The Impact of Chinese Accession to the World Trade Organization on U.S. Meat and Feed-Grain Producers

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Introduction

China's rapid economic growth and gradual transition towards a market economy have brought about significant changes in its food consumption patterns and trade behavior. With increased income and improved market accessibility, Chinese consumers, especially those in urban areas, are shifting their food consumption from grains to meats and other high-value food products (Wang, Jensen, and Johnson 1993). Between 1984 and 1996, China's per capita grain consumption declined from 142 kilograms (kg) to 94 kg in urban areas and from 267 kg to 256 kg in rural areas, whereas the per capita consumption of meats, eggs, milk, vegetable oils, and fruits increased significantly in both urban and rural areas (China's State Statistical Bureau). As a result of the ongoing transition in food consumption patterns, extremely limited per capita arable land, and significant reductions in import restrictions, China's food imports have increased dramatically in recent years. For example, China's corn trade reversed from a net export of 11.1 million metric tons (mmt) in 1993 to a net import of 5.2 mmt in 1995, while total grain imports increased from 7.3 mmt to 20.4 mmt over the same period. China has also substantially expanded its imports of high-value food products such as edible oils—which jumped from 1.1 mmt in 1993 to 3.7 mmt in 1995 (USDA 1996).

Changes in China's food situation and trade behavior have important implications for U.S. agricultural exports. China has been a large buyer of U.S. wheat since the late 1970s and is gradually becoming a major importer of many other U.S. food products such as corn, vegetable oils, and broiler meat. Figure 1 indicates that the U.S. agricultural trade balance with China reversed from a deficit of $74 million in 1993 to a surplus of $640 million in 1994 and then jumped to a record surplus of $2.15 billion in 1995. This significant turnaround in U.S. agricultural trade with China is important for the United States to narrow its trade deficit with China, which increased from $1.7 billion in 1986 to $34 billion in 1995. Figure 2 shows the changes in U.S. agricultural exports to China for four products—wheat, corn, edible oils and oilseeds, and animals and products. While U.S. wheat exports to China have declined since

1989, exports of the other three products have increased dramatically in recent years. Between 1993 and 1995, U.S. exports to China increased from $26.2 million to $409.6 million for edible oils and oilseeds, from $48.7 million to $204 million for animals and products, and from zero to $629 million for corn (USDA 1996). In spite of the rapid growth in U.S. agricultural exports to China in recent years, China is still viewed by many U.S. producers and marketers as a tough market because of its many nuances and subtleties that are not well understood. Institutional barriers such as import quotas and tariffs are partly to blame, but it cannot be denied that a simple lack of information and a failure to study the underlying mechanisms of the Chinese market also contribute to the difficulty faced by U.S. traders. China's trade liberation has been limited in many respects, but there is evidence that China's food demand and trade behavior are increasingly determined by consumers.

Trends in China's meat market and implications for U.S. exports

Data on China's annual meat production since 1984, presented in Figure 3, suggest two major trends: First, total meat production has increased gradually from 16.946 mmt in 1984 to 59.151 mmt in 1996. Second, the growth rates for poultry, beef, mutton, and other meats have been significantly higher than the rate for pork. The share of pork has declined from 85.25 percent in 1984 to 68.26 percent in 1996.

The gradual shift from pork to beef and poultry is motivated by an income-driven desire for variety and an increased availability of beef and poultry products at urban markets. Beef consumption in China continues to be extremely low. Most urban consumers must choose between the expensive beef that is generally sold to restaurants and tourists and a less expensive local product that typically comes from draft animals. Per capita beef consumption is much higher in the pastoral provinces in the western regions, but the lack of a suitable and affordable transportation system has kept these interior supplies out of the prosperous coastal cities.

