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**INTERPRETATION OF LONG-TERM TRADE  
PROJECTIONS: CHINA'S ROLE IN  
FORECAST DISCREPANCIES AND ITS  
IMPACT ON EXPECTATIONS FOR WORLD  
AGRICULTURAL TRADE**

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## **Interpretation of Long-Term Trade Projections: China's role in forecast discrepancies and its impact on expectations for world agricultural trade.**

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Making long-term projections of global market conditions, and U.S. export demand in particular, is difficult at best. FAPRI projections extend only over the next 10 years because it is our judgment that longer-term projections depend on numerous factors that are highly uncertain or even unknowable so far in advance. Other organizations and agencies conduct world market assessments over shorter and longer periods than FAPRI's projection. OECD recently extended its projection period from five to ten years. The International Food Policy Research Institute (IFPRI) has done projections to 2025 and the Food and Agriculture Organization of the United Nations (FAO) has done one to 2030. Sparks Companies, now Informa, has done a long-term export assessment for the U.S. Army Corps of Engineers that extends to 2050. Usually, projections that go beyond 10 years are done for a specific purpose and much less frequently than the annual FAPRI outlook.

It is important when interpreting projections, especially long-term projections, to be clear on the purpose of the analysis and the underlying assumptions used in the process. FAPRI's 10-year outlook is not a "forecast" in the sense of being a prediction of what is expected to occur over the next 10 years. Instead, it is a projection conditional on a number of assumptions, some of which are very unlikely to hold for 10 years. For example, FAPRI's baseline assumes that current policies remain in place indefinitely, even though one might reasonably expect changes in U.S., China, European Union (EU), and other major trading countries policies, and a new World Trade Organization (WTO) agreement to occur sometime in the next 10 years. In addition, rapid economic growth in areas such as China invariably leads to changes in government policies as well as changes in consumer demand and productivity.

This constant policy approach is used by FAPRI as well as the USDA for the purpose of generating a baseline from which to do policy scenarios that evaluate the future impacts of proposed policy changes. Further, as a research institute that analyzes but does not make policy or even policy recommendations, it would be improper for FAPRI to suggest likely future legislation from congress. With these factors in mind, the use of a constant policy baseline is a fundamental assumption in all FAPRI baseline projections for policy analysis.

Aside from the constraint of a constant agricultural policy baseline, there remains significant uncertainty in the projection. Market conditions, the macro-economic

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climate, macroeconomic policy shifts, and technological growth all play a significant role in uncertainty about the future. Nowhere is this uncertainty better illustrated than in China. With its vast population and large agricultural production, changes in China easily ripple through international trade in primary agricultural products. With this in mind, we will discuss some of the sources of errors in the FAPRI baseline, which errors may be unavoidable, and methods to reduce the occurrence of the remaining errors. While the reasons long-run export projections could miss the mark are numerous, we will focus on policy conditions, macro-economic forecasts, rates of technological change, and data on initial conditions.

## The 1998 FAPRI China Corn Market Projection

To illustrate these errors, we will look at the impact of China's grain projections on a global commodity baseline through a discussion of the 1998 FAPRI China corn outlook as seen in Table 1 (FAPRI). The selection of the 1998 projection is not to illustrate specific errors, but is due to limitations on coverage and time frame constraints. Prior to 1998, the FAPRI China feed grains were modeled as an aggregate including corn, barley and oats. Beginning in 1998, barley, oats, and corn were presented as individual supply and utilization tables. Therefore, to focus on corn, we needed a projection after 1997. In addition, we needed sufficient time to have elapsed to compare projection values to "historical" values. The 1998 FAPRI world projection was a logical choice for analysis.

Table 1: 1998 FAPRI China corn projection

	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07
	(Million Hectares)										
<b>Area harvested</b>	24.50	23.50	24.79	24.84	24.88	24.90	24.93	24.95	24.98	25.00	25.03
	(Metric Tons per Hectare)										
<b>Yield</b>	5.20	4.47	5.00	5.08	5.15	5.23	5.32	5.41	5.50	5.59	5.69
	(Million Metric Tons)										
<b>Production</b>	127.47	105.00	123.97	126.07	128.19	130.34	132.56	134.86	137.26	139.74	142.33
<b>Beginning stocks</b>	23.70	41.00	20.00	20.40	21.49	22.79	23.22	23.10	23.08	22.94	22.71
<b>Domestic supply</b>	160.17	146.00	143.97	146.47	149.68	153.13	155.79	157.96	160.34	162.69	165.04
<b>Feed use</b>	88.60	95.00	98.28	101.52	104.28	107.75	110.87	113.82	117.00	119.92	122.78
<b>Food and other</b>	26.75	27.25	27.52	27.75	27.91	28.12	28.35	28.56	28.77	28.95	29.10
<b>Ending stocks</b>	41.00	20.00	20.40	21.49	22.79	23.22	23.10	23.08	22.94	22.71	22.43
<b>Domestic use</b>	156.35	142.25	146.20	150.77	154.98	159.10	162.32	165.46	168.71	171.59	174.31
<b>Net exports</b>	3.82	3.75	-2.23	-4.30	-5.30	-5.97	-6.53	-7.50	-8.37	-8.90	-9.26

The 1998 China corn projection, shown graphically in Figure 1, is characterized by growing consumption that outpaces production throughout the projection period. Stock levels are stable, in line with historical levels, and are shrinking somewhat relative to domestic consumption at 15 percent. This would be considered quite a tight stock situation: the shortfall between consumption and production is met through increasing imports of corn. While the amount of trade is small relative to overall production and consumption, it should be noted that it represents a definite departure from China's historical trade position as a net exporter of corn.

