What Do We Know About the Accuracy and Impact of USDA Reports in the Corn Market?

by

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Executive Summary

This study reviewed over 80 previous studies that evaluated the accuracy and market impact of USDA reports relevant to the corn markets. These reports included Prospective Plantings, Acreage, Crop Production, Crop Progress, Grain Stocks, Export Sales and World Agricultural Supply and Demand Estimates (WASDE). Our analysis of previous literature revealed

- Extensive evidence of the lack of bias and consistent accuracy in USDA *yield forecasts* with accuracy improving over time.
- Revisions to USDA *production forecasts* were sometimes positively correlated and directionally consistent, suggesting they could be smoothed. However, it is difficult to anticipate this smoothing pattern ahead of time and market participants seem to be aware of it, thus its impact is likely minimal.
- Additional sources of information, such as weather models, crop conditions and private precision agriculture data, demonstrated limited potential for improving USDA *yield forecasts*.
- WASDE price forecasts were traditionally published as a range without a confidence level. Several studies suggested appropriate methods for evaluating their accuracy as well as developed alternative methods for generating more accurate prediction intervals. However, USDA switched to publishing point price forecasts in May 2019.
- Midpoints of WASDE corn price forecasts were typically more accurate than futures-based alternatives.
- Errors in WASDE balance sheet forecasts were associated with structural changes in commodity markets that took place in the mid-2000s, challenges with predicting periods of economic growth and changes in exchange rates. Errors in supply and use forecasts contributed to ending stocks forecast errors. Ending stocks forecasts were inefficient with predictability in revisions consistent with smoothing.
- There was a notable decline in the ability of market participants to anticipate USDA grain stock estimates for corn through 2013. These large surprises for corn grain stocks were likely due to unresolved sampling errors for corn production estimates, suggesting a need for a revision of January corn production estimate as well as a survey of corn feed use.
- While USDA baseline corn price forecasts have large errors, they tend to perform better than futures-based alternatives up to three years in advance
- USDA's corn Prospective Plantings, Acreage, and October Crop Production forecasts were consistently more accurate than private forecasts. The only evidence of private forecasts dominating the USDA was found for August corn production during 1990s and early 2000s. However, USDA has regained its advantage in August corn production forecasts since the mid-2000s
- Extensive evidence of futures market reaction to USDA reports in the form of larger return variance. However, this reaction signals that these reports provide new information to the markets. Reaction tends to be stronger when multiple reports are released at the same time.

- Extensive evidence of futures market reaction to unanticipated information in USDA reports measured as the difference between USDA announcement and private industry expectations, or "market surprise." Strongest reaction to October and November crop production surprises and January and March grain stock surprises.
- Extensive evidence of WASDE reports reducing market uncertainty as measured by a drop in option implied volatility following report release. Market uncertainty in corn and soybean markets decreases not only immediately following the report release but remains low for up to five days. This decrease in market uncertainty was more pronounced when there had been greater disagreement among industry expectations prior to the reports.
- Information value tests show that August and October crop production reports get us closer to knowing the final estimate, thereby reducing uncertainty in the markets. Prospective Plantings and Acreage reports play a much bigger role in reducing supply uncertainty than Crop Production reports since 1983. The informational value of USDA forecasts has increased over time and was the strongest in the most recent 2002-2019 subperiod.
- Several studies demonstrated positive trading returns would be possible from knowing USDA's crop production reports in advance.
- Intraday data allowed to measure that the strongest price reactions to the releases were found immediately after markets opened and persisted for about ten minutes. Some subtle reactions in the last trading session before the release, suggested that traders adjusted their market exposure in anticipation of the release.
- Extending trading hours resulted in brief shocks in corn futures price volatility around the release of WASDE reports that may pose a challenge for producers whose risk management strategies are affected by intraday price swings. Typically, however, the heightened volatility has not lasted more than 30 to 60 minutes, thus it should not affect long-term risk management positions.

It is important to recognize the role of USDA information in market price discovery and reduction of information asymmetry. In order to maintain this role and ensure the quality of this information, it is important to keep communication lines open. Greater efforts can be made to increase transparency of USDA outlook and data products.

Background

In response to grower concerns regarding the increasing complexity of the crop report survey process, the accuracy of reports for market integrity and a declining participation rate (documented by Johansson, Effland, and Coble, 2017), commodity groups and farm organizations have invested time and resources to improve the NASS survey process and results. Growers and staff from the National Corn Growers Association (NCGA) began to collaborate with NASS officials in 2016 to address these issues.

Recognizing the need to ensure robust, accurate production data for the Farm Service Agency to deliver an effective and equitable county revenue-based commodity program, NCGA embarked upon a collaborative communications campaign with NASS to promote grower participation in the crop production survey. This joint effort primarily targeted counties with insufficient data due to low response rates. The outreach resulted in some limited success attaining higher participation in key areas and served to advance the discussion with NASS on improving the crop survey process to enhance growers' confidence in USDA's reports. These efforts have been expanded and extended by the National Corn Growers Association through commissioning this independent study to establish the state of knowledge regarding the accuracy and market impact of USDA information on corn markets.

In response to public concerns, USDA has put together a number of presentations to address the quality of their crop estimates in 2019 (e.g., USDA's Office of the Chief Economist, 2020). However, it is important to discuss these recent developments in the context of the objective historical track record of USDA reports related to their accuracy, reliability and market impact. The questions that need to be answered are: How well do the USDA reports typically reflect market realities? Are the approaches used by USDA valid and reliable? What are the

drawbacks and can they be improved? The answers to these questions may help rebuild public confidence in USDA information and improve farmer participation in its collection.

The goal of this study is to conduct a systematic review of previous studies that evaluated the accuracy and market impact of USDA reports relevant to the corn market. These reports will include Prospective Plantings, Acreage, Crop Production, Crop Progress, Grain Stocks, Export Sales and World Agricultural Supply and Demand Estimates (WASDE).

