving forces for this strong demand for feedgrains in Asia have been income growth and urbanisation – both of which have led to strong demand for animal products (Laffan 2003, Wang et al. 2004). However, due to a shortage of agricultural resources, especially land, animal production in the Asian region has become increasingly intensified (Bruinsma 2003, pp. 164-66).

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[1] Based on Table 3, feedgrain demand for each developing region is first worked out. Feedgrain is equal to 'all uses' minus 'food use' and 'other use'. Other use is calculated by making reference to the proportion of 'other use' out of 'all uses' that is available in Bruinsma (2003, p. 75). Then, total demand for feedgrain in Asia in 2015 and 2030 is derived by adding the demand in each of the three sub-regions: Near East/North Africa, South Asia and East Asia. The Near-East/North Africa sub-region contains several African countries (Algeria, Egypt, Morocco and Tunisia). In 2003, these countries used about 13 million tonnes of corn for feed purposes. It is assumed that their feed use of all cereals will be 18 and 23 million tonnes in 2015 and 2030, respectively, which are taken away from the Asian sums.

[2] In Japan, corn is by far the largest feed item. In the early 1970s sorghum accounted for a major portion in the feedgrain use (highest being 45% in 1970, equal to corn's proportion) but has dropped gradually to about 10% at present. In Israel, sorghum used to be the major feed item in the late 1960s and early 1970s but recently corn and feed wheat have replaced sorghum and become major feed items followed by barley.

Intensification requires more feedgrains. Asia's limited ability to expand cereal production means that Asia will increasingly rely on feedgrain imports from the international market.

In fact, most major feedgrain importers are in Asia. Japan has been the world's largest feedgrain importer for some years. Let us take corn as an example. [3] In 2003, Japan imported 16500 million tonnes of corn, accounting for 21% of total world imports, which were 77520 thousand tonnes. This is followed by South Korea, which imported 9500 thousand tonnes of corn, accounting for 12% of total world imports. South Korea has in recent years become another major feedgrain importer and almost all its feedgrain needs are met through imports. Corn imports by Japan and South Korea alone accounted for one-third of the world total imports. Figure 2 lists all major corn importers who imported not less than one million tonnes of corn in 2003, and shows that half of them are from Asia with the key importers in East Asia. Altogether, Asia's corn imports in 2003 accounted for over 50% of total world imports.

Projections by FAO suggest that Asia's strong demand for feedgrain imports will continue. This is also endorsed by USDA projections. Table 4 shows that in the next decade Asia's corn imports will continue to account for over 50% of world total imports.

The China factor

No discussion about global feedgrain demand and supply would be complete without addressing China's demand and supply. Indeed, the rapid expansion of worldwide livestock production in the past few decades is to a large extent attributable to the remarkable growth of livestock industries in China. During 1989-99, world annual growth rate of total livestock production was 2%. Excluding China, this rate, however, was merely 0.8% (Bruinsma 2003, p. 161). Not surprisingly, the demand for feedgrains by China's fast expanding livestock industries has attracted much attention and many researchers projected that China's demand for feedgrain would increase rapidly and China would need to import a large quantity of feedgrains, especially after its WTO accession.

Some earlier studies predicted that by 2000 China's feedgrain supply would not be sufficient to meet its rapidly expanding demand. They suggested that China would need to import a large quantity of feedgrains to satisfy its strong demand and the imports would be over 20 million tonnes. The fact is that in 2000 China exported over 10 million tonnes of feedgrains. [4] Since 2000, China has been exporting feedgrains of approximately 10 million tonnes per annum. This was the case even after China's accession to the WTO in late 2001. During 2002-2003, China net exported over 20 million tonnes of feedgrains.

Deviations in projections from the realised actual observations are not something new. Nonetheless, some

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[3] While some coarse grains are used for brewing purposes or for human direct consumption, a large portion of coarse grains is used for animal feed. On the other hand, corn constitutes a major portion of coarse grains and is still the most popular ingredient used for feed purposes. Corn also accounts for a major portion of traded coarse grains, being about 75%.