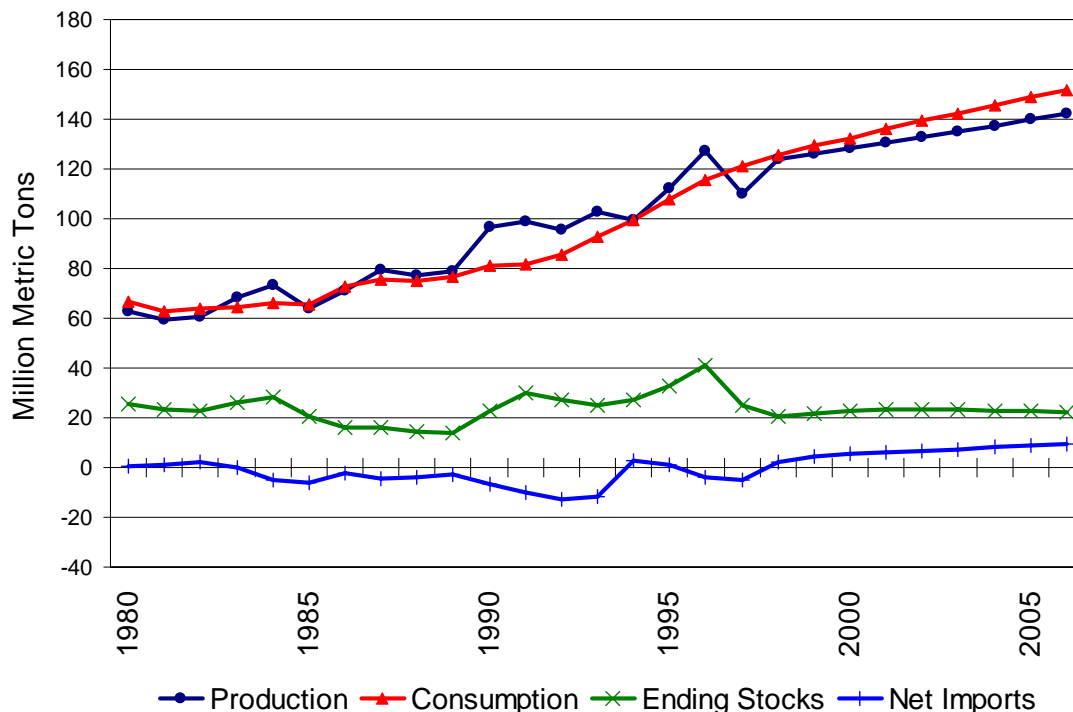


Figure 1: 1998 FAPRI China corn projection

In comparing the projection to the actual values, the focus is on an average of the 2002-2004 time period. By observing an average of several years, we can avoid distortions associated with production or trade shocks in a single year that could make error values misleading. The errors for the 1998 FAPRI China corn projection are shown in Table 2. The table shows the difference between the projection and the current historical numbers, while the stock change shown represents the actual stock change from historical data. In the 1998 projection, stock changes for 2002-2004 were negligible. The immediate interpretation of these results is that the errors in consumption and production projections would offset each other, and changes in stock data almost fully explain the trade projection errors. We now look at each of these components in more detail.

Table 2: 1998 FAPRI China corn projection minus actual levels

	2002	2003	2004	Average	
				2002-2004	2002-2005
	(Million Metric Tons)			(mmt)	(percent)
Production	11.2	19.2	9.6	13.3	11.0
Consumption	13.3	13.0	12.8	13.0	10.1
China net imports	21.7	15.1	13.2	16.7	-180.7
U.S. net exports	20.4	15.1	20.1	18.5	41.7
Actual stock change	-19.8	-21.1	-9.9	-16.9	

Sources: Projections are FAPRI 1998, and actuals are USDA PS&D database

## Area and technological change

In observing the supply side errors, the production was overestimated by an average of 13.3 million metric tons over the 2002-2004 period. Production is derived in the model through estimated area and yield equations. The production errors could originate in one or both equations. It is clear from the 1998 area and yield projections, in comparison to historical data, that both were over-estimated (Figure 2). With respect to anticipated errors it is necessary to determine if supply side errors appear random or systematic through time, so a comparison of subsequent projections should provide additional information.