USDA Reports

Figure 1 shows that the USDA annual forecasting cycle for corn starts at the end of March with Prospective Plantings (PP) reports released by NASS. These reports contain information about producer planting intentions based on producer responses to the March Agricultural Survey. Good and Irwin (2011) provide a thorough review of the survey procedures used by the USDA. Planted acreage estimates from Prospective Plantings reports serve as a foundation for early production estimates by USDA.

Crop Progress (CP) reports are released by NASS each week during the growing season (April through November). "CP reports contain weekly cumulative planting, fruiting, and harvesting progress and crop condition of selected crops in major producing states over the growing season. These estimates are based on survey data collected from around 4,000 respondents… Progress data for corn are expressed as a percentage of the crop planted, silking, dough, dented, mature, and harvested… Condition data are expressed as a percentage of the crop in excellent, good, fair, poor, and very poor condition. These estimates should reflect the effects of all variables on the status of a crop, such as temperature, precipitation, planting date, solar radiation, insect infestation and disease" (Lehecka, 2014, p. 90).

The WASDE forecasting cycle for the corn marketing year (September through August) starts in May preceding the marketing year and continues for 18 months until November following the marketing year. WASDE reports are released between the 9th and the 12th of each month at 3pm EST until April 1994, at 8:30am EST from May 1994-December 2012, and at 12pm EST from January 2013 to present. These reports, released by the World Agricultural Outlook Board (WAOB) combine supply and use information from all available sources, including National Agricultural Statistical Service (NASS), Foreign Agriculture Service (FAS), Economic Research Service (ERS), Farm Service Agency (FSA), and Agricultural Marketing Service (AMS), and combine it in a balance sheet format that shows resulting changes in ending stocks and price. Separate balance sheets are maintained for over 90 countries to produce estimates for both US and World supply and use for major crops and livestock. When WASDE reports are released simultaneously with other reports (such as Crop Production) they include the latest information from these reports.

Additional information on expected supply becomes available at the end of June from the annual Acreage reports that provide updated survey information on planted acreage and estimates of harvested acreage. Both Acreage and Prospective Plantings reports were released at 3pm EST through 1994, at 8:30am EST from 1995-2012, and at 12pm EST from 2013 to present. Crop Production reports for corn are released from August through November and include and survey-based estimates of acreage, yield and production. The Crop Production Annual Summary reports published in January contain final production information for corn. Crop Production reports typically have been published between the 9th and the 12th of each month and released at 3pm EST until April 1994, at 8:30am EST from May 1994-December 2012, and at 12pm EST from January 2013 to present.

Grain Stocks reports track available supply throughout the marketing year, which is a function of annual production and the pace of use, and are issued by NASS quarterly, in the beginning of January, and at the end of March, June, and September and describe stocks in storage at the beginning of these months. These reports describe stocks of multiple crops, including corn, soybeans, and wheat, as well as the number and capacity of on- and off-farm storage facilities. The release schedule for Grain Stocks reports changed similarly to the other reports described above with 3pm EST release time through June 1994, 8:30 am EST release time from September 1994-September 2012 and 12pm EST release time from January 2013 to present.

Export Inspections reports are released by Agricultural Marketing Service weekly on Mondays during the marketing year and reflect the quantity of commodities inspected for export by the Federal Grain Inspection Service (FGIS) during the previous week beginning on Friday and ending on Thursday, midnight. Exports exempted from inspection are included in Export Sales reports. Export Sales reports cover the same reporting period as the inspections report, but are released later in the week on Thursday. Thus, "Export Inspections reports provide the first public reporting of a fairly comprehensive measure of the current pace of confirmed exports. However, if sales or cancellations of designated commodities are large enough, the USDA issues a daily press release." (Colling, Irwin, Zulauf, 1996, p.128)

How Accurate and Reliable are USDA Production Forecasts?

While a brief summary of forecast accuracy and reliability is presented at the end of each WASDE report, there is an extensive body of literature that explores the accuracy and efficiency of USDA forecasts. It is important to be aware of the USDA report shortcomings with respect to

accuracy and efficiency in order to take them into account in interpreting forecasted information for decision making. A quick comparison across tables 1, 2 and 3 shows that the accuracy of crop production forecasts (shown in table 1) have received the most scrutiny, followed by WASDE price forecasts (table 2), while the evaluation of other forecasts (table 3) received less attention. This probably is not surprising given that crop production forecasts tend to cause strong market reactions, as discussed in the previous sections.

A number of the studies of the USDA crop production forecasts, included in table 1, focus on both the methodology and accuracy associated with these estimates. For example, Good and Irwin (2006), Good and Irwin (2011), Good and Irwin (2013), Irwin, Good and Sanders (2015), and Irwin and Good (2016) explain the methodology behind USDA crop yield forecasts and argue that in order to build trust and support across producers and encourage them to participate in the surveys on which these forecasts are built, USDA should "open the black box" behind their forecasts and become more transparent about their methods and any changes to their approaches. These studies also argued that that WAOB corn and soybean yield forecasts presented in May-July WASDE reports did not have a substantial bias and remained consistently accurate over time (1993-2012). NASS corn and soybean yield forecasts (presented in August-November WASDE) were also unbiased, but there was some evidence of improvement in corn yield forecasts, while soybean yield forecasts have become more conservative over time with an increasing tendency to under-estimate final yields during 2004-2012. Furthermore, Irwin, Good and Sanders (2014) argued that the accuracy of USDA corn yield forecasts has improved over time, particularly since 2011. Thus, the general consensus of these studies is that USDA crop production forecasts are accurate and unbiased but USDA needs to do a better job

communicating their methods and procedures to the public to maintain and improve survey response rates.

