6-14-2017

Projecting Corn and Soybean Crops: How Accurate Are Crop Forecasts?

Fabio Mattos
University of Nebraska-Lincoln, fmattos@unl.edu

Kattie Cumming
University of Nebraska-Lincoln

Xiaoli L. Etienne
West Virginia University

AGRICULTURAL ECONOMICS

June 14, 2017

agecon.unl.edu/cornhuskereconomics

Cornhusker Economics

Projecting Corn and Soybean Crops: How Accurate Are Crop Forecasts?

Market Report	Year Ago	4 Wks Ago	6-12-17
Livestock and Products, Weekly Average			
Nebraska Slaughter Steers, 35-65% Choice, Live Weight.	119.24	*	135.06
Nebraska Feeder Steers, Med. & Large Frame, 550-600 lb.	161.26	178.82	187.68
Nebraska Feeder Steers, Med. & Large Frame 750-800 lb.	145.42	151.90	*
Choice Boxed Beef, 600-750 lb. Carcass.	225.53	244.35	250.22
Western Corn Belt Base Hog Price Carcass, Negotiated	80.48	70.76	78.72
Pork Carcass Cutout, 185 lb. Carcass 51-52% Lean.	86.63	81.50	91.04
Slaughter Lambs, wooled and shorn, 135-165 lb. National.	143.29	159.39	182.77
National Carcass Lamb Cutout FOB.	340.95	399.58	422.54
Crops, Daily Spot Prices			
Wheat, No. 1, H.W. Imperial, bu.	3.76	3.03	3.28
Corn, No. 2, Yellow **Columbus**, bu.	4.05	3.32	3.43
Soybeans, No. 1, Yellow **Columbus,** bu.	10.85	8.77	8.48
Grain Sorghum, No.2, Yellow Dorchester, cwt.	6.51	5.58	5.81
Oats, No. 2, Heavy Minneapolis, Mn, bu.	2.60	2.58	2.89
Feed			
Alfalfa, Large Square Bales, Good to Premium, RFV 160-185 Northeast Nebraska, ton.	165.00	128.75	*
Alfalfa, Large Rounds, Good Platte Valley, ton.	75.00	67.50	70.00
Grass Hay, Large Rounds, Good Nebraska, ton.	80.00	65.00	*
Dried Distillers Grains, 10% Moisture Nebraska Average.	156.00	104.00	101.00
Wet Distillers Grains, 65-70% Moisture Nebraska Average.	50.00	40.00	39.50

*** No Market**

Commodity prices are determined by the dynamics of supply and demand and they oscillate over time according to expectations of market participants, who form and update their outlooks based on new information available in the market. As new information about supply and demand of commodities becomes available, buyers and sellers review their beliefs and trade in the market accordingly. This process of price discovery is crucial for various business decisions in the agricultural sector, such as production, marketing and risk management. For instance, if new information on supply and demand suggests that corn prices will decrease, grain producers might want to choose a risk management strategy that protects them against falling prices.

Public-available crop reports are one of the main sources of information about underlying supply and demand in many agricultural markets. Government agencies, such as the United States Department of Agriculture (USDA), collect and analyze data on crop supply and demand, and then distribute their results and forecasts to all market participants. The World Agricultural Supply and Demand Estimates (WASDE) report is prepared and released by the USDA every month, and it is the report most commonly followed by grain market participants. The WASDE publishes data on supply and demand for corn and soybeans (along with other commodities) in the United States and other countries.

Figure 1 shows the main supply and demand variables for corn and soybeans accounted for in the WASDE report. Essentially, the supply side takes into account the availability of grain in the market, while the demand (use) side considers the various ways in which the grain is used. Starting with supply, the amount of grain available in a given year is determined by beginning stocks (how much is carried over from the previous year), production (amount produced domestically in the current year) and imports (amount bought from other countries). On the demand (use) side, we can look into two major groups: domestic use and exports. Domestic use refers to the different activities that consume grain in the domestic market. For example, in the United States, corn is

used domestically to feed livestock and produce food products and ethanol, while soybeans are mostly used in the domestic market to produce soybean meal and oil (crushings). Adding exports (i.e. international demand) to domestic use gives us the total amount of grain that is used or consumed in a given year. Finally, subtracting total use from total supply leads to the amount of grain still available at the end of the year (ending stocks).

Figure 1. Main supply and demand variables for corn and soybeans in the WASDE report.