One very interesting aspect of Chinese meat demand is that Chinese consumers tend to discount those cuts most in demand in the United States and to favor those cuts that are less desired in U.S. and European markets. For example, the white internal organs and the reproductive tracts typically sell at a price equal to or greater than muscle meat prices in the same Chinese markets. Also, bone-in chicken feet are generally sold at a premium price compared to chicken breast meat (see Hayes and Clemens [1997]for a detailed cut-by-cut price comparison). If this taste difference continues into the future, a very large market for U.S. variety meats would emerge even if U.S. muscle meats were too expensive for Chinese tastes. This type of export demand would allow the U.S. livestock industry to add value to carcasses while at the same time reducing U.S. muscle meat prices.

A second difference between U.S. and Chinese tastes involves the amount of external fat acceptable to consumers. Approximately 80 percent of Chinese pork comes from “backyard” production, that is, animals fed with household and farm waste, a diet low in some essential amino acids. As a result, animal growth rates are slow and the amount of exterior fat is extremely high. In urban markets, however, this meat sells at as much as a 30 percent discount to leaner meat from modern production units (Hayes and Clemens 1997). This would seem to indicate that the presence of so much exterior fat is driven more by the needs of producers than by the will of consumers.

Chinese pork and poultry imports following tariff reductions

It is likely that China will join the World Trade Organization (WTO) in the very near future. Given the potential for growth in China’s consumption of animal products indicated previously, this event will undoubtedly send ripples across the ocean that will significantly affect U.S. export demand for meat products. This section briefly explores the potential changes in China’s pork and poultry trade following a significant reduction in import tariffs for these products.

In preparation for WTO accession, the Chinese government recently reduced the tariffs on pork and poultry meat imports from 45 percent to 20 percent (*China Daily* 1998). Along with the import tariff, the government collects a 17 percent value added tax on all imported meat products, making the new effective tariff rate 40.4 percent. In addition to lowering tariffs, the Chinese government’s animal health agency has approved a number of slaughterhouses in Canada, Australia, and the United States for export of beef, pork, and poultry products to approved Chinese import companies in 1997 and 1998 (Fuell and Zhang 1997b). Despite these efforts to diminish the barriers to meat imports, official trade in meat products has not grown significantly in recent months. The industry perception in the United States is that, even at the reduced tariff rates, it is still too costly to import meat products through official channels. Unofficial transshipments and smuggling of pork products into China through Hong Kong is estimated to be as large as 7 times greater than official imports (Fuell and Zhang 1997a). These "gray channels" are a viable, less expensive alternative to direct imports. However, this trade is not reflected in reported trade statistics. Lowering import tariffs to a level that makes direct import of meat products cheaper than illegal alternatives could cause a noticeable increase in official trade, not only due to lower import costs but also as a result of trade shifting from gray channels to official import channels.

Using a partial equilibrium model of China's livestock and grain sectors, we have examined the impact of a 100 percent reduction in the official tariff rate on Chinese pork and poultry imports. The 17 percent value-added tax is assumed to remain in place, making the effective tariff rate in the scenario 17 percent. The demand side of the simulation model is divided into urban and rural components for both livestock products and grains. Chinese consumers are assumed to maximize a weakly separable utility function subject to their income constraint. Consequently, consumption is modeled as a two-stage budgeting process in which consumers allocate their income to broad commodity groups in the first stage and then divide group expenditures among individual commodities in the second stage. The model does not contain a complete representation of the first stage decision process; rather, each commodity group's share of consumer expenditures is determined by an Engle curve augmented by a price term. The livestock product group is the largest commodity group, containing beef, pork, mutton, poultry, eggs, aquatic products, and milk. The grain group includes wheat, rice, soybeans, corn, and barley. The second-stage allocations for the two commodity groups are modeled by separate almost ideal demand systems (AIDS) (Deaton and Muellbauer 1980).

Given the importance of the elasticities to the quality of the model's projections, a synthetic approach was taken to specifying the demand system. Expenditure and own-price elasticities were collected from a number of studies (see the footnotes at the bottom of Tables 1 and 2). These were used in conjunction with the parameter restrictions implied by the symmetry, homogeneity, and adding-up properties of demand to determine the appropriate cross-price elasticities that maintain a net substitution relationship for all goods. The resulting elasticity matrices are given in Tables 1 and 2. Income elasticities were calculated by multiplying individual commodity and commodity group expenditure elasticities by an income elasticity for food expenditures. The income elasticity for food expenditures by urban households was 0.76 (Lewis and Andrews 1989) and the value for rural households was slightly lower at 0.707 (Fan, Wailes, and Cramer 1995).