Another issue that received considerable attention in the literature is whether USDA crop production forecasts were smoothed, resulting in big crops getting bigger and small crops getting smaller. This issue was first raised by Isengildina, Irwin and Good (2006), who showed that revisions of NASS corn and soybean production forecasts over 1970-2004 were sometimes positively correlated and directionally consistent. This pattern of predictability in production forecast revisions is consistent with the concept of "smoothing," which may be due to a conservative bias in farm operators' assessments of yield potential and in the procedure for translating enumerator's information about plant fruit counts into objective yield estimates. The authors argued that losses in forecast accuracy due to smoothing were statistically and economically significant. Xie, Isengildina-Massa and Sharp (2016) developed a statistical procedure for correction of smoothing in corn, soybean, wheat and cotton production forecasts and demonstrated potential improvements in accuracy resulting from this correction. However, in a follow up study (Isengildina, Irwin and Good, 2013) found that although the pattern of smoothing may appear obvious to market analysts in hindsight, it is difficult to anticipate. In other words, one would need to know that we are expecting a big crop to apply the pattern of "big crop getting bigger" to crop production revisions. Irwin, Good and Newton (2014) updated and extended this analysis to show that historically not all big crops got bigger and the challenges with anticipating the size of 2014 crop during August. Nevertheless, Isengildina-Massa, Karali and Irwin (2017) showed that market participants appear to be aware of smoothing and adjust for it in forming their price expectations.

Several other studies explored how additional information can be used to improve yield forecasts. Irwin and Hubbs (2020) found that several alternative crop weather models generated errors that were larger than WAOB and NASS corn yield forecasts. Irwin and Hubbs (2018) argued that while crop condition ratings provide useful information for yield forecasting, considerable amount of uncertainty exists in this measure during the growing season. Specifically, historical model errors for mid-June are associated with about 10bu/acre errors relative to the final crop yield estimate for corn and 2.5 bu/acre errors for soybeans, indicating they should be used with caution. Tack et al. (2019) explored whether non-random private farm level data available from precision agriculture sources can be used to generate accurate forecasts of corn yield. Their findings revealed that these non-representative samples of data result in biased yield estimates on both regional and national levels. "To the extent that large farms are the early adopters of precision technology, our results suggest that, if not corrected for bias, data from those farms could introduce inaccuracy relative to a representative national sample." (p. 680)

How Precise and Efficient are USDA Price Forecasts?

Evaluation of USDA price forecasts (table 2) focused both on their performance and their ability to accurately reflect uncertainty associated with the forecast. Differently from all other USDA forecasts, price forecasts have historically been published as a range. WASDE provides a judgmental price projection from a balance sheet approach that includes ranges reflecting uncertainty associated with prices in the future (Vogel and Bange, 1999). These price ranges were constructed symmetrically but the distribution of forecast prices is asymmetric and does not represent a constant confidence interval (Isengildina-Massa, and Sharp, 2012). Researchers

proposed appropriate methods for evaluating accuracy of these forecasts as intervals (Isengildina, Irwin and Good, 2004), as well as alternative methods for generating more accurate prediction intervals (Isengildina-Massa, Irwin and Good, 2010; Isengildina-Massa et al., 2011; Adjemian, Bruno and Robe, 2020). The biggest issue with these forecasts was the lack of confidence level information to accompany price ranges, rendering them difficult to interpret. However, rather than adopting some of these recommendations and publishing more informative intervals, USDA decided to switch to publishing point price forecasts in May 2019. Given the confusion about what price ranges represented, these ranges have usually been reduced to their midpoints in interpretation and analysis. For example, Hoffman et al. (2015) demonstrated that WASDE corn price forecasts were more accurate than several futures-based benchmarks in 9 out of 16 forecasting periods over 1980-2012. However, combining WASDE and futures-based forecasts reduced forecasts errors by 12-16 percent on average. This study further demonstrated that favorable average trading profits could be generated in some months using WASDE projections, suggesting that WASDE projections of the U.S. corn season-average price provide useful information to the market and could enhance the efficiency of the agricultural sector.

What About the Accuracy of Other USDA Forecasts?

Among other USDA forecasts, WASDE ending stocks forecasts, NASS Grain Stocks estimates, and USDA's baseline production and price forecasts received most attention. "Ending stocks measure the carryover of a commodity that enters the supply side of the market in the following marketing year. These stocks are a measure of the scarcity of the crop just before the next crop harvest, and they play an important role in the decision-making process for agricultural

producers, processors, and policymakers." (Xiao, Hart, and Lence, 2017, p. 221) At the same time, ending stocks is a residual category in the WASDE balance sheet, calculated as a difference between total supply and total use for the marketing year. Even though most WASDE balance sheets contain a "residual" category on the use side, Botto et al. (2006) demonstrated that errors in supply and use forecasts tend to contribute to ending stocks forecast errors, as shown in figure 2. This graph shows that a 1% overestimation in production in May reports resulted in approximately a 4% overestimation in corn ending stocks. Xiao, Hart, and Lence (2017) demonstrated that USDA ending stocks forecasts are inefficient with predictability in revisions consistent with smoothing. The authors point out that "Concerns, such as those voiced by the soybean industry, that the USDA ending stock estimates were not adequately capturing the export demand growth resulting in higher ending stock estimates and lower crop prices likely have some merit. (p.239)" Isengildina-Massa, Karali, and Irwin (2013) examined the sources of errors in WASDE balance sheet forecasts and contributed them largely to structural changes in commodity markets that took place in the mid-2000s, challenges with predicting periods of economic growth and changes in exchange rates, while inflation and changes in oil price had a much smaller impact.