Corn	Soybeans
Beginning stocks (1)	Beginning stocks (1)
+ Production (2)	+ Production (2)
+ Imports (3)	+ Imports (3)
= Total supply (1+2+3)	= Total supply (1+2+3)
Feed and residual (4)	Crushings (4)
+ Food, seed and industrial use (5)	+ Seed (5)
= Domestic use (4+5)	+ Residual (6)
+ Exports (6)	= Domestic use (4+5+6)
= Total use (4+5+6)	+ Exports (7)
	= Total use (4+5+6+7)
Ending stocks (total supply - total use)	Ending stocks (total supply - total use)

Each WASDE report contains supply and demand information for the United States and all other major producers and consumers of grain in the world. In addition to data on the current and previous crop years, the WASDE report also releases forecasts for the next crop year that begins in September and runs through August of the following year. Figure 2 presents an example of the WASDE report released in June 2017, showing forecasts for the corn market in 2017/18 (the next crop year).

The leadership position of U.S. agriculture in the world and the comprehensiveness and the timeliness of its information have historically established crop reports from USDA as the benchmark for all supply and demand data worldwide. However, the landscape in commodity markets has been changing in the recent past. The share of U.S. major grain exports in the global market declined steadily over the past several years, while the relative importance of other countries has increased. Currently, countries like Argentina, Brazil, China and Ukraine have a much larger share of the world grain market than they had 10-15 years ago. As the relative importance of other countries in the world grain market increases, more and better data is necessary in order for market participants to assess conditions in these countries and respond accordingly. Despite all the technology advances in collecting and assessing data, it may still be challenging to forecast supply and demand in foreign countries, especially when the agriculture industry in these countries is undergoing rapid changes. As many other countries become increasingly important in the world market, two questions emerge. Does the WASDE report forecast supply and demand for other countries as accurately as it does for the United States? In addition, are WASDE forecasts for the world market accurate at all?

We explored these questions by looking into WASDE forecasts for corn and soybeans for production, imports, domestic use, exports, feed (corn only), crushings (soybeans only) and ending stocks. The first estimate for a given crop year is released in the month of May preceding the beginning of the crop year, while the last estimate for the same crop year is released a few months after its end. Therefore, there are approximately 20 monthly estimates for each variable for a given crop year. We calculated the "forecast error" by comparing each monthly estimate to the final number for the variable. For example, in May 2017, the WASDE estimated that U.S. corn exports for 2017/18 will be 47.63 million metric tons. Later, after the end of the 2017/18 crop year, let us assume that U.S. corn exports turn out to be 55 million metric tons. Thus, the estimate released in May 2017 (47.63) was 13.4% lower than the actual number for 2017/18 (55). Therefore, -13.4% is the forecast error for U.S. corn exports in May 2017.

We investigated these estimates for four countries: Argentina, Brazil, China and United States. The sample generally starts in the early 1980's, but the total sample size for each country varies from 14 to 36 years (Table 1). For example, the corn sample for Brazil starts in 2002/03 because corn was not a relevant crop in Brazil before that time. Hence, WASDE would not report individual estimates for corn in Brazil before 2002.

Table 1: WASDE sample periods for each country

	Corn	Soybeans
Argentina	1985/86 – 2015/16 (31 years)	1985/86 – 2015/16 (31 years)
Brazil	2002/03 – 2015/16 (14 years)	1985/86 – 2015/16 (31 years)
China	1988/89 – 2015/16 (28 years)	1997/98 – 2015/16 (19 years)
United States	1985/86 – 2015/16 (31 years)	1980/81 – 2015/16 (36 years)

Overall, our results indicate a certain degree of overestimation (estimates are higher than final numbers) and underestimation (estimates are lower than final numbers) in the WASDE reports for all variables in all countries. In particular, our findings suggest some caution with the forecasts released before the beginning of the crop year and in the first few months of the crop year. There is large variability in estimates during those early months (either overestimation or underestimation), i.e. initial forecasts are not especially accurate. More specifically, for corn, there is evidence of underestimation for production, domestic use and feed in Argentina; production, imports and ending stocks in Brazil; production and ending stocks in China; and imports in the United States. For soybeans, there is evidence of underestimation for production, domestic use, crushings and ending stocks in Argentina, Brazil and China. In the United States, domestic use, crushings and exports tend to be underestimated in the early months, while ending stocks tend to be overestimated. Figure 3 (corn) and Figure 4 (soybeans) illustrate these findings for each variable in each country as they show average forecast errors in each month of the forecasting cycle (the average forecast error in a given month is the average of errors in that month across all years in our sample).

