

Feedstuffs
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Land Use, Production to Shape China's Future
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Feedstuffs Utilization and Production

Cattle accounted for about 26 percent of all ME and 14 percent of CP requirements by animals and aquaculture in China in 2007 (Table 7). Those proportions are projected to increase to 36 and 20 percent, respectively, 2030. Pigs have been, by far, the largest user of feedstuffs, accounting for 32 percent of ME and 41 percent of CP in 2007. Those proportions are projected to decline to 25 and 27 percent in 2030. Nutrition, particularly type of feedstuffs, is central to understanding the extent to which China can meet the great increases projected in livestock and aquaculture to meet changes in demand for them.

Each country feeds its animals according to resource availabilities, tastes and preferences, food safety desires, and comparative advantage in production of feedstuffs. This is a key point to understand and project China's livestock structure. For example, Americans have come to believe that large-scale feedlot type grain-fed beef is the standard for quality and production cost-effectiveness. Consequently, they believe that China will inexorably move toward such a system, and since China's grain production capacity is in doubt, substantial feedstuffs imports will thus be required. This is unlikely to happen, as the Australians Longworth, Brown and Waldron (2001)

pointed out a decade ago. The issue is a very important one and should be a major focal point of agricultural policy planning.

Energy feedstuffs availabilities are calculated to have been 1,309,210 million Mcal in 2007 (Table 8). Twenty nine percent of that was derived from principal crop sources, which essentially means harvested grains or seed heads fed directly to livestock. That proportion will increase marginally to 31 percent by 2030 as the industry and economy mature, still leaving 69 percent from other sources. By products, which includes silage in this definition, accounted for 21 percent in 2007 and is expected to grow to 26 percent in 2030 at which time animal and aquaculture energy requirements will reach 1,824,258 million Mcal. The largest proportion in both periods is crop residues, 38 percent in 2007, declining to 33 percent as the economy matures.

Protein sources are significantly different since byproducts accounted for 48 percent in 2007, increasing to 51 percent in 2030. Crop residues remain about the same, 28 and 26 percent for those two periods.

Crop Yields

Crops were divided into two types for projections, major and minor. Ten, chosen as major crops, account for about two thirds of sown (harvested) area (Table 9). Yield growth rates for the ten were ascertained by evaluating six factors that affect them; fertilizer, land reclamation, irrigation, seed variety, soil improvement, and “other” which includes management, mechanization, etc., as well as natural resource conditions in China, and international yields and conditions. Yield growth rates for the 24 minor crops for which published data are available (data not shown) were determined by evaluation of past growth rates, domestic and international demand and markets, and technology adoption by farmers and international yields. Sown areas

for each were set by consideration of past growth rates, comparison of the impact on total production by yield increases and probable demand for them.

China's yields in the major crops are generally lower than in most economically developed countries, with the exception of cotton and wheat (Table 9). For example, maize yield in the United States averaged 9,491 kg in 2007 while in China was 44 percent less, 6,674 kg. Maize yields in China grew a relatively slow 1.0 percent annually from 2000-2007 but are projected to grow an average of 2.1 percent annually over the next 20 years. However, even at that rate the yield would only reach 8,701 kg, 8 percent below the US yield in 2007. The point is that comparison of the yield projections for 2030 among the ten major crops with five other countries in 2007 reveal projections for China are conservative considering the potential for yield increases due to advances in biotechnology and agricultural restructuring.

Land Use

Considerable latitude exists for yield enhancement in China from a comparative international point of view. On the domestic side, land reclamation and structural production improvement led to sown (harvested) area remaining about the same between 2000 and 2007 (about 155 million ha) despite considerable cultivated land being converted to non-agricultural uses. Sown area is projected to increase slightly to 2015, and then decline at an accelerated rate to 153 million ha in 2030 (Table 10).

Land will continually be reallocated to non-agricultural use and the multiple crop index is one important factor in answering the question of how it will impact agricultural production. Calculation of this index has been, and continues to be, problematic due to statistical discrepancies highlighted in China's first agricultural census in 1996.