The supply side of the model is divided into two major components according to commodity groupings. Two general structures are used to specify production functions in the livestock sector. First pork, beef, milk, and mutton productions are modeled in the standard stock and flow paradigm to ensure the viability of meat and milk output relative to slaughter, births, animal inventory, and breeding herd growth. Consequently, reduced form equations and identities are included for each of the important elements in the production process. Equations for flow variables, such as additions to breeding inventory, slaughter, and births, are estimated as functions of meat-to-feed price ratios and lagged inventories. Wherever possible, biological restrictions are incorporated into the estimated equations through the use of a logistic function to place an upper bound on births and slaughter (Chavas and Klemme 1986). Finally, meat production is calculated as the product of total slaughter and slaughter weight, and milk production is computed at an annual rate of 1.8 metric tons of milk per dairy cow. Second, production equations for poultry meat, eggs, and cultured aquatic output are estimated as functions of current and lagged output-feed price ratios. Supply elasticities for poultry, egg, and aquaculture may be calculated easily from the estimated equations, but elasticities for other livestock products are more easily calculated by simulating price shocks with the model while holding all other variables constant. The resulting elasticities of supply with respect to the output-feed price ratio measured at 1996 levels are given in Table 3.

China's demand for feed grains and protein meals is calculated from beef, pork, poultry, eggs, aquaculture, and milk production. It is assumed that sheep and goats are grazed in China and that cattle receive only a small quantity of grain per head to supplement their primary diets of straw and forage. It is also assumed that dairy cattle require a fixed quantity of grain feed to produce a kilogram of milk. Consequently, the predominant share of grain feed demand is derived from swine, poultry, egg, and aquaculture production. The linkage between livestock output and feed-grain demand is described by the relationship in equation (1). The equation states that the total demand for feed $i\,(d_i)$ is the sum over all meats of the per unit input of feed $i\,(c_{ij})$ to produce meat j, times the output of meat $j\,(X_j)$,

$$d_i = \sum_j c_{ij} X_j \,. \qquad (1)$$

It is evident from equation (1) that changes in either the level of meat production or the per unit feed requirement will cause total feed demand to change. Meat output levels originate in the livestock model, and changes in these levels generated by that model are used in calculating feed demand changes. For simplicity, it is assumed that input coefficients are invariant to price changes, but the impact of technological change is incorporated into the feed demand system. Consequently, feed demands are segregated in the model by production technology as well as product type. The total demand for any given feed used in the production of a particular meat product is the sum of the demands created by each type of production technology. For example, the demand for corn derived from pork production will be the sum of corn used by backyard producers, specialized household producers, and large-scale intensive growers. As the technological mix of production changes in China, the level and composition of total feed-grain demand also will be altered. Likewise, improvements in production methods, genetic breeding stock, and management practices will have an impact on the demand for feed. In order to capture these effects, feed demands are generated by equation (2). Changes in technology and industry composition are affected through the feed conversion ratio (FCR), meat-to-live-weight conversion, industry share, and grain's share of total feed. The present specification incorporates a 1.0 percent annual improvement in feed efficiency for all swine and poultry technologies, 1.5 percent for aquaculture, and 3.0 percent for dairy. Swine production by backyard and state farm producers is expected to decline at annual rates of 1.0 and 3.2 percent. Specialized household production of swine is assumed to increase by 7.0 percent annually over the next decade.

$$d_i = \sum_{meat} \left(\begin{array}{l} \left(\dfrac{\text{Meat Production}}{\text{Meat to Live Wt. Conversion}} \right) \times (\text{FCR}) \times \begin{pmatrix} \text{Industry} \\ \text{Share} \end{pmatrix} \times \\ \\ \begin{pmatrix} \text{Grain's Share} \\ \text{of Total Feed} \end{pmatrix} \times \begin{pmatrix} \text{Grain } i\text{'s Share} \\ \text{of Grain Feed} \end{pmatrix} \end{array} \right) . \qquad (2)$$

Commercial poultry and egg production are anticipated to grow by 3.5% annually, implying a

2.7 percent decline year on year in village poultry and egg production. Finally, grain's share of feed is expected to increase annually for specialized household swine producers (0.5 percent), commercial poultry and egg producers (1.0 percent), aquaculture (1.5 percent), and village poultry and egg farmers (1.0 percent).