For most variables, these findings suggest that, in the early months, estimates tend to be smaller than the actual number turns out to be in later months. In general, the magnitude of those forecast errors are generally larger in Argentina and China and smaller in the United States. Hence, it seems that the WASDE can forecast supply and demand more accurately in the United States than it does in other countries.

Regardless of the magnitude of forecast errors in the early months, there is one finding common to all forecasts in the WASDE report. They do become more accurate during the crop year (i.e. forecast errors tend to reduce significantly as months go by) and the variability of the forecasts decreases. In other words, the magnitude of overestimation or underestimation is generally larger when forecasts are made before the beginning of the crop year (or in the first few months of the crop year) than when they are made towards the end of the crop year (Figure 3 and Figure 4). This should be expected, since it becomes relatively easier to make forecasts as more information becomes available during the crop year. For example, once the crop starts being harvested, we have more and better information to forecast production; hence, we can naturally make more precise forecasts about production after the crop year starts.

Another finding of this analysis is that forecast errors have generally become smaller over the years, i.e. forecasts now tend to be relatively more accurate than they were in the past (say, 10-15 years ago). This could be due to many reasons. For example, market analysts might have improved their forecasting models and/or gained access to more and better data. Either way, it is certainly beneficial for market participants when the quality of forecasts improves over time.

Forecasting is a complex job that involves many challenges in understanding differences in market structure across commodities and countries, finding reliable and detailed information on supply and demand in different countries, creating a robust statistical model, among others. Therefore, it is not surprising that our findings indicate the presence of forecast errors for many supply and demand variables in Argentina, Brazil, China and United States. It could also be expected that the magnitude of forecast errors varies across countries, which can happen for various reasons. For example, data may be more readily available or of better quality in some countries than in others, or forecasters may have distinct levels of familiarity with markets in different countries. Nevertheless, it is positive that, in general, the accuracy of the WASDE forecasts has been improving over time and it also tends to improve during the crop year.

Finally, as we stated in the beginning, supply and demand forecasts are important in the process of price determination in commodity markets. Since forecasts are not perfect, it is often useful to learn about the magnitude and direction of forecast errors for different variables in different countries, which can help understand and sometimes anticipate price movements in the market.

Fabio Mattos
Assistant professor
Department of Agricultural Economics
University of Nebraska-Lincoln

Katie Cumming
Graduate research assistant
Department of Agricultural Economics
University of Nebraska-Lincoln

Xiaoli L. Etienne
Assistant professor
Division of Resource Economics& Management
West Virginia University

Figure 2: Example of supply and demand information on the WASDE report – Projections for the corn market in 2017/18

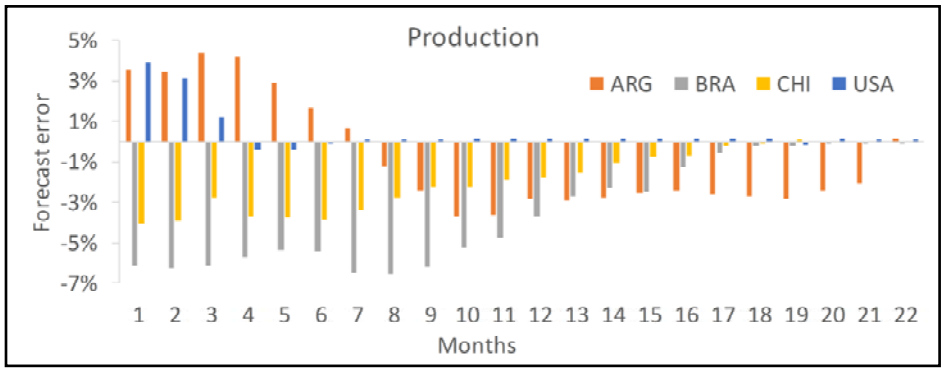
World Corn Supply and Use [1/]
(Million Metric Tons)