The multiple crop issue is crucial because of the need to determine if projections of the sown area are realistic. The approach taken in the modeling was to evaluate historical multiple crop index's, which were 1.17 in 1995, 1.22 in 2000, and 1.28 in 2007. Clearly, there will come a time when the index can no longer rise. A conservative path was followed, with the index only growing to 1.32 by 2030. The result is cultivated cropland declining from 121.8 million ha in 2007, to 116.2 million ha in 2030. In effect, it can be concluded that the sown area projections are at least reasonable.

The implications of the sown/cultivated area analysis is that, as irrigation water becomes scarcer, placing greater constraints on crop yield growth, it will be imperative that crop research and extension continue to be expanded, and technology adoption accelerated, if China is to meet increased demand for food and animal feedstuffs. In particular, given the projected shortfall in protein, it would appear that research should be focused on oilseed crops and adjustments in planting them, and expanded use of crop residues rather than energy oriented grain crops.

The projections of total production of cereal crops, following the PRC (Peoples Republic of China) definition, are for expansion from 463 million tons in 2007 to 559 million tons in 2020, and 629 million tons in 2030 (Table 11). Coarse grains are projected to grow from 163 million tons in 2007 to 268 million tons 2030 (using the international and USDA definition of coarse grains). Oilseed crops, following the PRC definition, are projected to grow from 27 million tons in 2007, to just 32 million tons in 2030, a 19 percent increase, unless there is some policy to shift more resources into additional oilseed crop production to meet projected protein shortfalls. There was a slight decline in oilseed production from 2000 to 2007.

Crop Residues

Crop residues in China account for nearly all of what are known as nonconventional feed resources (NCFR). Most of the more minor NCFR such as processing waste from canning fruit are included in the by-products category in the modeling. Residues, a major source of both energy and protein, were calculated to have accounted for 38 percent of ME and 28 percent of CP availabilities as feedstuffs (in effect, utilization, fed to animals) in 2007 (Table 8). Among them, wheat accounted for 16 percent, rice 18 percent and maize 36 percent for a total of 70 percent of protein from all residues (data not shown). Other residues include vines, roots and tubers, other field crops, vegetables, tree crops and non-crop sources. In 2007, 947 million tons of roughages were produced in China of which 417 million tons, 44 percent, were fed to animals (Table 12). The remainder is burned in the field, used as fuel and for making cellulosic products such as paper. The proportions of roughages produced change over time. For example, in 2007 vines, straw and stover accounted for 83 percent of roughages, and silage 17 percent. It is projected that by 2030 silage will account for 27 percent of the total.

Table 7. Metabolizable energy and crude protein requirements by species groups, China, economy robust, 2006-2008 and 2030

SPECIES	Total requirements		Species Proportions	
	ME	CP	ME	CP
	-Million Mcal-	-1000 MT-	----- Percent -----	
			<u>2006-2008</u>	
Draft/beef cattle	432,491	10,752	26	14
Other large animals	160,159	6,624	10	9
Total large animals	592,650	17,376	36	23
Small ruminants	164,713	6,229	10	8
Pigs	534,133	31,076	32	41
Poultry	134,539	8,170	8	11
Aqua products (cultivated)	226,483	13,607	14	18
Total	1,652,518	76,459	100	100
			<u>2030</u>	
Draft/beef cattle	760,922	23,743	36	20
Other large animals	117,386	5,562	6	5
Total large animals	878,309	29,305	41	25
Small ruminants	249,599	10,087	12	9
Pigs	539,991	31,872	25	27
Poultry	264,414	23,768	12	20
Aqua products (cultivated)	198,930	21,622	9	19
Total	2,131,242	116,654	100	100

Source: Simpson , modeling results.