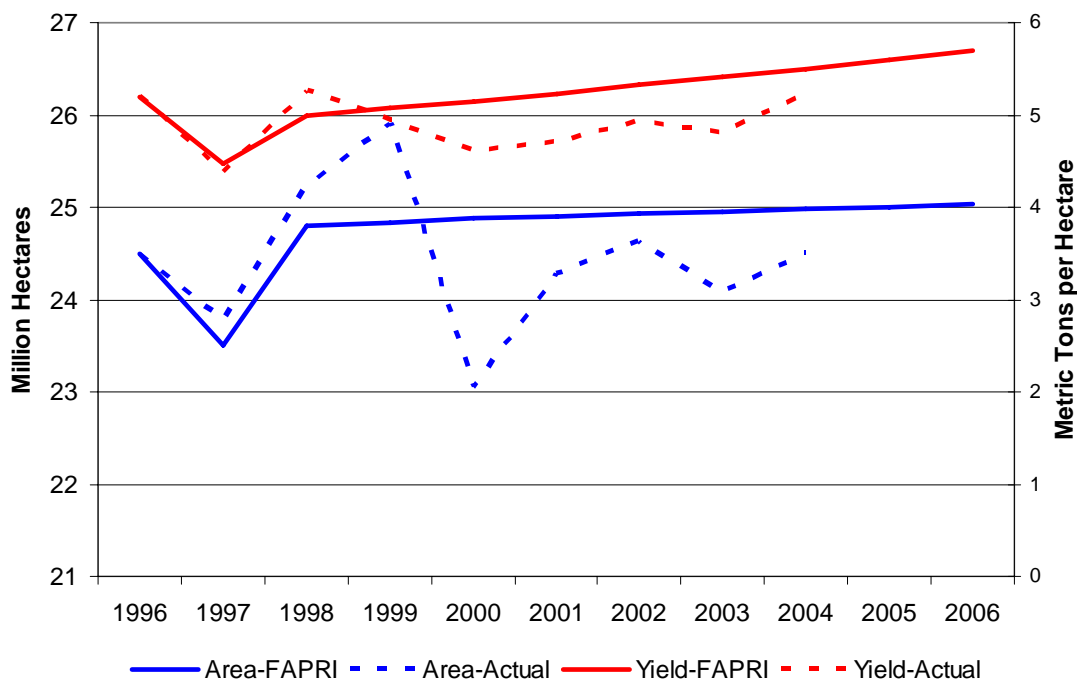


Figure 2: 1998 FAPRI China area and yield projections compared to actual levels

Figures 3 and 4 show the 1998 projection and subsequent FAPRI China corn area and yield projections through 2004; historical data is shown in black. The area projections are reasonably consistent and don't appear to exhibit systematic error; therefore, the errors would be evenly distributed around the historical data. The yield projections, while showing consistency in growth rates among the projections, exhibit a significant upward bias. Actual yields almost always fell below baseline yields in all projections from 1998-2004. The results indicate the presence of bias but not its source. Yield growth rates in the FAPRI model are generally a result of trend analysis, and it appears that forecast growth rates are in line with historical trends, while reported yields have slowed since 1998. The systematic errors could be a result of bias by analysts at FAPRI, but there are also other factors to consider.

Simple trend analysis can fit historical data quite well, but will not capture technological changes in growth until well after such changes have occurred. Yields appear to have slowed, but this would take several years to be fully implemented into a trend analysis. The bias may also be a result of changes in reporting of yields by Chinese farmers. As the government of China changes policies from taxing to subsidizing farmers, then the incentives for farmers to under report acreage and over report yields may be eliminated, which may reduce yield estimates. To compensate for these errors adjustments to trends can be made by analysts, who may interject their opinions about technology growth in China. Yields for many commodities in China are equal to or higher than yields in the United States. However, China's corn yields are significantly lower than the United States, which may provide potential for growth. This growth rate is a source of significant uncertainty in the projections and creates a greater need for interpretation by FAPRI analysts. FAPRI has adjusted to this new information in more recent projections (Figure 4).