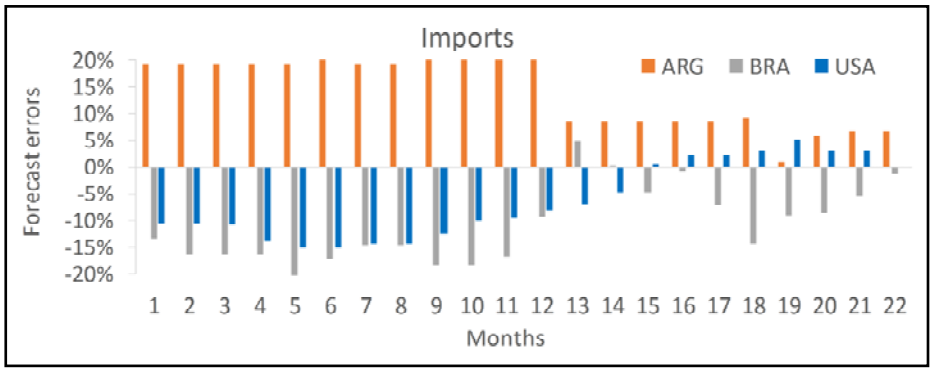
2017/18 Proj.		Beginning Stocks	Production	Imports	Domestic Feed	Domestic Total [2/]	Exports	Ending Stocks
World [3/]	May	223.90	1,033.66	144.79	650.86	1,062.30	151.91	195.27
	June	224.59	1,031.86	145.79	650.36	1,062.12	152.91	194.33
United States	May	58.30	357.27	1.27	137.80	315.61	47.63	53.60
	June	58.30	357.27	1.27	137.80	315.61	47.63	53.60
Total Foreign	May	165.60	676.40	143.52	513.06	746.69	104.29	141.67
	June	166.29	674.60	144.52	512.06	746.51	105.29	140.73
Major Exporters [4/]	May	14.89	147.50	0.41	65.30	84.00	64.20	14.59
	June	15.58	147.50	0.41	65.30	84.50	64.20	14.79
Argentina	May	2.86	40.00	0.01	7.50	11.30	28.50	3.06
	June	2.87	40.00	0.01	7.50	11.30	28.50	3.07
Brazil	May	9.27	95.00	0.30	52.00	61.00	34.00	9.57
	June	9.77	95.00	0.30	52.00	61.50	34.00	9.57
South Africa	May	2.76	12.50	0.10	5.80	11.70	1.70	1.96
	June	2.95	12.50	0.10	5.80	11.70	1.70	2.15
Major Importers [5/]	May	21.61	124.27	84.30	152.80	206.05	3.93	20.19
	June	21.61	122.77	85.30	152.70	205.75	3.93	19.99
Egypt	May	2.11	6.00	10.00	13.40	15.90	0.01	2.20
	June	2.11	6.00	10.00	13.40	15.90	0.01	2.20
European Union [6/]	May	5.99	63.50	14.00	56.10	75.00	2.50	5.99
	June	5.99	62.00	15.00	56.00	74.70	2.50	5.79
Japan	May	1.24	-	15.00	11.50	15.10	-	1.15
	June	1.24	-	15.00	11.50	15.10	-	1.15
Mexico	May	6.41	25.00	15.50	22.70	40.70	0.70	5.51
	June	6.41	25.00	15.50	22.70	40.70	0.70	5.51
Southeast Asia [7/]	May	3.22	29.61	15.10	36.65	44.45	0.72	2.76
	June	3.22	29.61	15.10	36.65	44.45	0.72	2.76
South Korea	May	1.91	0.08	10.20	8.00	10.30	-	1 .89
	June	1.91	0.08	10.20	8.00	10.30	-	1.89
Selected Other								
Canada	May	2.42	15.20	0.80	8.50	14.10	1.50	2.82
	June	2.42	14.40	0.80	8.50	14.10	1.50	2.02
China	May	101.31	215.00	3.00	166.00	238.00	0.02	81.29
	June	101.31	215.00	3.00	166.00	238.00	0.02	81.29
FSU-12	May	2.61	48.35	0.36	20.43	23.21	25.71	2.40
	June	2.61	48.85	0.36	20.03	22.81	26.71	2.30
Ukraine	May	1.24	28.00	0.03	7.00	8.40	20.00	0.86
	June	1.24	28.50	0.03	6.90	8.30	20.50	0.96