NASS Grain Stocks reports are widely used by the industry to gauge a pace of domestic use based on how much crop was still left in storage. The accuracy of these reports in the post 2006 sub-period has been questioned in recent years. The challenge with evaluating the accuracy of these reports is the lack of the "final value" as these reports deal with a "flow" variable. In a number of studies by Irwin, Sanders and Good (2014a, 2014 b, 2014c, 2014d, 2014e) published grain stock values have been compared to industry expectations to point out that there was a notable decline in the ability of market participants to anticipate USDA stock estimates for corn

through 2013. The authors argued that the potential reasons for larger surprises in corn grain stocks estimates are not due to commonly proposed reasons, but rather to unresolved sampling errors in production estimates. They demonstrated that USDA stocks estimates undoubtedly encompassed sampling errors for both production and stocks estimates and it is highly likely that unresolved sampling errors for corn production estimates are large enough to explain even the largest surprises. Their analysis highlighted the potential value of adding a survey of corn feed use that would allow a fuller accounting of corn usage as well as a revision of January corn production estimates similar to what has historically been done for soybeans. (Irwin, Sanders, and Good, 2014e)

USDA 10-year baseline forecasts are also important because they are widely used for policy analysis (Irwin and Good, 2015). The studies of these forecasts typically show that it is extremely difficult to forecast prices that far into the future. For example, percentage errors for USDA 5-year ahead baseline corn price forecasts from Irwin and Good (2015), shown in figure 3 reveal that forecast errors were negative (USDA forecasts greater than actual prices) in the early years and positive (USDA forecasts less than actual prices) in later years. Errors were also larger in the later years, with errors exceeding 40 percent in five of the last eight years. When compared to futures-based forecasts, USDA forecast errors tended to be smaller for the one-, two-, and three-year time horizons, but larger for all longer-term forecasts except at ten years. These findings suggest that the low accuracy of the long-term forecasts should be recognized and considered for decision making.

Boussios, Skorbianky, and MacLachlan (2021) examined USDA's baseline forecasts for U.S. harvested area over 1997-2017 and found a tendency to consistently overestimate the harvested area for wheat and underestimate soybean and corn harvested area and proposed to use

alternative econometric models to improve the accuracy of these forecasts. Their results suggest that the forecasts generated using the proposed econometric models produced predictions with an average absolute forecasting error 10 years out that was between 26 percent to 60 percent smaller than those provided by baseline projections. These models have been adopted by USDA to complement their existing forecasting tools.

Can Private Forecasters Beat the USDA?

The accuracy of USDA forecasts relative to their private counterparts was explored by Egelkraut et al. (2003) and Isengildina-Massa, Karali, and Irwin (2020). Egelkraut et al. (2003) assessed the accuracy of USDA's corn and soybean production forecasts relative to the private forecasts released by Conrad Leslie and Sparks Companies over 1971–2000 and found that the relative accuracy of USDA forecasts varied by crop and month. Their results suggest that USDA forecasts appeared more accurate than private forecasts of corn production, especially later in the forecasting cycle. For soybeans, private forecasts appeared more accurate than USDA's in the beginning of the forecasting cycle (August and September), but USDA forecasts were dominant for October and November.

Isengildina-Massa, Karali, and Irwin (2020) evaluated the accuracy of USDA crop Acreage and Production forecasts relative to their private counterparts over 1970-2019. Their findings reveal that in the vast majority of cases, USDA forecasts are more accurate than their private counterparts. The accuracy domination of the USDA forecasts is most consistent in corn, largest in wheat, and least prevalent in soybeans. Specifically, they found consistent accuracy advantages of USDA in corn Prospective Plantings, Acreage, and October Crop Production forecasts throughout the study period. On the other hand, the only evidence of private forecasts

dominating the USDA was found for August corn Production during 1990s and early 2000s. However, it appears that USDA has regained its advantage in August corn production forecasts since the mid-2000s.

To the best of our knowledge, the relative accuracy of the WASDE ending stocks forecasts has not been investigated in prior studies, likely because private expectations data for these forecasts is not available for a long time period.

Do USDA Reports Move the Markets?

The answer is typically yes, although previous studies differ in terms of measures of information, market reaction, time periods, and evaluation methodology. Regardless of these differences, most of these studies follow what is known an event study approach. The basic notion of the event study is simple: if prices react to the announcement of information ("the event") in an efficient market, then the information is valuable to market participants (Campbell, Lo, and MacKinlay, 1997) as it helps find new, better informed, equilibrium price. Thus, ***market reaction to report releases is considered evidence of their informational value***.

Specifically, variability of futures prices around important scheduled news announcements should be characterized by a "spike" in variability on the announcement date and "normal" variability on non-announcement dates (Sumner and Mueller, 1989). For example, figure 4 shows corn market reaction to WASDE report release (Isengildina-Massa et al., 2008) across the reaction window (5 days before and after report release). Since, under market efficiency, futures prices represent the conditional expectation of spot prices at contract maturity, the spike in futures return variance reflects the change in market participants' expectation of spot prices due to the news announcement. Note that the change in futures prices can be either

positive or negative depending on the implications of the news for the level of prices, therefore the analysis focuses on changes in volatility as a measure of market reaction, typically measured as price changes (futures returns). The purpose of the statistical tests is to determine whether futures return variability on event (report release) sessions is significantly different from normal variability on non-report days.

Table 4 provides a summary of the first set of event studies where the event is measured by the date and time of USDA report release and indicates plentiful evidence of corn market reaction to USDA reports. Most of these studies (e.g., Isengildina-Massa et al, 2021; Ying, Chen, and Dorfman, 2019; Dorfman and Karali, 2015) measured unconditional market impact (where other factors were not considered) and measure market reaction using various parametric and non-parametric tests. For example, figure 5 shows corn market reaction to USDA reports over 1985-2018 (Isengildina-Massa et al, 2021) and suggests that markets move the most when several reports are released at the same time, such as WASDE, Grain Stocks, and Crop Production Annual Summary in January, Prospective Plantings and Grain Stocks reports in March, Acreage and Grain Stocks in June and WASDE and Crop Production in August. On the other hand, most WASDE reports released by themselves do not cause significant market information (significance indicated by horizontal black line) with the exception of May WASDE that contain first estimates for the next marketing year. Thus, report clustering may have led to overestimation of WASDE market impact in some of the earlier studies that did not take it into account.