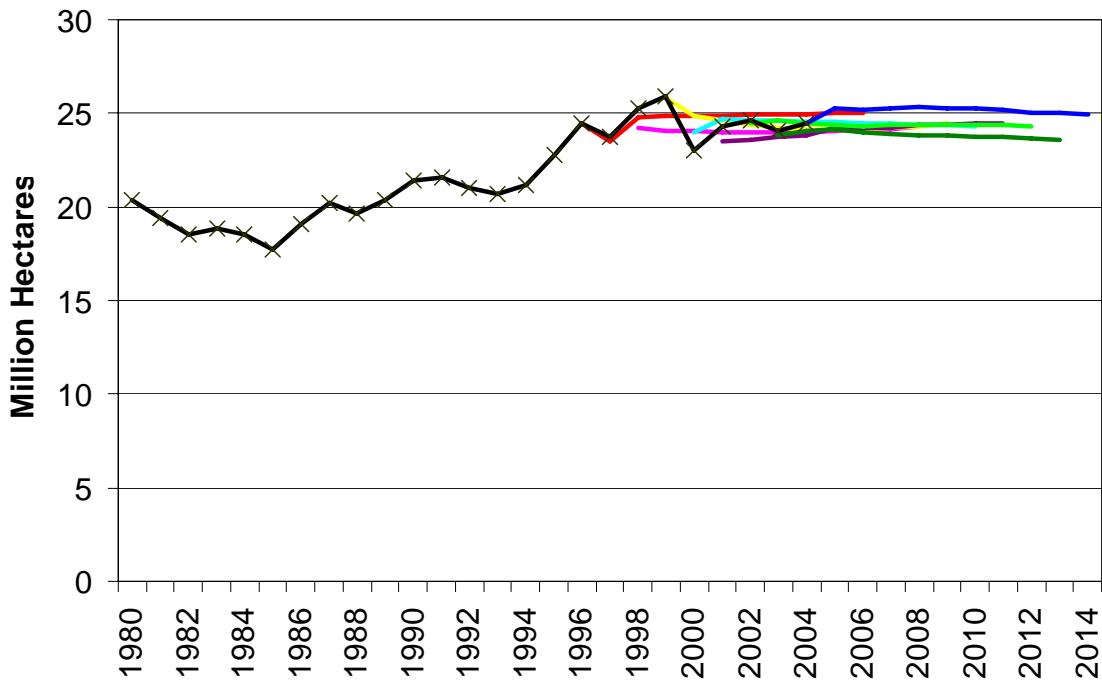


Figure 3: China's corn area forecasts and history, 1998-2005

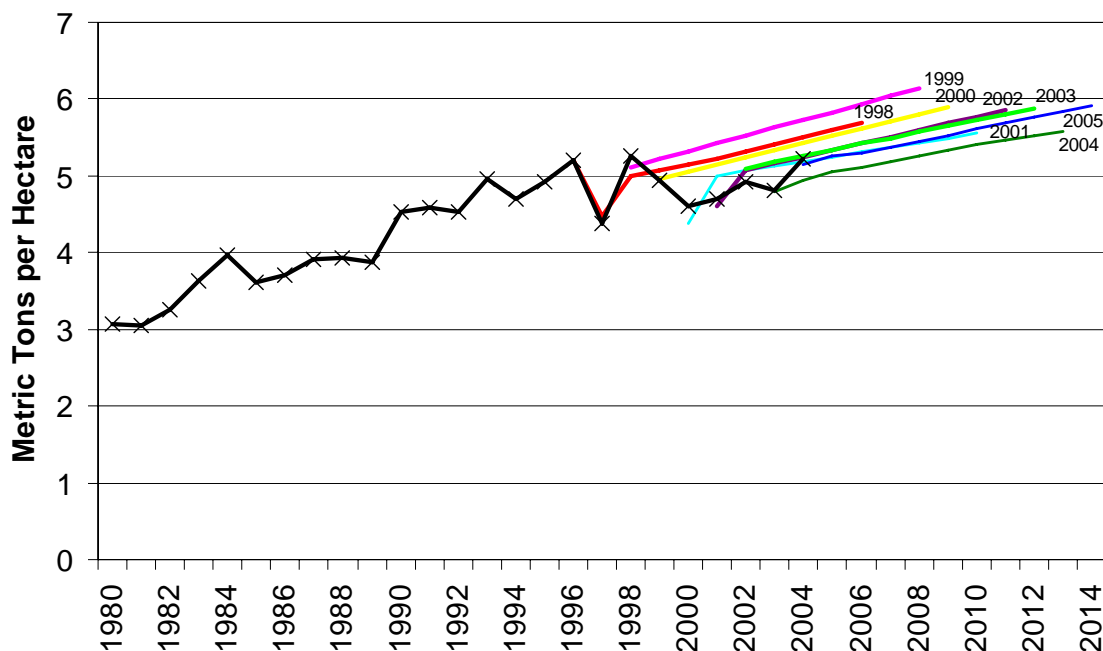


Figure 4: China's corn yield forecasts and history, 1998-2005

### Consumption and Macroeconomic conditions

Focusing on the demand side of the ledger we observe the average error for consumption over the 2002-2004 period from the 1998 projection was similar to the production error at 13.0 mmt, or about 10 percent too high (Table 2). In the FAPRI modeling system, the demand for corn within China is driven primarily by the livestock numbers which is a derived demand for meat. The meat demand is determined by population and income growth. Looking at the macroeconomic variables, we have 5 percent lower 2004 GDP in China than anticipated in 1998 and 0.75 percent lower population. Both of these errors in the exogenous macroeconomic forecast would have caused us to over estimate consumption; however, these variables alone account for only a small fraction of the 10 percent error.