[4] Corn is the major feedgrain item in China. Some other minor cereals are also used for feed purposes but the quantity is small. In recent years, a small portion of rice and wheat has also been used for feed. Feedgrain export is mainly corn export. In the future, when China imports feedgrains, corn will also be the major item that will be imported unless other feed cereals have clear price advantages (Xin et al. 2003). In this paper, China's feedgrains trade primarily refers to corn trade. Given that China is cautious about its food security, when there is the need for China to import grains, China will most probably try to meet the demand for foodgrains with domestic supplies but import feedgrains. Hence, China's future grains import may be largely composed of feedgrains (Zhou and Tian 2003a).

Table 4. World corn trade baseline projections (m t)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Importers												
European Union [a]	2.8	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.0
Former Soviet Union [b]	0.8	0.8	1.0	1.2	1.2	1.3	1.3	1.3	1.4	1.6	1.6	1.7
Egypt	4.8	5.2	5.2	5.4	5.7	5.7	5.9	6.1	6.4	6.5	6.5	6.6
Other N. Africa & Middle East [c]	10.2	9.2	9.8	10.3	10.4	10.7	10.9	11.1	11.4	11.7	12.0	12.3
Japan	16.4	15.5	15.4	15.3	15.2	15.1	15.0	14.9	14.8	14.7	14.6	14.5
South Korea	8.6	8.5	8.5	8.5	8.5	8.7	8.8	8.9	9.1	9.2	9.3	9.5
Taiwan	4.4	4.3	4.5	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.8	4.8
China	0.1	0.1	0.3	0.7	1.6	2.4	3.0	3.7	5.0	5.8	6.8	7.3
Indonesia	1.1	1.2	1.3	1.5	1.6	1.7	1.8	1.9	1.9	1.9	2.0	2.0
Malaysia	2.4	2.4	2.6	2.8	2.8	2.9	2.9	3.0	3.0	3.1	3.2	3.2
Other Asia & Oceania	2.2	2.6	3.3	3.8	4.1	4.2	4.5	4.7	4.7	4.9	4.9	5.0
Mexico	4.0	6.5	6.8	6.9	7.4	7.7	8.0	8.3	8.6	8.7	9.0	9.4
Central America & Caribbean	3.6	3.5	3.5	3.6	3.6	3.7	3.8	3.9	4.2	4.5	4.6	4.9
Brazil	0.4	0.5	0.8	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Other South America	4.7	5.0	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9
Sub-Saharan Africa [d]	2.3	1.4	1.5	1.7	1.7	1.8	1.8	1.8	1.9	1.9	2.0	2.0
Other foreign [e]	5.3	4.6	2.2	2.3	2.2	2.3	2.4	2.4	2.6	2.7	2.8	2.9
United States	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total trade	74.2	74.1	74.5	76.8	79.1	81.2	83.2	85.5	88.6	90.7	93.0	94.8
Exporters												
European Union [a]	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
China	8.6	10.0	8.0	6.0	5.0	4.3	4.1	3.9	3.6	2.3	2.1	1.9
Argentina	9.5	8.1	8.5	9.8	10.1	10.3	10.7	11.0	11.5	11.9	12.3	12.7
Brazil	1.5	1.2	1.0	0.9	0.8	0.7	0.7	0.7	0.7	0.6	0.6	0.6
Republic of South Africa	1.4	1.6	1.3	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8
Eastern Europe	3.2	2.5	2.8	3.4	3.8	4.6	5.0	5.3	5.6	6.0	6.7	7.0
Former Soviet Union [b]	0.4	0.4	0.4	0.2	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.5
Other foreign	1.6	1.4	1.5	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
United States	48.0	48.9	50.8	53.3	55.9	57.8	59.1	61.0	63.5	66.0	67.3	68.6
US trade share (%)	64.6	66.0	68.2	69.5	70.7	71.2	70.9	71.3	71.7	72.8	72.4	72.3

[a] Excludes intra-EU trade, covers EU-15.
[b] Includes intra-FSU trade.
[c] In the FAO report, 'Near East' is used, instead of 'Middle East'. See the note to Table 3.
[d] Includes Republic of South Africa
[e] Includes unaccounted.