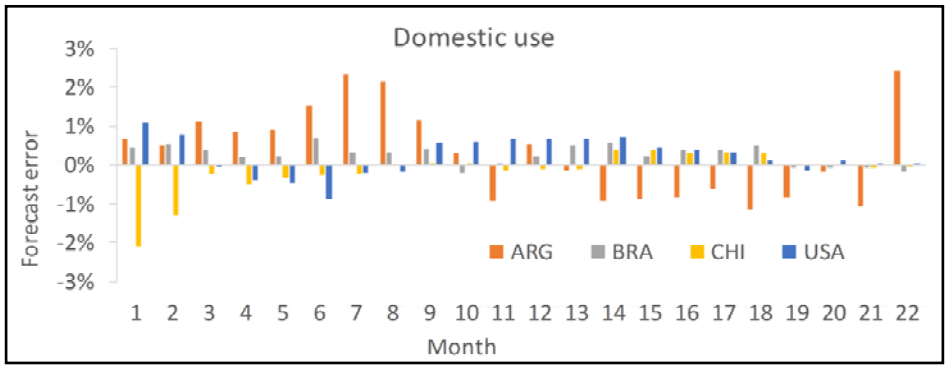
[1/] Aggregate of the local marketing years.
[2/] Total foreign and world use adjusted to reflect the differences in world imports and exports.
[3/] World imports and exports may not balance due to differences in marketing years, grain in transit, and reporting discrepancies in some countries.
[4/] Argentina, Brazil, and South Africa.
[5/] Egypt, the European Union, Mexico, Japan, South Korea, Taiwan and Southeast Asia.
[6/] Trade excludes intra-trade.
[7/] Indonesia, Malaysia, Philippines, Thailand and Vietnam.

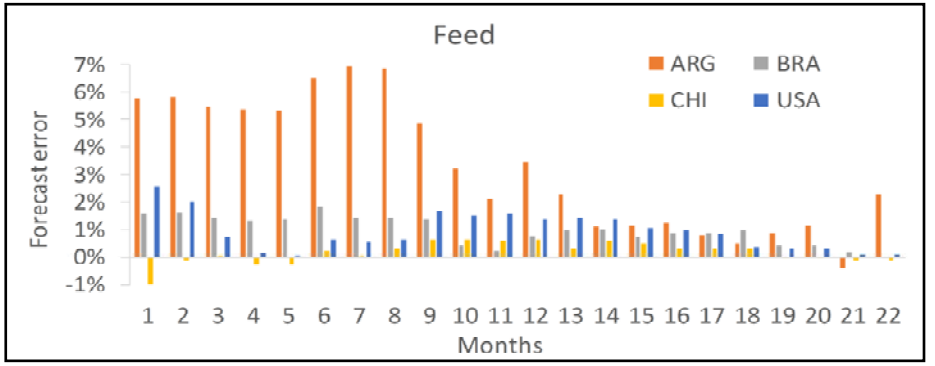
Source: USDA, June 2017 (https://www.usda.gov/oce/commodity/wasde/latest.pdf.

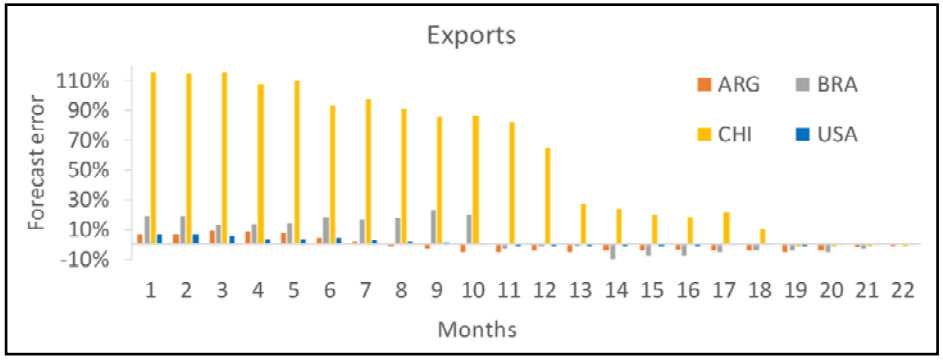
Figure 3: Corn – Average forecast errors in each month of the forecasting cycle for Argentina (ARG), Brazil (BRA), China (CHI) and United States (USA) [a], [b], [c]