The production of grains and oilseeds is computed as the product of per hectare yields and the number of hectares planted to each crop. Sown area is modeled as a multistage decision process. Initially, total area sown to grains and oilseeds is determined as a function of expected trends in multicropping, loss of agricultural land to industry and urban uses, land degradation, and land reclamation. Once the total grain and oilseed area is determined, it is parceled out to various crop uses according to a system of share equations driven by relative changes in gross revenues for wheat, rice, coarse grains, and oilseeds. Yields are also a function of environmental factors, multicropping practices, and irrigation and fertilizer usage. Supply responsiveness to price changes is determined by the sown area equations. The share of grain and oilseed area allocated to oilseed production is further broken out into soybean, rapeseed, and sunflower seed areas according to changes in gross revenues. The first stage allocation includes both own-price and cross-price effects, but the allocation of oilseed area assumes there is no direct substitution among the oilseeds. The supply elasticities implied by the system of area allocation equations are given in Table 4.

With the exception of rice, the market price for Chinese grains is calculated from the corresponding U.S. F.O.B. grain and oilseed prices by adjusting these international prices for exchange rates, tariffs, and transportation costs. The assumed price transmission elasticity for grains is 1. In the livestock sector, pork and poultry prices are also a function of U.S. prices, but the assumed price transmission elasticity is approximately 0.06. This low price transmission elasticity reflects the enormous difficulties facing U.S. exporters in trying to access some of China's internal markets as well as some of the differences in tastes discussed earlier. This is an assumed value. If we had used a value that was twice as big, then the trade impact results shown here would have been approximately twice as large.

Net trade for these commodities is residually determined from supply and demand conditions. Prices for other commodities are endogenously determined by domestic market equilibrium conditions. Thus trade is either determined exogenously or by export supply and import demand functions. International price interaction is derived from a reduced form specification of U.S. and rest-of-world trade. Elasticities were chosen to approximate price and trade responses generated by the Food and Agricultural Policy Research Institute's (FAPRI) agricultural trade model. Quantity data for all components of the model were obtained from the U. S. Department of Agriculture's (USDA) Production, Supply, and Distribution Database (USDA 1997)

The simulation model was calibrated to the FAPRI November 1997 preliminary baseline (FAPRI 1997). In a series of simulation runs, Chinese import tariffs for pork and poultry were individually reduced by 100 percent to represent the maximum possible trade impact from WTO accession. A complete set of results is available from the authors on request. Tables 5 and 6 summarize some of the more important results. By 2007, Chinese pork imports are more than 500,000 tons greater than those in the baseline and U.S. pork exports rise by an almost similar amount. On the other hand, prices in both markets are almost unaffected. The maximum change in U.S. prices occurs in the first year after liberalization and is only 4.41 percent greater than the baseline. This small price impact reflects the low price transmission elasticity used in the model as well as the enormous size of both markets.

The poultry results in Table 6 are very similar to the pork results in Table 5. Chinese poultry imports increase by almost 300,000 tons, and again the United States captures the lion's share. Price effects are moderate. Because poultry trade in both countries is already well established, the trade impacts, as a percentage of existing levels, are much smaller in the poultry scenario, equaling only a 5 percent to 7 percent increase for the United States and a 30 percent to 50 percent increase for China.

Chinese pork and poultry prices start out at a level that is well above the U.S. price, and the difference widens as Chinese demand grows. Again, we see the impact of the low price transmission elasticity. Had we used a larger transmission elasticity, a proportionally larger change in trade volume would have reduced the price disparity.