In addition to the macroeconomic forecast error, there was a significant revision in the USDA's historical data on livestock numbers after the completion of the 1998 projection (USDA-FAS). While the last year or two of the USDA's historical data is often considered preliminary and subject to revision, such changes are ordinarily small and extend back only a few years. This late 1998 USDA revision in livestock numbers reduced cattle and swine inventories by 12.2 percent and 18.7 percent respectively, which forced a change in the level of animal inventories going back several years. The USDA information represents the best data available and is the basis for all FAPRI analysis, but this type of data revision, by definition, is not anticipated and could easily account for the majority of the consumption projection error.



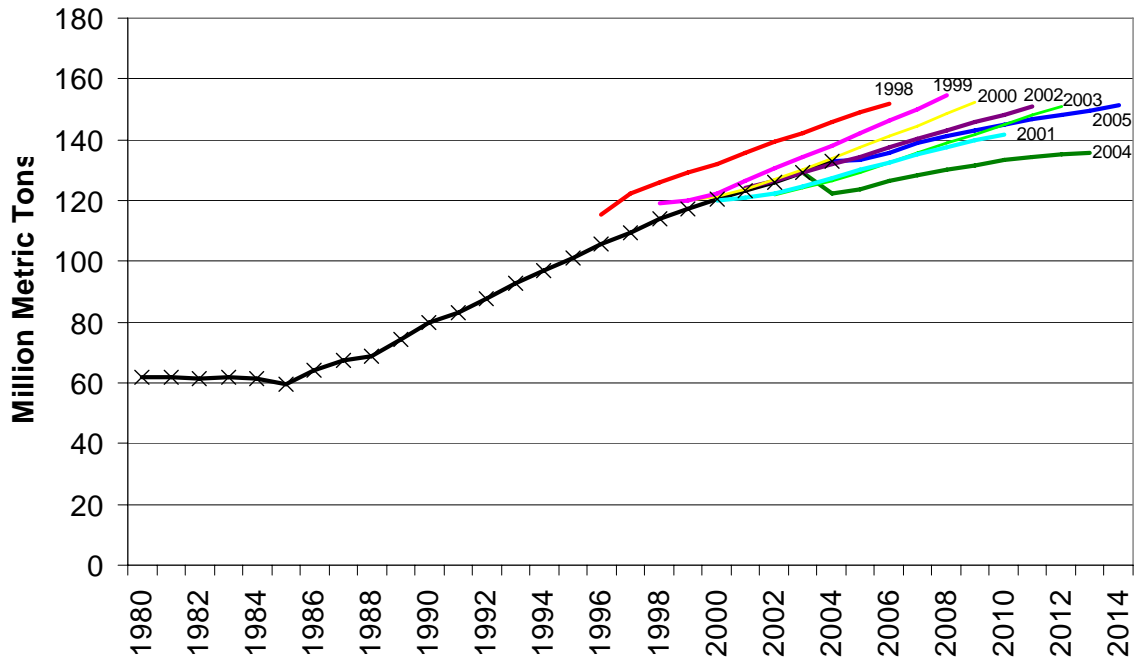


Figure 5: China corn consumption forecasts and history, 1998-2005

### China's stock holding and another major data revision

While the livestock revision alludes to the uncertainty surrounding China data, other variables have seen similar significant revisions. The errors associated with overestimation of production and consumption are quite similar in size and, taken together, can be considered largely trade neutral. Combined, they would not explain any error in the net-trade projection. Again referring to Table 2, it can be seen that China's net imports of corn were overestimated by 16.7 million metric tons annually. In both the original projection and the historical data, corn consumption has outpaced production for the last six years. The only way this is possible is through imports or stock reductions. While the 1998 projection called for China to become a net importer of corn, in reality they have continuously been a small net-exporter of corn, and must have met the production shortfall through stock reductions of approximately 16.7 million metric tons per year. In 1998, the USDA indicated China had total corn stocks of 25 million metric tons. With production running below consumption since 1998, stock reductions that would average 16.7 mmt per year from 2002-2004 and only 25 mmt of available stocks, would give us *negative* stock numbers.