Table 8. Metabolizable energy and crude protein feedstuffs availabilities for animals and aquaculture by feedstuffs categories, China, economy robust, 2006-2008 to 2030

Item	2006-2008	2015	2020	2030
	<u>Metabolizable energy</u>			
	-----Million Mcal-----			
By-products (1)	268,521	338,786	396,702	478,369
Crop residues and other NCFR	502,032	595,927	576,687	598,167
Grassland	156,511	167,712	171,153	174,435
Principal crop (2)	382,147	431,182	484,316	573,286
Total	1,309,210	1,533,608	1,628,858	1,824,258
	-----Percent-----			
By-products	21	22	24	26
Crop residues and other NCFR	38	39	35	33
Grassland	12	11	11	10
Principal crop	29	28	30	31
Total	100	100	100	100
	<u>Crude protein</u>			
	-----1,000 MT-----			
By-products	28,065	30,881	35,965	42,047
Crop residues and other NCFR	16,431	20,720	20,655	22,053
Grassland	5,529	5,931	6,120	6,277
Principal crop	8,247	10,732	12,009	14,082
Total	58,272	68,264	74,749	84,460
	-----Percent-----			
By-products	48	45	48	50
Crop residues and other NCFR	28	30	28	26
Grassland	9	9	8	7
Principal crop	14	16	16	17
Total	100	100	100	100

Source: Simpson , modeling results.

(1) Includes silage.

(2) Essentially grains or seed heads fed to livestock.

Table 9. Growth rate in technology and adoption, and yield per hectare of major crops, China economy robust, 1994-1996 to 2030 and comparison with other countries

Item	Seed	Maize	Rape	Paddy	Sorghum	Soybeans	Wheat	Barley	Triticale	Ground
	cotton		seed	rice						nuts
Growth rate in technology (1)										
-----Compound annual growth rate yield in percent-----										
1994-1996 to 2006-2008	-0.21	0.67	2.59	0.54	0.66	-0.57	2.24	2.75	-9.33	1.50
1999-2001 to 2006-2008	1.81	1.00	1.59	0.22	3.12	-0.42	1.64	2.10	-9.76	0.73
2006-2008 to 2015	1.00	2.05	1.50	1.20	1.45	1.30	1.55	1.65	1.45	1.45
2015 to 2020	0.90	2.05	1.40	1.20	1.00	2.10	1.20	1.50	1.40	0.90
2020 to 2030	0.50	2.25	1.00	0.45	1.00	2.25	0.95	1.00	1.40	0.55
Yield per hectare										
-----kg-----										
1994-1996	1,500	4,939	1,359	6,018	4,314	1,722	3,567	2,696	3,077	2,682
1999-2001	1,179	4,748	1,528	6,250	3,230	1,690	3,830	2,910	3,257	2,938
2006-2008	1,462	5,350	1,847	6,418	4,670	1,608	4,654	3,734	950	3,206
2015	1,583	6,293	2,081	7,061	5,240	1,782	5,264	4,256	1,065	3,597
2020	1,656	6,965	2,231	7,495	5,507	1,978	5,587	4,585	1,142	3,762
2030	1,741	8,701	2,464	7,839	6,084	2,471	6,141	5,065	1,313	3,974
-----Percent-----										
Increase 2006-2008 to 2030										
Total	19.0	62.6	33.4	22.1	30.3	53.7	31.9	35.6	38.2	24.0
Compound annual	0.8	2.1	1.3	0.9	1.2	1.9	1.2	1.3	1.4	0.9
-----kg-----										
Yield per ha 2006-2008										
China	1,462	5,350	1,847	6,418	4,670	1,608	4,654	3,734	950	3,206
Argentina	0	6,674	1,446	6,816	4,709	2,824	2,473	3,409	0	2,554
Germany	3,749	9,096	3,644	0	0	1,000	7,416	5,809	5,637	0
Japan	0	2,556	1,306	6,445	0	1,630	4,093	3,472	0	2,283
United Kingdom	0	0	3,227	0	0	0	7,847	5,850	4,276	0
United States	2,318	9,491	1,445	7,832	4,064	2,746	2,778	3,311	0	3,519

Source: Simpson , modeling results.