Conclusions

The results from our scenario analysis suggest that liberalization of China's pork and poultry markets will cause a relatively large change in world trade levels without causing any serious price disruptions. The United States is in a good position to capture much of the benefits of such a liberalization, because it already dominates world trade in unsubsidized poultry products and because it is the low-cost producer of pork among countries that are free of foot and mouth disease.[1]

The results presented here are by necessity based on a simplified trade model. Were we to fully model the taste differences that exist across countries, it seems likely China would be an exporter of pork loins and chicken breasts and a large importer of less expensive cuts and variety meats. Another simplification concerns the dollar-yuan exchange rate. Casual observation would seem to suggest that the yuan is undervalued relative to the dollar. The trade effects would have been much greater had we built in an appreciation of the yuan. A third simplification is the arbitrarily low price transmission elasticity chosen for the study.

The key results from this study are first that Chinese meat consumption will continue to be sensitive to per capita incomes. Continued growth in incomes at levels close to those seen recently will cause large increases in demand for meat products. Second, if markets are allowed to decide where these additional supplies should originate, U.S. exports of poultry and pork should increase dramatically. Third, as long as the trade increases generated by market liberalization are close to the levels projected in this study, the price impact in U.S. and Chinese markets will be relatively small.

[1] China claims to be free of foot-and-mouth disease, but this claim would be contradicted by any pork imports from countries where the disease is prevalent.

Table 1. Urban Marshallian Demand Elasticities

	First Stage												
	Meats	Grains	Beef	Pork	Poultry	Mutton	Eggs	Fish	Dairy	Rice	Wheat	Soybeans	Coarse Grains
Meats	**-0.288**[2]		Second Stage										
Grains		**-0.430**[2]											
Beef			**-0.430**[1]	-0.040	-0.060	-0.040	0.060	-0.078	-0.104				
Pork			-0.279	**-0.970**[1]	0.190	-0.045	-0.050	-0.100	0.050				
Poultry			-0.089	0.094	**-1.333**[2]	-0.083	0.100	-0.070	0.050				
Mutton			-0.028	-0.009	-0.041	**-0.430**[1]	-0.022	-0.040	-0.060				
Eggs			0.161	-0.075	0.026	-0.134	**-1.084**[2]	0.284	0.050				
Fish			-0.108	0.047	-0.040	-0.051	0.353	**-1.480**[2]	-0.087				
Dairy			-0.015	0.036	0.036	-0.005	0.050	0.002	**-2.095**[2]				
Rice										**-0.570**[3]	-0.470	0.026	0.030
Wheat										-0.412	**-0.580**[4]	0.232	0.200
Soybeans										-0.029	-0.017	**-0.270**[5]	0.060
Coarse Grains										-0.029	-0.020	0.062	**-0.240**[6]
Income	0.735[2]	0.055[2]	0.579[2]	0.673[2]	0.898[2]	0.579[2]	0.437[7]	1.089[2]	1.614[2]	0.057[4]	0.060[7]	-0.003[7]	-0.003[7]

[1]Chern and Wang (1994), [2]Huang and Bouis (1996), [3]Fan, Cramer, and Wailes (1994), [4]Huang and David (1993), [5]Sullivan, Roningen and Leetmaa (1992), [6]Fan, Wailes and Cramer (1995), [7]Assumed