Several of these studies (e.g., Fortenbery and Sumner, 1993; Isengildina-Massa et al, 2008; Ying, Chen, and Dorfman, 2019; and Isengildina-Massa, et al, 2021) also examined **changes in the impact** of USDA reports **over time**. For example, Ying, Chen, and Dorfman

(2019) found that the impact of Prospective Plantings, Acreage, Grain Stocks, WASDE and Crop production reports increased over time, while the impact of Crop Progress reports decreased. On the other hand, Isengildina-Massa, et al (2021) found a slight decrease in impact of August and November Crop Production reports over time, while the impact of other reports has remained strong, as shown in figure 6. Thus, there is some evidence that the impact of the reports focused on estimating production may have declined in recent years, likely due to increased competition from private data sources and expansion of remote sensing technology for crop production estimation.

Another group of studies measure the release of USDA reports using dummy variables, along with modeling the underlying market dynamics to control for effects like daily, monthly and seasonal patterns, inventory conditions and delivery horizon to better isolate the report impact (e.g., Karali, 2012; Mattos and Silveira, 2016). These studies demonstrate the impact of USDA reports on not just volatility but the co-movement (covariances) across various commodities (Karali, 2012), and reveal that markets react to both USDA and international market information (Mattos and Silveira, 2016). For example, Mattos and Silveira (2016) find that USDA reports increase the conditional standard deviation of corn futures returns by 28.13% during August-October and 11.91% during the rest of the year. On the other hand, the impact of CONAB (Brazilian Food Supply Company) reports are statistically distinguishable from zero only in the November-January period, when they increase the conditional standard deviation of futures returns by 11.42%. Thus, corn market reaction to USDA reports is much stronger than that to Brazilian market reports.

Overall, these studies examined market reaction to Crop Production reports (e.g., Isengildina-Massa et al, 2020; Good and Irwin, 2006; Milonas, 1994; Fortenbery and Sumner,

1993; French, Leftwich and Uhrig, 1989; Sumner and Muller, 1989; Fackler, 1985), Prospective Plantings reports and Acreage reports (e.g., Ying, Chen, and Dorfman, 2019; Dorfman and Karali, 2015; Karali, 2012; Isengildina-Massa et al, 2021); Grain Stocks reports (Isengildina-Massa et al, 2021; Ying, Chen, and Dorfman, 2019; Dorfman and Karali, 2015; Karali, 2012), WASDE reports (Arnade, Hoffman, and Effland, 2021; Isengildina-Massa et al, 2021; Ying, Chen, and Dorfman, 2019; Mattos and Silveira, 2016; Dorfman and Karali, 2015; Karali, 2012; Isengildina et al, 2008), Crop Progress reports (Lehecka, 2014), and Export Sales reports (Patterson and Brorsen, 1993; Conklin, 1983).

Are Markets "Surprised" by USDA Information?

The concept of "market surprise" focuses on the "new" information in the USDA reports by calculating the difference from the previously released information in either earlier reports or private industry expectations. Private industry expectations are typically obtained from either Bloomberg or Thompson Reuters surveys in more recent studies, or Conrad Leslie and Sparks in the past. This group of studies, shown in table 5, also follow an event study framework, but measure market reaction not to the fact of report release (as in the first group of studies, measured by the date and time), but to the "market surprise" with the goal of measuring "the event" more precisely. The rationale behind this approach is that in an efficient market prices should react only to **unanticipated information** (Fama, 1970). These studies regress the unanticipated information in a USDA report on the price change immediately after the release of the report and focus on reports that make it possible to measure the unanticipated information, such as Crop Production reports (e.g., Karali, Irwin, and Isengildina-Massa, 2020; Karali et al, 2019; Adjemian and Arnade, 2017; McKenzie, 2008; Good and Irwin, 2006; Garcia et al, 1997;

Orazem and Falk, 1989), Grain Stocks reports (e.g., Karali et al, 2019; Irwin, Good and Sanders, 2016; Irwin, Sanders and Good, 2014), Export Inspections reports (e.g., Colling, Irwin and Zulauf, 1996) and WASDE reports (Plante and Dhaliwal, 2017).

In general, this approach reveals an even stronger market reaction to USDA reports by removing the "noise" of other information that may hit the market on the same day and focusing on the "news" component of the reports. For example, Karali et al (2019) show the average size of market surprises across different reports (figure 7) and demonstrate that Grain Stocks reports had the largest surprises, followed by August crop production reports. Furthermore, Karali et al (2019) demonstrate that in the most recent years, market reaction to October and November crop production reports was the strongest, as shown in figure 8. For grain stocks reports, corn market reaction was the strongest for January and March releases in recent years, as shown in figure 9.

Other studies in this group focused on additional elements of market reaction that are possible to isolate using this approach. For example, McKenzie (2008) used the Hamilton-type approach to derive statistically optimal weights to be placed on a number of different sources of information, including the "news" element of USDA crop production reports. He found that "the August reports along with *ex post* prices do contain valuable information, and this helps to explain the puzzle of why futures prices continue to react to the release of USDA reports." (p.365). Adjemian and Arnade (2017) demonstrated that USDA crop production reports affect not only the US, but international corn markets as well, as shown in figure 10. Plante and Dhaliwal (2017) examine the effects of oil and grain inventory shocks (measured as surprises for ending stocks estimates in WASDE reports) on oil, ethanol, corn and soybean futures prices. This study demonstrates that while corn and soybean prices react only to grain inventory shocks

and energy futures prices react only to oil inventory shocks, ethanol futures prices react to both oil and grain inventory shocks, thus serving as a link between two sectors.

While these studies tend to measure information content of USDA reports more precisely, a recent study by Karali, Irwin and Isengildina Massa (2020) warns that the traditional measure of "surprise" may be riddled with measurement error and the findings of these studies should be interpreted with care.

Do USDA Reports Increase or Decrease Market Uncertainty?

Even though markets react to USDA information by moving to a new equilibrium which results in significant price changes as demonstrated by the studies discussed so far, it would be incorrect to automatically interpret these price changes as increases in market uncertainty. The next two sets of studies help provide insight on this issue.