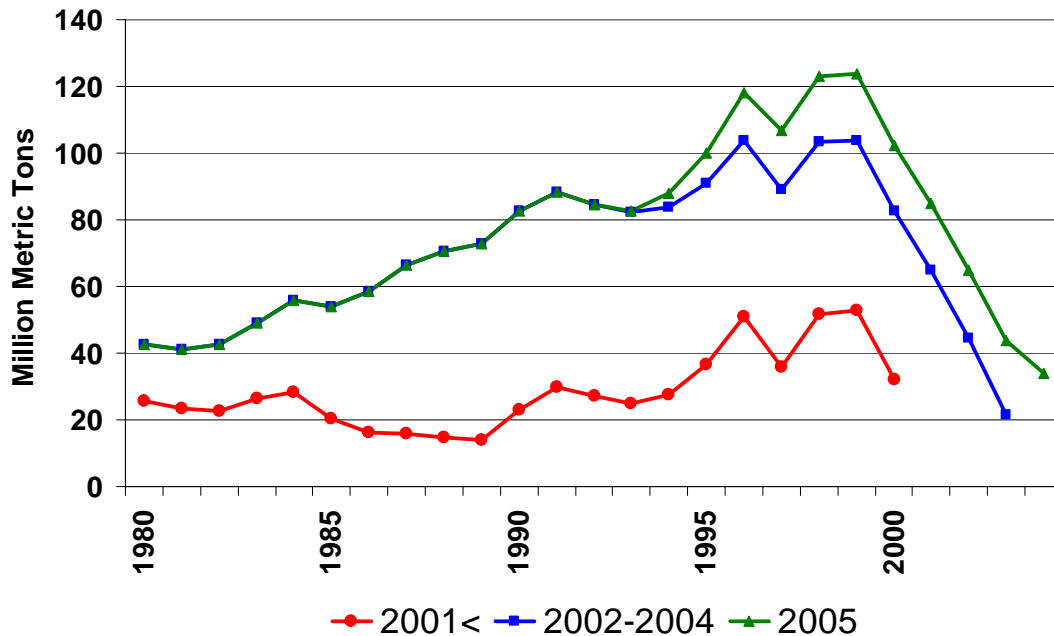


Figure 6: China corn stock, USDA PS&D Annual Estimates

The government of China considers agriculture grain stock levels to be a state secret. China's government does not regularly release information on grain stock inventories being held. Moreover, the information which is released is for all grains and not by individual composition of grain stocks, therefore no official reporting of stock levels for corn is available. The issue is further complicated by lack of an inventory date within the crop year for the total grains, which means it could be beginning, end, or middle of crop year. The grain stocks in China are held by three main entities which include the government, commercial sector, and farm households. The largest share of total grain stocks are held for food security concerns by farm households for personal consumption. The government sector includes central government state reserves, grains in circulation, and local government reserves. Given the large grain inventory held by farm households, an accurate estimate of grain inventory may be difficult for the government to ascertain. (Hsin-Hui and Gale)

While production continued to lag behind consumption, and the Chinese maintained a net-export position, it became apparent to the USDA in 2002 that, if the other variables were to be believed, their historic stock levels were far to low. In that year they made an adjustment in stocks, adding approximately 50 mmt to the total stock levels through history, and made additional upward revision of nearly 15 mmt in 2005 shown in Figure 6. Historical stock numbers in the 1998 projection were far lower than the revision, and would be considered largely constrained, so stock changes were very minimal. However, as shown in Table 2, the USDA now estimates that the actual stock changes over the 2002-2004 period averaged 16.9 mmt annually. This amount closely resembles the projection error for China net imports of 16.7 mmt. All else equal, the error associated with China's net trade position can be almost entirely explained by the revision in historic stock numbers.

Because the Chinese were able to meet demand through stock reductions (previously thought impossible) instead of importing the needed corn, this has major implications for the U.S. corn export projection. The United States is the dominant force in corn trade, and U.S. corn exports from the 1998 FAPRI projection averaged 18.5 mmt above actual amounts in 2002-2004 (Table 2). While not the complete story, the error in China trade due to the revision in their historic holdings of 16.7 mmt annually accounts for over 90 percent of the 18.5 mmt U.S. corn export error. As this data change was incorporated into FAPRI projections, the China import and U.S. export paths have adjusted (Figures 7 and 8)

The overestimation of U.S. corn exports is not unique to the 1998 FAPRI projection and has been a source of public debate. The old USDA China corn stock data with constrained stocks, accounts for a significant portion of this export optimism when the best information available asserted that China corn stocks were approaching pipeline levels. With the new higher stock levels, optimism about a large volume of China corn imports has also cooled somewhat; however, current historical stocks data puts China in a stock position similar to that assumed in 1998 (Figure 6). If the current stock situation is to be believed, it puts China's corn stocks at 34 million metric tons or approximately a 90 day supply for domestic consumption. There are indicators that stocks truly have tightened over the last several years as internal China grain prices have risen substantially. Further stock revisions are certainly possible and would again effect the projection of China's corn net trade position.