(1) Modeling includes parameters on fertilizer, land reclamation, irrigation, seed variety, soil enhancement, other factors like shift to mechanization, structural change and management improvement.

Table 10. Sown (harvested) and cultivated land, and multiple crop index, China, economy robust, 1994-1996 to 2030

	Sown (harvested) area of major crops				Sown (harvested) area of minor crops			
	Total	Area	Percent	Percent of all crops	Total	Area	Percent	Percent of all crops
		change	change			change		
		from	from			from		
2006-2008	2006-2008	2006-2008	2006-2008	2006-2008	2006-2008			
	-----1,000 ha-----		-----Percent-----		-----1,000 ha-----		-----Percent-----	
1994-1996	105,377				43,519			
1999-2001	104,867				50,880			
2006-2008	103,596	-	-	66.5	52,100	-	-	33.5
2015	103,509	-87	-0.08	66.1	53,019	918	1.76	33.9
2020	102,849	-747	-0.72	66.2	52,475	375	0.72	33.8
2030	102,339	-1,257	-1.21	66.7	51,096	-1,004	-1.93	33.3

Total area of all crops based on calculations from major and minor crops (1)

Year	Sown (harvested) area							
	Total FAO base/Simpson harvested area	Change from 2006-2008	Change from 2006-2008	USDA data for 1996 used in place of 1994-1996	Published difference from revised	Year	Apparent Multiple crop index(2)	Apparent cultivated area (2)
	-----1,000 ha-----		--Percent--	--1,000 ha--	--percent--			--1,000 ha--
1994-1996	148,897			152,381	-2.29	1996	1.17	130,039.0
1999-2001	155,747			156,127	-0.24	1999-2001	1.22	128,355.0
2006-2008	155,696	-	-	155,584	0.07	2006-2008	1.28	121,755.5
2015	156,528	831.7	0.5			2015	1.30	120,406.1
2020	155,325	-371.7	-0.2			2020	1.31	118,568.4
2030	153,435	-2,261.3	-1.5			2030	1.32	116,238.6
	FAO total harvested area		FAO-USDA		USDA			
	calculated by adding all crops together	USDA cultivated land area	blend apparent multiple crop index	USDA crop sown area	USDA apparent multiple crop index			
	--1,000 ha--	--1,000 ha--		--1,000 ha--				
1996	157,306	130,039	1.21	152,381	1.17			
1997	158,452	129,903	1.22	153,969	1.19			
1998	159,761	129,642	1.23	155,706	1.20			
1999	160,784	129,206	1.24	156,373	1.21			
2000	160,235	128,243	1.25	156,300	1.22			
2001	159,528	127,616	1.25	155,708	1.22			
2002	158,320	125,930	1.26	154,636	1.23			
2003	155,689	123,392	1.26	152,415	1.24			
2004	159,260	122,444	1.30	153,553	1.25			
2005	162,316	122,067	1.33	155,488	1.27			
2006	162,619	121,776	1.34	157,021	1.29			
2007	163,434	121,735	1.34	153,464	1.26			
2008				156,266				

Sources: FAO DATASTATS, USDA and Simpson , modeling results.

(1) Note. There was a major revision in cultivated area after the first agricultural census. Data from 1995 and before were not revised.

Table 11. Production of cereal and oilseed crops, China, economy robust, 1994-1996 to 2030