Source: Adapted from USDA (2003a, p. 117).

understanding of the causes that might have led to such deviations is useful.

A detailed account on the possible causes is available in a GRDC report on China's feedgrains market, entitled *China's Regional Feedgrain Markets: Developments and Prospects* (Zhou and Tian 2003a). According to this report, fundamental to the discrepancies are problems of China's data availability, data coverage, data reliability, model choice by researchers, and researchers' understanding of some realities that are peculiar to China, such as diverse feeding practices and uncertain policy

environments. These problems result in the derivation of different income elasticities, feed-meat conversion ratios, and animal product demand projections, which then lead to projections that differ between researchers or that deviate from the actual observations.

Some studies may have also overestimated China's total feedgrain demand and feedgrain import requirements for the next couple of decades. According to some projections, China's feedgrain supply in 2010 will be approximately 280 million tonnes, while demand will be some 310 million tonnes, or even higher at 345 million tonnes.

Figure 2. World major corn importers in 2003
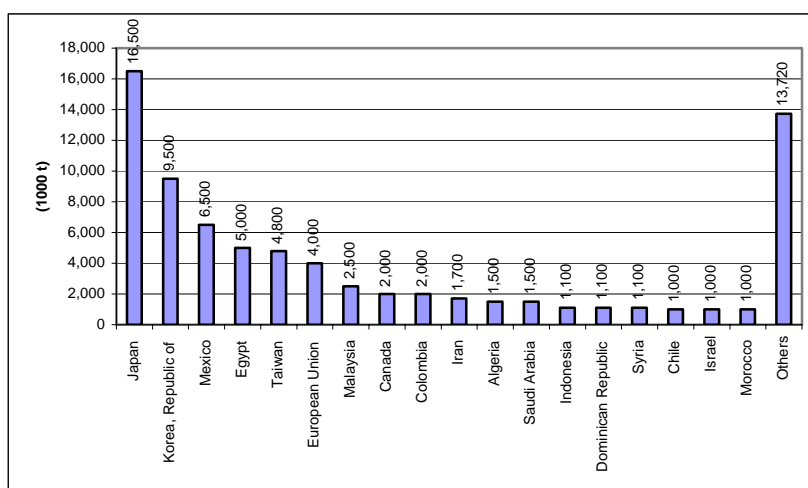
Source: Based on USDA (2003b).

Thus, by 2010, China would require feedgrain imports of some 30 million tonnes or even more (for a more detailed survey of existing feedgrain projections, see the GRDC report by Zhou and Tian 2003a). However, based on the GRDC report, China's feedgrain demand and import requirement in 2010 is likely to be much smaller than some earlier projections. Simulations in the report reveal that technological improvements in animal raising, income growth, and the export growth of animal products all have relatively greater impacts, compared to other simulated factors, on the demand for feedgrains. Assuming that technological progress and income growth will maintain their current rates to 2010, China's demand for feedgrains is expected to grow by 27-30% by 2010, and domestic feedgrain production, by 25-28% (Scenarios 6 and 7 in Table 5). China's demand for feedgrain in 2010 will be around 202 to 207 million tonnes and the supply of

feedgrains will be in the range of 199 to 203 million tonnes. Feedgrain import will be in the range of 3 to 4 million tonnes.

China may need to import more feedgrains if it experiences a faster per capita income growth and is able to export livestock products to the world market. Currently, consumer income growth and ability to export livestock products are the two major constraints on further expansion of China's livestock industries. There has been a slowing down in consumer income increase in both urban and rural areas in the past several years.