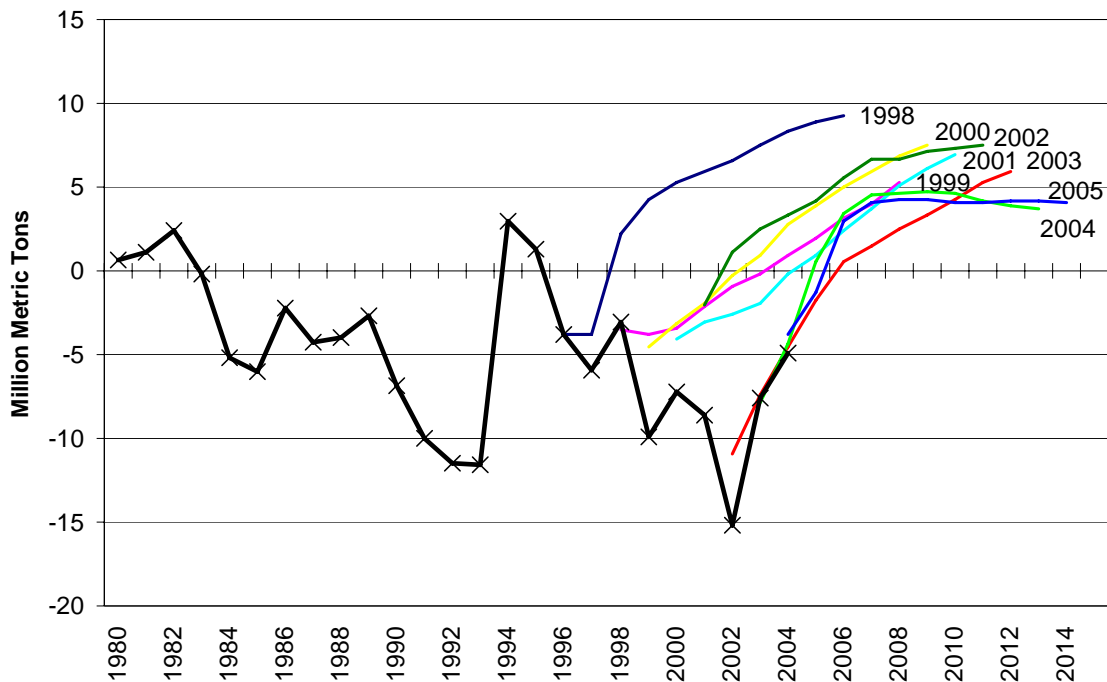


Figure 7: China corn net imports, Actual and FAPRI forecasts, 1998-2005

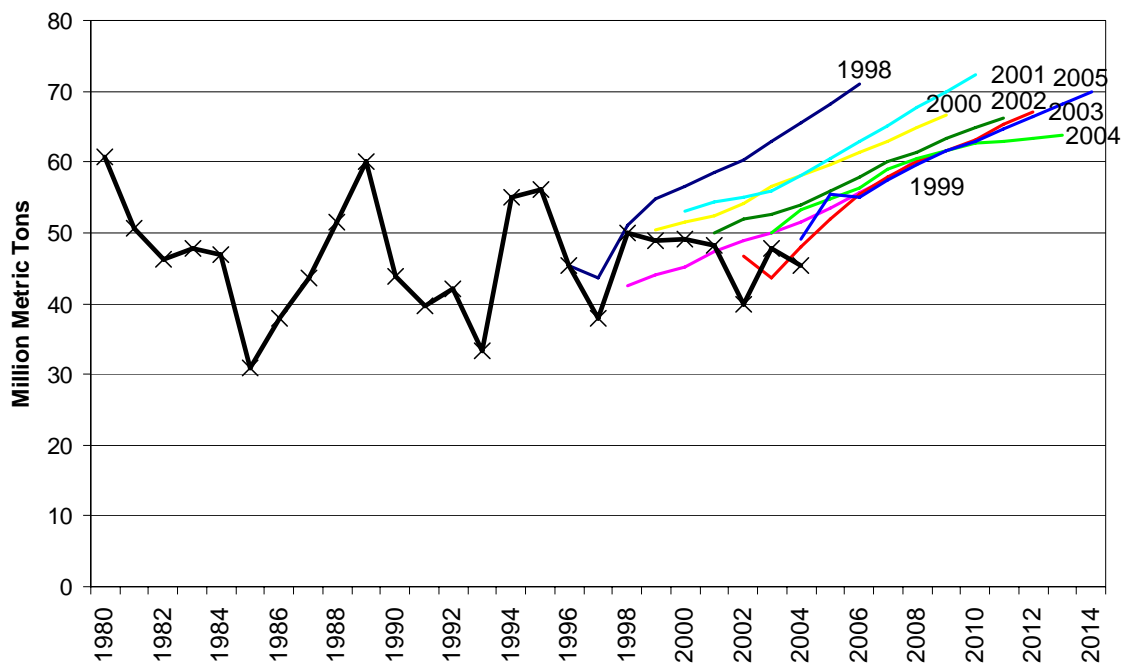


Figure 8: U.S. Corn net-exports, Actual and FAPRI forecasts, 1998-2005

### What the 1998 China Forecast Tells Us.

As discussed earlier, FAPRI baselines are current policy baselines. We must assume current domestic U.S. policies throughout the projection period and, given the five year life of U.S. farm programs, such assumptions are almost guaranteed to be wrong. This situation is even more problematic in China, where rapid growth means rapid and continual changes in China's policies. While self sufficiency is important in certain food grains, the Chinese have become increasingly willing to import cotton and soybeans. At the same time, the government has moved from taxation to modest subsidization of its farmers. Rapid growth in the economy and technology has also added uncertainty to the use of inputs and yields within China along with the government's movement toward an open economy based on market signals. Given the assumptions required for the baseline process, these types of errors may be unavoidable. It is for this reason that FAPRI goes through great effort to stress that the outlook is based on current policies.