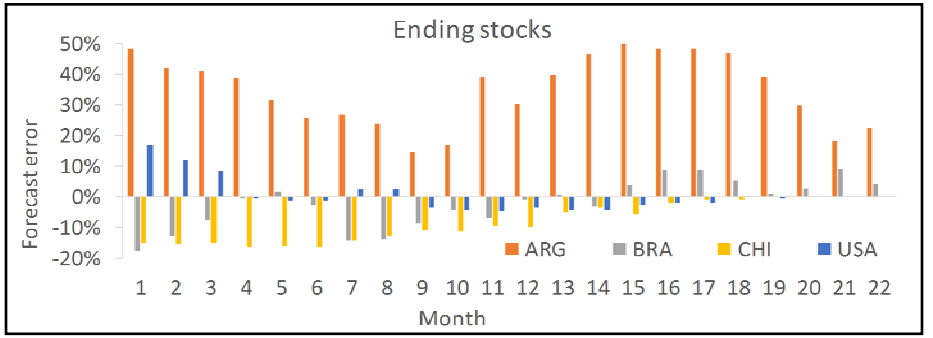






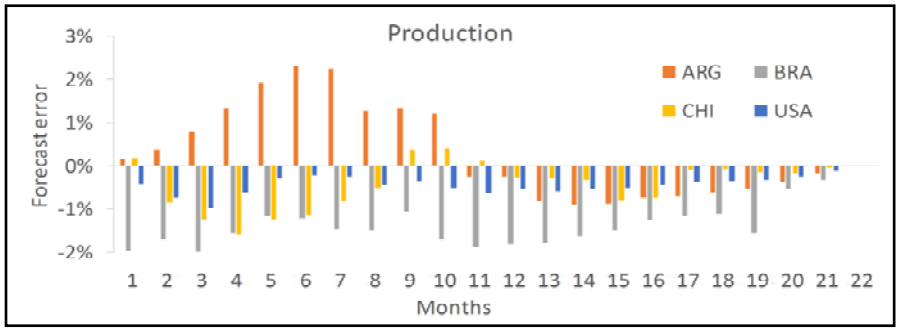


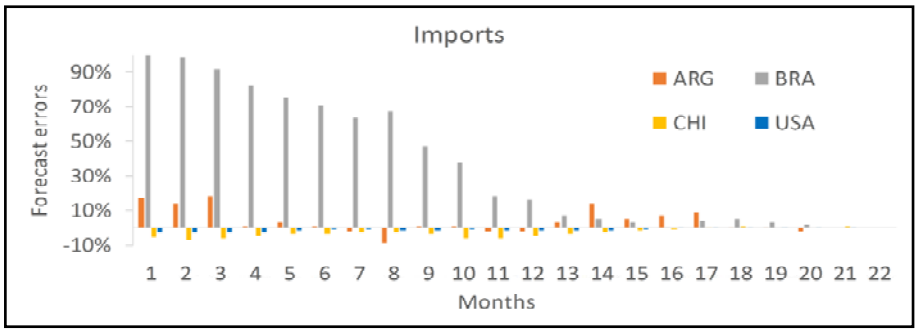


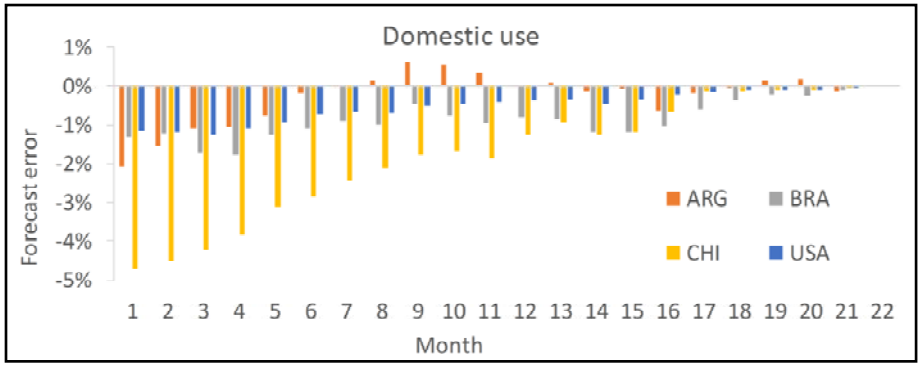


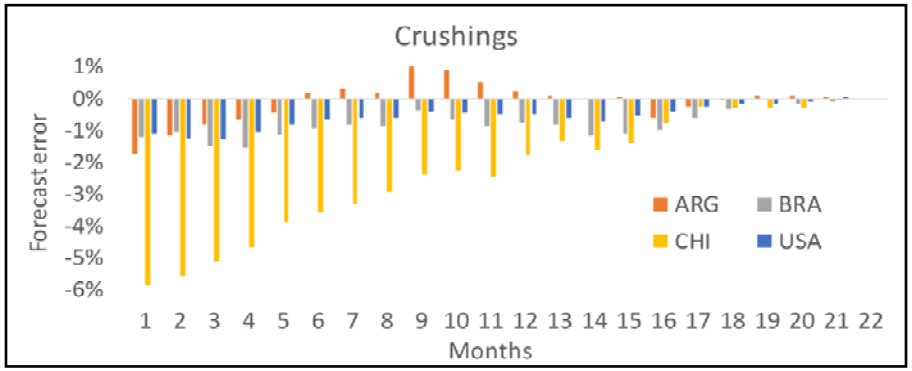
[a] Average forecast error is the average of all forecast errors in a given month across all years in our sample; [b] Negative forecast errors imply underestimation, while positive forecast errors imply overestimation; [c] Month = 1 is June prior to the beginning of the crop year, month = 2 is July prior to the beginning of the crop year, ……, month = 22 is March after the end of the crop year (the USDA still needs a few months after the end of the crop year to compile all the data and release final numbers for the crop year).