Crop	1994-1996	1999-2001	2006-2008	2015	2020	2030
-----1,000 MT-----						
Production of cereal crops (PRC definition)						
Rice	187,442	189,841	188,009	205,170	214,965	219,722
Wheat	104,027	102,463	110,076	122,511	128,360	141,089
Maize	113,300	116,240	156,728	187,281	207,280	258,935
Millet	3,430	2,137	1,710	1,332	1,143	1,034
Sorghum	5,678	2,867	2,508	2,712	2,850	3,149
Other grains	5,625	3,788	3,790	4,240	4,606	5,169
Total	422,930	422,218	462,822	523,246	559,205	629,098
Production of coarse grains, international and USDA definition						
Barley	4,401	2,946	3,457	3,950	4,310	4,872
Maize	113,300	116,240	156,728	187,281	207,280	258,935
Rye	1,224	842	333	290	295	297
Oats	1,101	895	383	414	407	442
Sorghum	5,678	2,867	2,508	2,712	2,850	3,149
Total	125,703	123,790	163,410	194,647	215,144	267,695
Production of oilseed crops (PRC definition)						
Groundnuts	10,103	13,898	13,410	15,072	14,768	13,902
Rapeseed	8,823	10,948	11,214	12,537	13,266	14,321
Sesame	569	787	602	657	722	833
Sunflower	1,352	1,732	1,613	1,754	1,951	2,122
Linseed (flax)	476	333	487	526	574	621
Other oilseeds	0	0	0	0	0	0
Total	21,324	27,698	27,326	30,545	31,281	31,799
Annual increases from previous period (percent)						
Cereal crops (China definition)	--	-0.02	1.15	1.55	1.34	1.18
Coarse grains (USDA definition)	--	-0.19	3.53	2.21	2.02	2.21
Oilseed crops (China definition)	--	3.32	-0.17	1.40	0.48	0.16

Sources: FAO DATASTATS and Simpson , modeling results.

Table 12. Total residues and silage produced, fed and treated, China economy robust, 2006-2008 to 2030

Item	2006-2008	2015	2020	2030	2006-2008	2015	2020	2030
	-----1,000 TONS-----				-----Percent-----			
<u>Total residues and silage produced and proportion of the total</u>								
Vines	182,668	200,119	226,570	264,540	19	19	20	20
Straw	385,007	394,380	388,955	387,607	41	37	34	30
Stover	218,968	235,684	246,475	293,775	23	22	22	23
Residues	786,643	830,183	862,000	945,923	83	78	75	73
Silage	160,898	237,451	281,435	351,227	17	22	25	27
Total	947,541	1,067,634	1,143,435	1,297,151	100	100	100	100
<u>Total residues and silage fed to animals and proportion of the total</u>								
Vines	42,014	51,220	56,643	66,135	23	26	25	25
Straw	127,433	152,646	142,350	125,754	33	39	37	32
Stover	86,994	103,940	94,998	109,342	40	44	39	37
Residues	256,440	307,805	293,990	301,231	33	37	34	32
Silage	160,898	237,451	281,435	351,227	100	100	100	100
Total	417,338	545,256	575,425	652,458	44	51	50	50
<u>Increase in total residues and silage fed compared to base period</u>								
Vines					--	22	35	57
Straw					--	20	12	-1
Stover					--	19	9	26
Residues					--	20	15	17
Silage					--	48	75	118
Total					--	31	38	56
<u>Treated residues and proportion of their total produced</u>								
Vines	5,480	10,006	11,329	13,227	3	5	5	5
Straw	65,921	83,626	84,402	88,214	17	21	22	23
Stover	43,924	57,774	70,100	93,438	20	25	28	32
Residues	115,325	151,406	165,830	194,880	15	18	19	21
Silage	0	0	0	0	0	0	0	0
Total	115,325	151,406	165,830	194,880	12	14	15	15
<u>Treated residues and proportion that is fed to animals</u>								
Vines	5,480	10,006	11,329	13,227	13	20	20	20
Straw	65,921	83,626	84,402	88,214	52	55	59	70
Stover	43,924	57,774	70,100	93,438	50	56	74	85
Residues	115,325	151,406	165,830	194,880	45	49	56	65
Silage	0	0	0	0	0	0	0	0
Total	115,325	151,406	165,830	194,880	28	28	29	30

Sources: Simpson, modeling results with recognition of Tingshuang, Sanchez and Peiyu, 2002 for much of their basic data that was used for initiation of this work on crop residues.