Table 2. Rural Marshallian Demand Elasticities

	First Stage		Beef	Pork	Poultry	Mutton	Eggs	Fish	Dairy	Rice	Wheat	Soybeans	Coarse Grains
			Second Stage										
Meats	**-0.268**[2]												
Grains		**-0.448**[2]											
Beef			**-1.040**[1]	-0.005	0.010	-0.010	0.010	-0.010	0.175				
Pork			0.140	**-0.980**[1]	-0.334	-0.050	0.300	-0.229	-0.350				
Poultry			0.102	-0.032	**-0.530**[1]	0.297	-0.050	-0.120	-0.150				
Mutton			-0.011	-0.011	0.054	**-1.040**[1]	0.034	-0.015	0.020				
Eggs			0.125	0.020	-0.156	0.313	**-0.900**[1]	-0.172	-0.200				
Fish			0.015	-0.012	-0.156	-0.009	-0.069	**-0.810**[1]	0.532				
Dairy			0.215	0.008	-0.017	0.045	-0.001	0.092	**-2.085**[2]				
Rice										**-0.695**[5]	-0.616	0.018	0.110
Wheat										-0.214	**-0.640**[5]	0.045	0.130
Soybeans										-0.044	-0.055	**-0.270**[3]	0.100
Coarse Grains										-0.087	-0.098	0.197	**-0.240**[4]
Income	0.595[2]	0.174[2]	0.270[2]	0.602[2]	0.672[2]	0.270[2]	0.402[2]	0.866[5]	1.224[2]	0.181[6]	0.245[5]	0.002[5]	-0.017[5]

[1]Gao, Wailes and Cramer (1996), [2]Huang and Bouis (1996), [3]Sullivan, Roningen and Leetmaa (1992), [4]Fan, Wailes and Cramer (1995), [5]Assumed, [6]Huang and David (1993)

Table 3. Livestock Product Supply Elasticities

	Beef	Pork	Poultry	Mutton	Eggs	Aquaculture	Milk
Impact	0.640	0.300	0.713	1.138	0.934	0.303	0.000
5-year	0.922	1.704	1.175	1.776	0.934	0.303	0.267

Table 4. Grain and Oilseed Supply Elasticities

	First Stage				Second Stage		
	Coarse Grains	Wheat	Oilseed	Rice	Soybean	Rapeseed	Sunflower
Coarse Grains	0.195	0.033	-0.113	-0.073			
Wheat	0.029	0.112	-0.113	-0.080			
Oilseed	-0.070	-0.081	0.112	0.021			
Rice	-0.048	-0.061	0.022	0.112			
Soybean					0.406		
Rapeseed						0.144	
Sunflower							0.201

Table 5. Scenario Consumption, Trade and Price Changes Following a 100 Percent Reduction in the Chinese Pork Tariff

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
China										
Demand	Thousand metric tons									
Scenario	43872	45594	47900	50190	52379	54745	56946	59257	61521	62863
Change from Base	0	285	314	336	332	323	347	368	355	349
Net Imports										
Scenario	-128	234	306	368	397	413	452	491	496	496
Change from Base	0	346	418	477	496	503	544	583	580	575
Farm-level Price	US dollars per hundredweight									
Scenario	55.77	60.66	63.67	68.25	73.77	79.74	85.44	91.04	96.94	97.10
Baseline	55.77	61.21	64.26	68.87	74.38	80.34	86.08	91.71	97.58	97.70
Percent Change	0.00	-0.91	-0.92	-0.91	-0.83	-0.74	-0.74	-0.73	-0.66	-0.62
United States										
Net Exports	Thousand metric tons									
Scenario	315	836	872	898	1128	1371	1269	1205	1452	1748
Change from Base	0	338	406	464	485	494	535	573	570	566
Barrow-Gilt Price	US dollars per hundredweight									
Scenario	45.83	44.87	47.26	49.15	45.20	42.09	47.07	51.01	47.08	43.49
Baseline	45.83	42.98	45.52	47.54	44.08	41.25	46.00	49.74	46.07	42.56
Percent Change	0.00	4.41	3.84	3.38	2.52	2.02	2.32	2.56	2.19	2.19

Table 6. Scenario Consumption, Trade, and Price Changes Following a 100 Percent Reduction in the Chinese Poultry Tariff