During 1997-2002, per capita income growth in urban areas was 8.3%, down from 20.5% during 1992-97. In rural areas, it was only 3.4% during 1997-2002, down from 21.7% during 1992-97. Most notable is the decline in income in rural areas, where 70% of the country's population reside. On the other hand, China's ability to export its

Table 5. China's feedgrain demand and supply after WTO: simulation results

	Supply (m t)		Demand (m t)		Price (RMB ¥)		Deficit (Demand - Supply)
	+/-%	Total	+/-%	Total	+/-%	Total	(m t)
Base (1999)		159		159		1081	0
Scenario 1	1.46	161	1.46	161	-2.54	1054	0
Scenario 2	-2.86	154	-2.86	154	-13.80	932	0
Scenario 3	1.19	161	2.90	164	5.74	1143	2.72
Scenario 4	0.86	160	2.51	163	4.12	1126	2.62
Scenario 5	-2.12	156	-2.12	156	-4.87	1028	0
Scenario 6	27.90	203	30.25	207	13.76	1230	3.73
Scenario 7	25.22	199	27.26	202	3.42	1118	3.24

Base Scenario: Derived by using a non-linear programming solver (GAMS) based on the 1999 estimated feedgrain demand and supply balance sheet.
Scenario 1: Technological improvements in feedgrain production, elasticity of production=0.8, R&D growth rate=0.4Scenario 2: Technological improvements in animal raising, leading to a 10% decrease in derived demand for feedgrain.
Scenario 3: Income growth, per capita income growth=8%, income elasticity of demand for feedgrain=0.8.
Scenario 4: Growth in export of livestock products, increases in export by 5%.
Scenario 5: Imposition of restrictions on regional trade flows, very heavy restrictions. Scenario 6: Demand and supply in 2010, elasticity of production=0.5, R&D growth=4%, income growth=4%, income elasticity of demand for feedgrain=0.8.
Scenario 7: Demand and supply in 2010, elasticity of production=0.5, R&D growth=4%, income growth=4%, income elasticity of demand for feedgrain=0.6.

Source: Zhou and Tian (2003b..

livestock products to the world market, especially to high-income markets, is limited due to the insurmountable barriers of SPS and TBT categories. In addition to these two variables, whether the Chinese will consume more livestock products or aquatic products remains to be seen when their income further increases.

Assuming that there will be a faster increase in consumer income (Scenario 3) and that China can increase its livestock product export (Scenario 4) (though both are unlikely in the near future), a further 5.3 million tonnes of feedgrain may be demanded and imported from the world market. This would lead China's feedgrain demand in 2010 to being in the vicinity of 210 million tonnes and its import requirement to being still less than 10 million tonnes. This suggests that, in the near future, China is unlikely to become a large net importer of feedgrains.

In the past few years, China has been a major exporter of feedgrains (chiefly, corn). This may change in the foreseeable future because of reduced domestic grain supply. The following forces, when combined, will lead to China's reduced feedgrain export. (1) China's total grain output has been low for four consecutive years. (2) Feedgrain export was high for several years. (3) Grain import was low. (4) In the meantime, domestic grain demand increases steadily. This reduces the level of stock and China cannot continue this pattern of grain distribution for too long without substantial domestic grain output increases. Indeed, following a grain price hike in late September and early October in 2003, China's corn export has already been curtailed.

It can be expected that China's corn export will be significantly reduced. It is most likely that China will start to import feedgrains from the international market and on the other hand will continue to export feedgrains but in smaller amounts. China will continue to be an exporter of feedgrains due to regional supply and demand differences – Northern China runs a corn surplus while Southern China has a corn deficit. The proximity to South Korea and other Asian markets provides a ready source of demand for corn exported from Northern China (Zhou and Tian 2003b).