Table 4 lists the studies that measure options market reaction to USDA reports. These studies focus on how the arrival of new information alters the amount of uncertainty that market participants expect to be resolved before option expiration as indicated in changes in **option implied volatility**. Implied volatility is a forward-looking measure of volatility that reflects changes in expectations of market participants about future uncertainty. Around scheduled news events, resolution of uncertainty is characterized by a rise in implied volatility before the announcement date, a peak on the day before the announcement, and a fall to a new lower level on the report day, as shown in figure 11. For example, McNew and Espinosa (1994) find reduced implied volatility in corn and soybean options after release of USDA Crop Production forecasts. They observe that if market participants make their decisions on the basis of both risk and return,

then any information which would reduce risk is valuable. If USDA reports reduce price uncertainty, then they are viewed as being more credible.

Isengildina-Massa et al. (2008) demonstrate that WASDE report releases reduce uncertainty in corn and soybean markets about 70% of the time over 1985-2002. Implied volatility in these markets dropped substantially more following the sessions that contained both WASDE and NASS Crop Production reports (by 1.1 and 1.5 percentage points in corn and soybeans, respectively) compared to sessions that contained only WASDE reports (0.3 percentage points in both corn and soybean markets). Furthermore, it appeared that the impact of these reports increased during the later sub-period associated with greater market uncertainty. Cao and Robe (2022) extend these findings to demonstrate that market uncertainty in corn and soybean markets decreases not only immediately following the report release but remains low for up to five days after the release of WASDE, Grain Stocks, Prospective Plantings and Acreage reports. Following WASDE reports, this decrease in market uncertainty was more pronounced when there had been greater disagreement among industry expectations prior to the reports. There was little evidence that tightness of stocks affected market reaction to these reports. Furthermore, it appears that market reaction (drop in implied volatility) was stronger during the periods of greater market uncertainty modeled using changes in the VIX index.

On the other hand, Adjemian et al. (2018) examined patterns in implied volatility to assess whether October 2013 WASDE report, which was not issued due to government shut down, was "missed" by the markets. Using daily and intraday data, the authors found that "corn and soybean markets did not display characteristic patterns in terms of uncertainty resolution and price changes that are normally observed around scheduled USDA release times, meaning that options prices (and therefore the price of hedging) were higher than they likely would have been

had a WASDE report come out," (p. 669) thus confirming the uncertainty-reducing features of USDA reports.

Does USDA Information Have Value?

Another group of studies, shown in table 7, applied informational value tests to assess whether information released in the reports gets us closer to knowing the final estimate, thereby reducing uncertainty in the markets. Several of these studies (e.g., Garcia et al., 1997; Isengildina-Massa, Karali, and Irwin (2020) implemented the test of informational value developed by Baur and Orazem (1994), focusing on the reduction in the market's supply forecast variance resulting from the introduction of the government forecast. For example, Garcia et al. (1997) found that the largest reduction in corn supply forecast variance was associated with August crop production report with subsequent crop production reports having only marginal value. Even though the relative accuracy of USDA and private forecasts in this study was similar, a significant price reaction to USDA reports, implied that USDA forecasts are perceived as less risky and more objective by market participants. Isengildina-Massa, Karali, and Irwin (2020) confirmed the importance of August crop production report in reducing corn market's supply forecast variance, but also showed an increasing value of October crop production reports in post 2002 subperiod. In addition, these authors argued that Prospective Plantings and Acreage reports play a much bigger role in reducing supply uncertainty than Crop Production reports since 1983. Furthermore, these authors find that the information value of USDA forecasts has increased over time and was the strongest in the most recent 2002-2019 subperiod.

Another approach to demonstrating informational value is by assessing whether advanced knowledge of the information in these reports would allow traders to correctly position themselves in the market. For example, Garcia et al (1997) use the test developed by Henriksson and Merton (1981) to demonstrate that traders can correctly determine market direction based on the information contained in corn and soybean production reports over 1971-1992, thus indicating that these reports have market timing value. McKenzie (2008) used a Hamilton-type (1992) approach to demonstrate that "there were periods when having advanced knowledge of the August report would have significantly adjusted rational agent expectations, augmenting information already embodied in futures prices. (p. 365)" Milacek and Brorsen (2017) developed trading models based on knowing the WASDE report in advance to estimate potential trading returns from using WASDE report predictions in the days before the report. Their findings reveal that the perfect foresight trading signal generated an average daily return of 1.11 cents per bushel for corn with July, September and October reports generating the highest returns.

McKenzie and Singh (2011) demonstrated that hedging stored grain over USDA report days is extremely important and beneficial from a risk management perspective to reduce potential losses due to large price movements on report days. Even though the volatility of basis was statistically highest on report days, hedging does lead to lower losses than storing unhedged cash grain, as shown in figure12. Additionally, Abbot, Boussios and Lowenberg-DeBoer (2016) used dynamic multi-period Monte Carlo simulation of the inventory adjustment models for the U.S. corn market to estimate the value of WASDE reports and its components. Their results show significant value to market participants from the WASDE reports, roughly $301 million or 0.55% of overall corn market value. The results also show significant value for each forecasted

component of the reports: area ($145 million), yield ($188 million), production ($299 million), demand/stocks ($300 million) and exports ($320 million).

How Long Does the Market Reaction Last? Insights from Intraday Data.

While traditional studies typically assessed market reaction to USDA using daily price changes, more recent studies have been able to zoom in using intraday data. These studies shown in Table 8 focus not just on market reaction, but overall market dynamics around USDA report releases. For example, Lehecka, Wang, and Garcia (2014), examined corn market reaction to USDA reports over 2009-2012, when the reports were released prior to market trading hours, and showed that the strongest price reactions to the releases was found immediately after markets opened and persisted for about ten minutes. They did not find evidence of systematic under- or over-reaction in prices. On the other hand, they found some subtle reactions in the last trading session before the release, suggesting that traders adjusted their market exposure in anticipation of the release.