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
China										
Demand	Thousand metric tons									
Scenario	14450	15032	15780	16612	17338	18131	18835	19536	20261	20548
Change from Base	0	173	176	178	175	172	171	170	168	177
Net Imports										
Scenario	450	706	784	826	872	913	951	989	1031	1062
Change from Base	0	235	282	289	285	281	280	280	277	285
Wholesale Price	US cents per pound									
Scenario	66.39	65.44	68.27	72.10	77.07	82.51	87.85	93.32	98.88	99.84
Baseline	66.39	66.22	69.05	72.89	77.85	83.30	88.64	94.12	99.68	100.64
Percent Change	0.00	-1.18	-1.14	-1.09	-1.01	-0.94	-0.90	-0.85	-0.81	-0.80
United States										
Net Exports	Thousand metric tons									
Scenario	2160	2483	2571	2634	2766	2879	2953	3029	3136	3280
Change from Base	0	155	174	174	171	168	168	168	167	172
12-City Broiler Price	US cents per pound									
Scenario	58.07	59.11	59.91	60.37	59.63	59.47	60.19	60.85	60.92	60.94
Baseline	58.07	58.06	58.78	59.26	58.55	58.40	59.14	59.80	59.88	59.86
Percent Change	0.00	1.81	1.93	1.87	1.84	1.83	1.78	1.74	1.73	1.80