The USDA Agricultural Baseline Projections also suggest that China's feedgrain import will be on the increase while its export will decline (see Figure 3). According to the projections, it will not be until 2008 that China's corn imports will surpass its exports to become a net feedgrain importer. However, the USDA's projections are based on a set of 'normal' circumstances (USDA 2003a, p. iii). It is most unlikely to take 4-5 years for China's feedgrain import to surpass its export. On the other hand, it is interesting to note that, under those 'normal' situations, the import needs in 2010 as projected by the USDA are surprisingly close to the simulation results as presented in the GRDC report (see Table 5, Scenarios 6 and 7), lending support to the claim that China's import needs are unlikely to be large by 2010.

Figure 3. China's corn imports and exports: projections
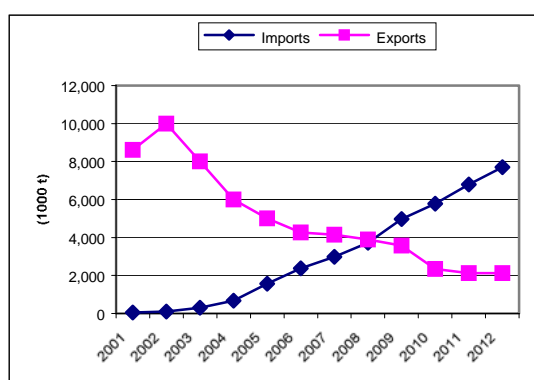
Source: Based on USDA (2003c).

What, then, are the likely import needs of China after 2010? It is hard to anticipate – too many uncertainties exist and China's policy environment continues to be a most uncertain factor. If we extrapolate on the basis of trends in Figure 3, then China's net corn import will not reach 10 million tonnes until 2017, and by 2020, China's net import would be still less then 13 million tonnes. Considering the size of China's total grain output, this amount is relatively small. Hence, even in the longer term, China's grain import may still be relatively small. Coincidentally, the recently released FAO report presents a similar view that China will not become a permanent large net cereal importer in the future (Bruinsma 2003, p. 71).

Conclusions and Implications

Driven by the increasing demand for animal products, especially in developing countries, globally the next three decades will see a strong increase in demand for feed, especially cereal feed. Feed will be the most dynamic element driving the world cereal economy and will account for an ever-growing share in aggregate demand for cereals.

Feedgrain demand in Asia, especially East Asia, will remain strong in the next several decades. Asia will become an increasingly important feedgrain user and a major feedgrain importer. The demand for feedgrains in Asia will account for 32% and 37% of total world feedgrain demand by 2015 and 2030, respectively. Due to Asia's limited ability to expand cereal production, Asia will increasingly rely on feedgrain imports from the international market.

China has recently become a major user of feedgrains, consuming about 160 million tonnes of feedgrains in 1999. This accounts for about a quarter of world feedgrain usage and 70% of feedgrain consumption in developing countries. So far, China has been able to meet such a strong demand with domestic supply. China's future demand for feedgrains will critically depend on its income growth and its ability to export. China may soon import feedgrains from the international market; the amount of imports, however, is unlikely to be large in the foreseeable future.

The strong demand for cereal feed globally and in the Asian region in particular offers an enormous opportunity for Australian cereal producers. Given that demand for feedgrains is a derived demand for animal products, Australian farmers in other related industries will also benefit

from the strong demand for feedgrains and for animal products. Potential for the export of cereals, other Australian feedstuff (such as hay products and concentrate meals), and animal products is expected to increase.

- *Cereals* Australia will be one of the major cereal exporters in years to come. However, Australia is likely to be a major food cereal exporter but unlikely to become a major cereal feed exporter. Australia's potential to produce a large quantity of corn for animal feed is limited, confined by agronomic conditions and the relative lower returns (e.g. compared to sorghum). In Australia, wheat (low grade) and barley (higher protein or low grade) are the two major feedgrain items. But a significant portion of these cereals is used by domestic livestock industries, resulting in a relatively small and unstable surplus supply of feedgrains. Australia will therefore be most likely a small player in the international feedgrain market but will continue to be a major foodgrain exporter. Indeed, Australia has a well-established international reputation in the supply of premium quality food wheat and malting barley and it pays for Australia to continue to be a premium quality foodgrain supplier. However, given that feed use of cereals will become the most dynamic element in driving the world cereal economy and it will account for an ever-growing share in aggregate demand for cereals, for long-term strategic planning, it is useful for the Australian grains industry to take the dynamics of cereal use into consideration.