In 2012, ICE and CME commodity exchanges expanded their trading hours, allowing trades during the release of key government reports. Kauffman (2013) showed that market volatility around WASDE report releases in 2012 has been substantially higher than in prior years and lasted longer, as shown in figure 13. Kauffman (2013) concluded that extending trading hours resulted in brief shocks in corn futures price volatility around the release of WASDE reports that may pose a challenge for producers whose risk management strategies are affected by intraday price swings. Typically, however, the heightened volatility has not lasted more than 30 to 60 minutes, thus it should not affect long-term risk management positions. On the other hand, Wang, Garcia, and Irwin (2014) argued that introduction of electronic trading has

significantly reduced bid-ask-spreads thus reducing order execution costs. However, these bid-ask-spreads were substantially larger during the index trader roll periods and on USDA report release days. The authors argue that the evidence of larger spreads during the roll periods point to a sunshine trading effect, with added liquidity entering the market in anticipation of predictable roll behavior, while the USDA announcement effects identify the importance of unexpected information and adverse selection on order execution costs.

In January 2013, the USDA has moved its report publication time to 11am central to allow markets the best change to absorb news during trading hours. Using intraday data over 2009-2014, Adjemian and Irwin (2018) compared market reaction to USDA reports across two regimes. The authors found that "when agricultural futures markets are permitted to discover prices freely in response to USDA reports the adjustment process is not instantaneous, as continuously-traded futures markets experience heightened volatility and trading volume in response to news relative to what was observed during the era of trading halts. Moreover, markets appear to now have a more difficult time distinguishing between the newsworthiness of USDA reports, at least in the very short-run, but these differences persist only for a handful of trading minutes. After that, announcement shocks at major agricultural markets resemble those that were observed when (trading) timeouts were in effect." (p. 1169)

Another change to the USDA report release rules was implemented in July 2018 when USDA decided to stop sharing reports with media members inside the lockup area ahead of the official publication time to prevent an unfair advantage their customers may have relative to the general public within the two seconds following the report release due to the proximity of their servers to USDA. Adjemian and Irwin (2020) examined the impact of this change on the market

reaction and did not find evidence that removing media members from lockup has increased announcement time price volatility using either daily or intraday data.

Several studies explored market dynamics around report releases using high frequency intraday data. For example, Shang, Mallory, and Garcia (2018) estimate that from 2008 to 2011 government news tended to increase the market bid-ask spread (BAS) for about an hour (through the channel of compensation for adverse selection), although average liquidity costs did not generally rise notably on USDA announcements days. Focusing on 2013–2016 data, after continuous trading of crop news began, Fernandez-Perez et al. (2019) documented that the BAS rises just preceding USDA announcement time and declines gradually over roughly the next twenty trading minutes. These studies decompose the BAS to draw inference about the path of information asymmetry and liquidity provision during announcement days. Couleau, Serra, and Garcia (2020) find that announcement days in these markets are characterized by price jumps clustered around the report release—consistent with the arrival of new information and that eliminating the timeout led to more price jumps around the announcement, and wider bid-ask spreads.

Overall, these studies confirm the findings of the previous studies using daily data and provide a more detailed look at the market reaction and dynamics around report releases by zooming in on a high frequency level. The evidence of the increased market volatility, price jumps and higher BAS following the release of USDA reports, indicates that these reports contain valuable information that helps markets find a new equilibrium price.

Conclusions and Implications.

This paper reviewed and analyzed dozens of previous studies in order to establish the state of knowledge about the accuracy, reliability and market impact of USDA reports. The need for this study has been repeatedly expressed in the popular press and by producer groups across the country. Agricultural producers are the foundation of USDA information system as most of it is survey based and relies on honest voluntary participation. Therefore, better understanding of USDA reports and the value they provide to agricultural markets would help maintain the quality of USDA information through increased survey participation rates.

One of the biggest concerns is that USDA reports increase market volatility. This is unequivocally true. However, it is not a bad thing. It is a signal that these reports provide new information to the market and the market uses this information to find a new equilibrium price that more closely reflects underlying fundamental conditions. In fact, if we observed the opposite, we could interpret it as a lack of value of USDA information.

Furthermore, volatility is not equivalent to uncertainty. When we are looking at forward measures of market uncertainty, such as implied volatility from options prices, we see a drop in implied volatility following report releases, indicating a reduction of market uncertainty due to this information. Additionally, informational value tests indicate that estimates contained in USDA crop production reports often bring us closer to the final value. Thus, we can conclude that even though these reports increase volatility, they help decrease future market uncertainty.

This would only be possible if USDA information was accurate and reliable. Most of the evidence confirms this argument. Even in cases where some shortcomings are highlighted, such as smoothing in production forecasts or lack of uncertainty information in price forecasts, it is difficult to find better sources of information and previous research shows that private

forecasters are not able to beat USDA in most cases. Once again, the evidence that markets react strongly to USDA forecasts that sometimes are similar in accuracy to their private counterparts is an indication that market participants view USDA as a reliable, objective source.

Given these findings, can market volatility resulting from report releases hurt agricultural producers with open positions in the futures markets? The answer to this question depends on the nature of these positions. Based on the evidence of swift market reaction to USDA news shown in previous studies, these market moves would be most dangerous for short term speculative positions. Therefore, previous studies emphasized the importance of hedging around the reports. Hedged positions would include offsetting effects from cash and futures markets and may result in higher margin requirements in the short term, but an unchanged hedge outcome upon hedge completion.

Overall, it is important to recognize the role of USDA information in market price discovery and reduction of information asymmetry. Without USDA information, agents with better resources and access to information would have an advantage over the rest of market participants through having a better insight of what the true market conditions are and what the equilibrium price should be. USDA helps uncover these market conditions for all market participants thereby providing a level playing field for all, even though the process is sometimes bumpy. In order to maintain this role and ensure the quality of this information, it is important to keep communication lines open. USDA cannot produce reliable estimates without participation of producers. Producers need to trust USDA and their approaches in order to be willing to participate in the information gathering process. Greater transparency and communication between these two critical sides of public information system is needed to maintain its integrity. While some efforts to facilitate this communication, such as USDA data users' meetings, are

already in place, greater efforts can be made to increase transparency of USDA outlook and data products. One of the most effective ways of doing this would be to have an experienced statistician who is directly involved in USDA forecasting process tasked with communicating forecasting practices, challenges, procedures and limitations with the public on the regular basis in order to "open up the black box."