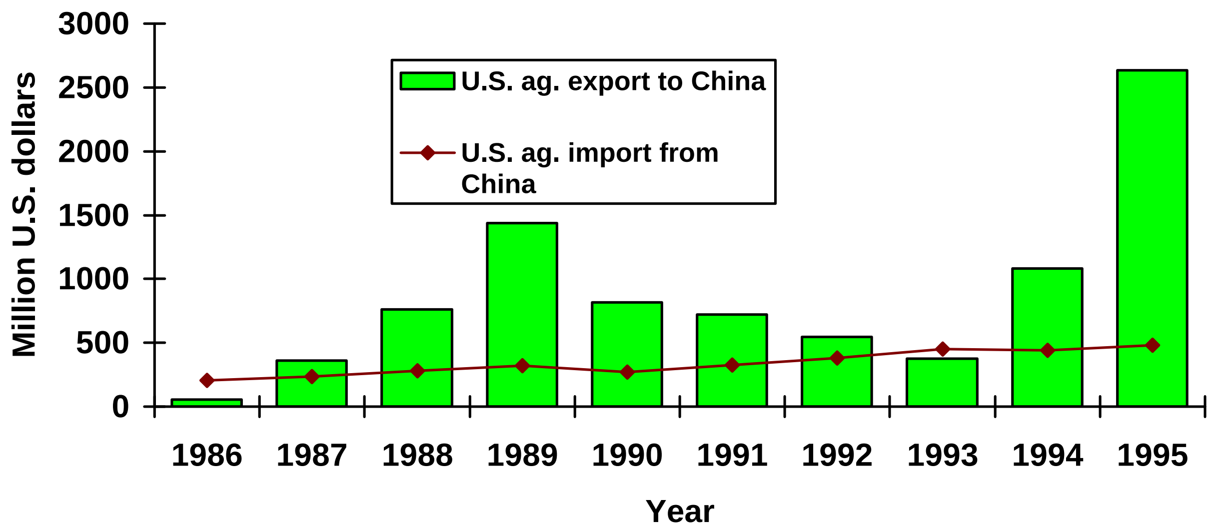

Figure 1. U.S. Agricultural Trade with China

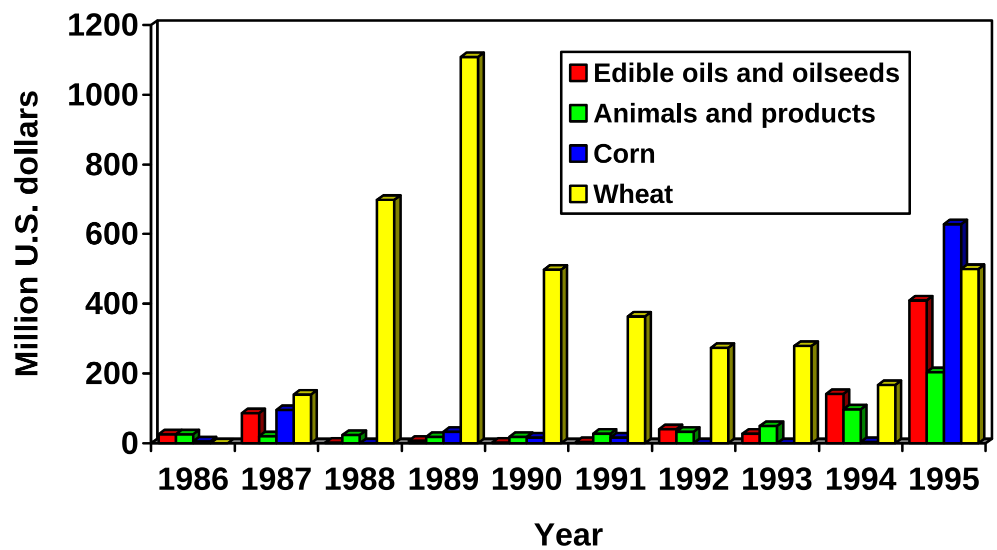

Figure 2. U.S. Agricultural Exports to China

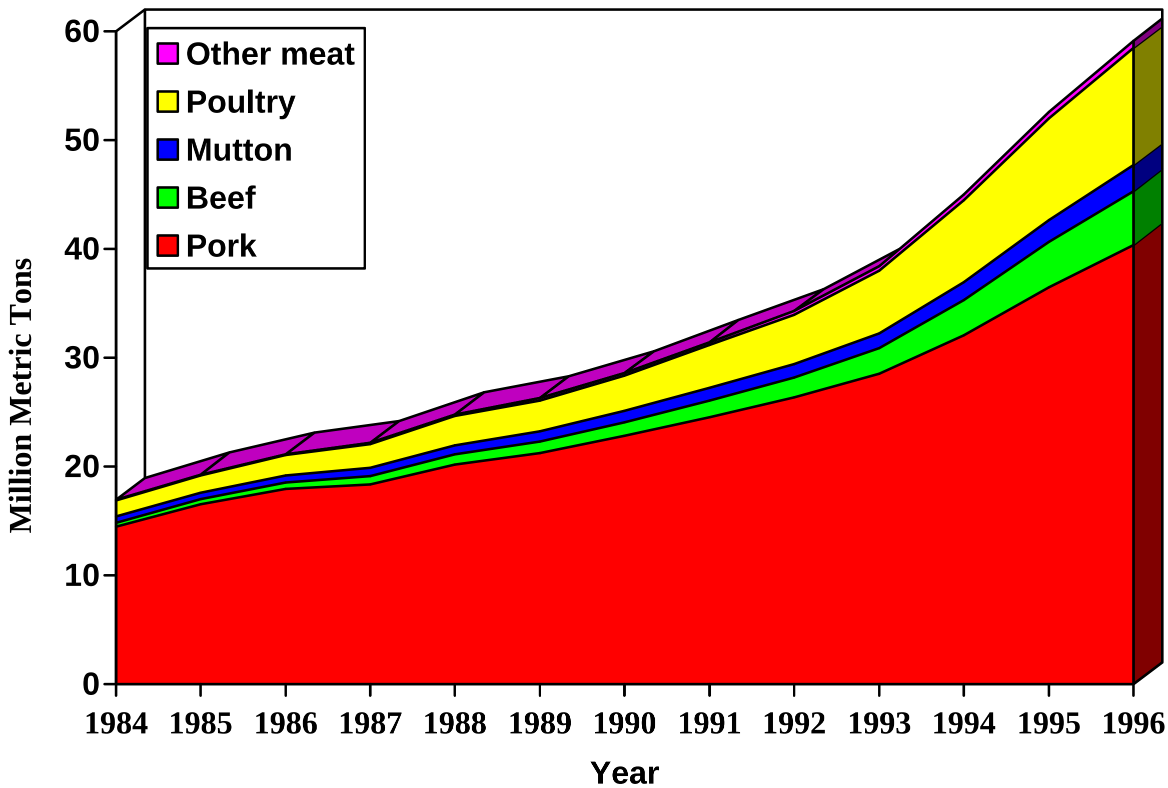

Figure 3. China's Production of Major Animal Products

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