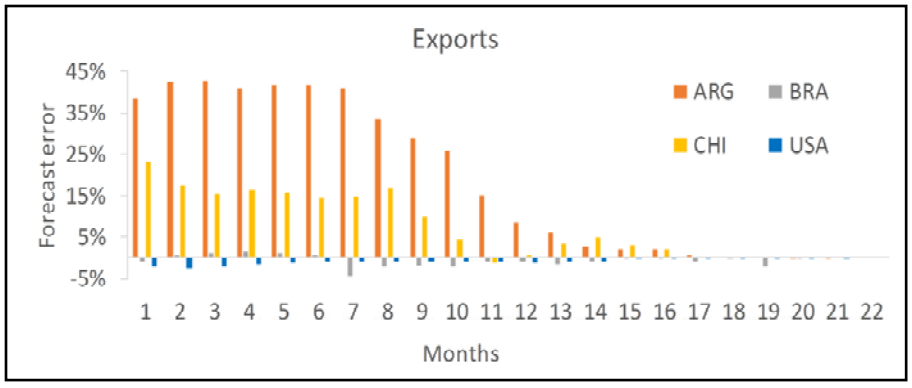
Figure 4: Soybeans – Average forecast errors in each month of the forecasting cycle for Argentina (ARG), Brazil (BRA), China (CHI) and United States (USA) [a], [b],

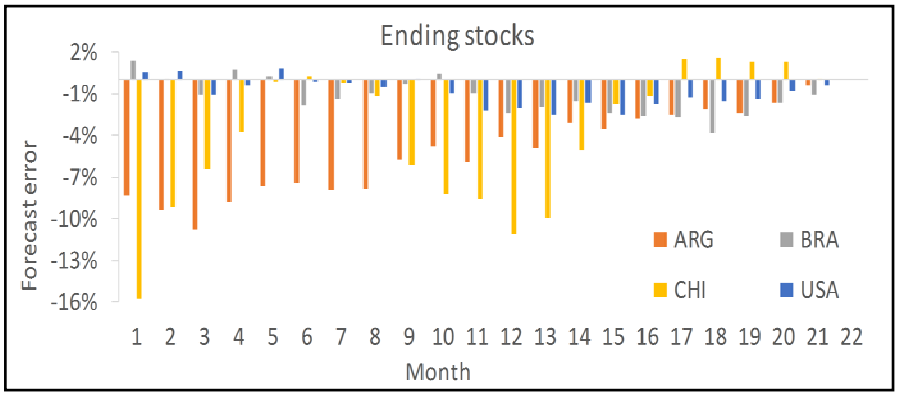












[a] Average forecast error is the average of all forecast errors in a given month across all years in our sample; [b] Negative forecast errors imply underestimation, while positive forecast errors imply overestimation; [c] Month = 1 is June prior to the beginning of the crop year, month = 2 is July prior to the beginning of the crop year, ……, month = 22 is March after the end of the crop year (the USDA still needs a few months after the end of the crop year to compile all the data and release final numbers for the crop year).