### We Should Concern Ourselves with Bias

The baseline process is a mix of structural equations and analyst judgment. Structural equations provide the basis for results and the elastic response. Some equations are estimated, while others, due to lack of sufficient data, are synthetic and represent the analyst's best judgment. The analysts exert additional influence on the results through use of equation adjustments. It is this analyst input that could be perceived as bias. While the 1998 China grain projection doesn't show any particular bias it should remain a concern.

Adjustments made to equation errors are only as good as the information available to the analysts as they try to simultaneously handle hundreds of equations spread across a single country's market and thousands of equations for a global commodity with numerous countries and regions. With all the public focus on China, one can imagine analysts getting caught up in the hype surrounding speculation on yield, production, demand, and trade. The FAPRI baseline review process, where the preliminary baseline is presented to a group of researchers and industry experts, provides an opportunity to correct misjudgments by the analysts before the final baseline. Given the importance of China in formulating an appropriate baseline, more effort should be made to involve Chinese researchers and experts in the review process and to spend additional resources to get the baseline more widely viewed by researchers within China as a check on the results.

### **Macro-Economic Factors**

As with constant policy errors, certain macroeconomic events are unpredictable. While one can argue if China's real GDP grows 7 or 8 percent, it may be difficult or impossible to know if or when China will allow its currency to float against the dollar and what form the currency policy will take. Other factors such as oil price shocks, military conflicts, political tensions, SARS, and avian influenza also impact the results. While the macro-economic forecast used in the baseline process is obtained from an outside source, understanding the reliability of those forecasts and the implications on China's agricultural projection should be evaluated and used to determine the bounds around any projection.

### **Errors from Best Available Data**

The importance of the quality of current information as a factor that influences the reliability of projections or forecasts has been shown in this review of the 1998 China corn projection. In many locations throughout the world, this data are taken as given or expectations are that revisions will be small. For a large country like China, having accurate current information makes a sizable difference in the anticipated export projections. For many years the data on China's grain stocks suggested they would be likely to reduce exports and increase imports of corn. FAPRI, USDA, and other analyses projected growing US exports based on strong increases in sales to China. As the China data was revised over time, the US export growth projections grew more modest as China's stocks data revisions showed a lower need for imports. If another large stock revision occurred by USDA, it may have a larger effect on U.S. corn trade projections than the U.S. farm bill proposed in 2007. Additional research on China's markets is critical for improving the quality of long term commodities projections and domestic and international policy analysis.

Model structure could also be adjusted to depend on the data that is considered to be the most reliable. It is generally assumed that trade data on China is the most reliable, with production and consumption data being less reliable and stocks information being the least reliable. However, the stock levels remain a constraint on this change.

Collaboration with other Chinese researchers could also yield some benefits. The use of consumption surveys could help improve demand elasticities and provide insight into how those elasticities might evolve under rapid economic growth.

### **Stochastics as a Potential Partial Solution**

The domestic portion of the FAPRI deterministic world outlook has been largely supplanted by analysis using a U.S. stochastic model with reduced form equation extensions to mimic the rest of the world. The stochastic model differs from the deterministic model by including draws from the unexplained variation associated with numerous equations in the model. This approach is preferable when looking at estimated government costs which have a non-symmetric distribution with regard to yields as government expenditures are truncated at zero. For example, the errors associated with trend yield analysis form a distribution which can be drawn from multiple times to simulate a possible range of yield forecasts. Those yield forecasts can be used to solve the model putting bounds around the endogenous variables from yield to price and demand. The current stochastic approach therefore largely looks at the second moment of the residual term and not the parameter estimates themselves.

Some of the sources of errors could be addressed with world stochastic crops and livestock models which currently do not exist. Distributions for exchange rates and GDP growth could be drawn on to account for uncertainty surrounding these variables. This would account for some of the uncertainty surrounding trade and demand categories. While the distribution of yields around a trend is currently employed in the United States, and similar procedure could be implemented in China and around the world, the distribution of errors does not impact errors associated with the underlying trend. The coefficient on trend also has a potential distribution which could be drawn on, capturing the uncertainty surrounding the growth rates in yields. This process of drawing on the coefficient itself is not employed anywhere within the FAPRI system. None of these implemented or proposed stochastic processes address problems associated with uncertainty surrounding current market conditions and large data revisions.

### **Conclusion**

In the dynamic and rapidly growing economy of China, the uncertainty surrounding any projection is enormous. Some errors are a result of the conditioning assumptions, such as those associated with a constant policy baseline, while others can arise from analyst judgment, macro-economic forecasts, and incorrect information on current market conditions. Given the myriad sources of error, a more rigorous and systematic examination of projection discrepancies each year may be advisable. This exercise also clearly shows that we do not know as much as we should about China's agricultural markets. Improvements in other forecast methods can be easily overwhelmed by great data uncertainty from the world's largest producer and consumer of food.

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