- *Other feed materials* In the longer term, relatively backward animal production systems in many developing countries will be transformed into new ones that can respond to demand for higher quality and differentiated products. This will generate demand for high protein feed ingredients such as meatmeals and oilmeals. The potential of lupin export can be further explored, especially in Western Australia. Another area with promising potential is to export hay products. The production of hay through rotation helps to control weeds and prevent the development of herbicide resistance in weeds. Deep-rooted perennials can grow over summer and hence lower the water table, thus helping to reduce the salinity problem. When exporting, the problem of 'bulk' could be reduced by processing, e.g. into pellets. Market promotion is necessary to educate the potential users about the values of such products.

- *Animal products* Not only will the developing countries in the Near East/North Africa and East Asia be the major feedgrain importers, they will also be the major animal product importers. For example, by 2030, meat import requirements in these two regions together will increase to over 7.5 million tonnes from less than 2 million tonnes in 1997/99, and the import requirements of milk and dairy product (in whole milk equivalent) will increase to 25.5 million tonnes from a little over 11 million tonnes in 1997/99. Most notable is the increase in meat import requirements in developing East Asia, from 0.73 million tonnes in 1997/99 to 4 million tonnes in 2030 (Bruinsma 2003, p. 96). When the demand by Israel and Japan is added, the total animal product import requirements in these two regions of Asia are much larger. Hence, Australian livestock industries are also expected to benefit from the increasing shortage of animal product supply in Asia, and East Asia in particular due to geographic proximity.

Acknowledgements

References

Bruinsma J (ed.) 2003, *World Agriculture: Towards 2015/2030, An FAO Perspective*, Earthscan, London.

FAO (Food and Agriculture Organisation of the United Nations) 2002, *World Agriculture: Towards 2015/2030*, *Summary Report*, FAO, Rome.

Laffan J 2003, 'Asian agrifood demand trends and outlook to 2010', paper presented to a seminar at the Asian Agribusiness Research Centre of the University of Sydney, 3 December 2003, Orange, Australia.

USDA (United States Department of Agriculture) 2003a, USDA Agricultural Baseline Projections to 2012, Office of the Chief Economist, Staff Report, WAOB-2003-1, Washington, DC.

USDA 2003b, 'PS&D Online Data', database maintained by Foreign Agricultural Service, available at http://www.fas.usda.gov/psd/complete_files/default.asp (accessed on 27 January 2004).

USDA 2003c, '2003 International Baseline Projections to 2012', database maintained by Economic Research Service, available at http://www.ers.usda.gov/data/internationalbaseline (accessed on 28 January 2004).

Wang JM, Zhou ZY and Cox R 2004, 'Animal product consumption trends in China', research report to Meat and Livestock Australia, Asian Agribusiness Research Centre, the University of Sydney, Australia.

Xin X, Tian W.M. and Zhou ZY 2003, 'China's feedgrains production and marketing', in Zhou, Z.Y. and Tian, W.M. 2003, *China's Regional Feedgrain Markets: Developments and Prospects*, Grains Research and Development Corporation, Canberra, pp. 63-75.

Zhou ZY and Tian WM 2003a, *China's Regional Feedgrain Markets: Developments and Prospects*, Grains Research and Development Corporation, Canberra.

Zhou ZY and Tian WM 2003b, *Feedgrains Market Development in China and Implications for Australia, summary report*, Grains Research and Development Corporation, Canberra.

Zhou ZY, Tian WM and Liu XA 2003, 'Developments and trends in household animal raising practice in China: a survey report', in Zhou ZY and Tian WM 2003, *China's Regional Feedgrain Markets: Developments and Prospects*, Grains Research and Development Corporation, Canberra, pp. 76-107.