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Table 1. Studies of the Accuracy of USDA Crop Production Forecasts.

Year	Commodity	Report	Article Title	Author	Journal Title
2021	corn	Crop Production Annual	Was the Final USDA Estimate of the 2020 U.S. Corn Yield an Outlier?	Irwin, S.	farmdoc daily
2021	corn, soybean, wheat	baseline	Evaluating U.S. Department of Agriculture's Long-Term Forecasts for U.S. Harvested Area	Boussios, David, Sharon Raszap Skorbiansky, and Matthew MacLachlan	ERS Report Number 285
2020	corn, soybean, wheat	Prospective Plantings, Acreage,	Can Private Forecasters Beat the USDA? Analysis of Relative Accuracy of Crop Acreage and Production Forecasts.	Isengildina-Massa, Olga; Karali, Berna; Irwin, Scott H.	Journal of Agricultural & Applied Economics (Cambridge University
2020	corn	WASDE, Crop Production	The Accuracy of Early Season Crop Weather Model Forecasts of the U.S. Average Corn Yield	Irwin, S. and T. Hubbs	farmdoc daily
2019	corn	Actual Production History	The Potential Implications of "Big Ag Data" for USDA Forecasts.	Tack, Jesse; Coble, Keith H; Johansson, Robert; Harri, Ardian; Barnett,	Applied Economic Perspectives & Policy
2018	corn, soybean	Crop Progress	Measuring the Accuracy of Forecasting Corn and Soybean Yield with Good and Excellent Crop Condition Ratings	Irwin, S. and T. Hubbs	farmdoc daily
2017	corn, soybean, wheat	Crop Production	Do Markets Correct for Smoothing in USDA Crop Production Forecasts? Evidence from Private Analysts and	Isengildina-Massa, Olga; Karali, Berna; Irwin, Scott H.	Applied Economic Perspectives & Policy
2016	corn	Crop Production	Opening Up the Black Box: More on the USDA Corn Yield Forecasting Methodology	Irwin, S. and D. Good.	farmdoc daily
2016	corn, soybean,	WASDE	Can Rationality of USDA's Fixed-Event Crop Forecasts be Improved	Xie, R.; Isengildina-Massa, O.; Sharp, J. L.	Advances in Business and Management
2015	corn	WASDE	Understanding and Evaluating WAOB/USDA Corn Yield Forecasts	Irwin, S., D. Good, and D. Sanders	farmdoc daily
2014	corn	Crop Production	Do Big Corn Crops Always get Bigger?	Irwin, S., D. Good, and J. Newton	farmdoc daily
2014	corn	Crop Production	Are USDA Corn Yield Forecasts Getting Better or Worse over Time?	Irwin, S., D. Good, and D. Sanders	farmdoc daily
2014	corn, soybean	WASDE, Crop Production,	Evaluation of Selected USDA WAOB and NASS Forecasts and Estimates in Corn and Soybeans	Irwin, S., D. Sanders, and D. Good.	farmdoc daily
2013	corn	Crop Production	USDA Corn and Soybean Production Forecasting Procedures Revisited With a Focus on Derived Ear Weights	Good, D. and S. Irwin	farmdoc daily
2013	corn, soybean	Crop Production	Do Big Crops Get Bigger and Small Crops get smaller? Further Ecivence on Smoothing in USDA forecasts	Isengildina, Olga; Irwin, Scott H.; Good, Darrel L.	Journal of Agricultural and Applied Economics

Table 1. (continued) Studies of the Accuracy of USDA Crop Production Forecasts.

Year	Commodity	Report	Article Title	Author	Journal Title
2011	corn, soybean	Crop Production	Have the Accuracy of USDA's August Corn and Soybean Production Forecasts Changed?	Irwin, S. and D. Good	farmdoc daily
2011	corn, soybean	Crop Production	USDA Corn and Soybean Acreage Estimates and Yield Forecasts: Dispelling Myths and Misunderstandings.	Good, D., and S. Irwin	Marketing and Outlook Brief 2011-02, Department of
2011	corn, soybean	Crop Production	USDA Corn and Soybean Yield Forecast Errors Across Report Release Months	Irwin, S. and D. Good	farmdoc daily
2006	corn, soybean	Crop Production	Are Revisions to USDA Crop Production Forecasts Smoothed?	Isengildina, Olga; Irwin, Scott H.; Good, Darrel L.	American Journal of Agricultural Economics
2006	corn, soybean	Crop Production	Understanding USDA Corn and Soybean Production Forecasts: Methods, Performance and Market Impacts over	Darrel L. Good and Scott H. Irwin	AgMAS Project Research Report
2003	corn, soybean	Crop Production	An Evaluation of Crop Forecast Accuracy for Corn and Soybeans: USDA and Private Information Agencies	Egelkraut, Thorsten M.	Journal of Agricultural and Applied Economics
1999	corn, soybean, wheat, cotton	Crop production	Understanding USDA Crop Forecasts	Vogel, F.A., and G.A. Bange	Miscellaneous Publication No. 1554, U.S. Department of
1997	corn, soybean	Crop Production	The value of public information in commodity futures markets	Garcia, Philip; Irwin, Scott H.; Leuthold, Raymond M.; Li Yang	Journal of Economic Behavior & Organization
1990	corn, soybean	Crop Production	USDA Crop Forecasts: A Good Track Record	James P. Houck; Carroll Rock	Choices

Table 2. Studies of the Accuracy of USDA Price forecasts.

Year	Commodity	Report	Article Title	Author	Journal Title
2020	corn, soybean	WASDE, Prices	Incorporating Uncertainty into USDA Commodity Price Forecasts.	Adjemian, Michael K.; Bruno, Valentina G.; Robe, Michel A.	American Journal of Agricultural Economics
2015	corn	WASDE, prices	Forecast performance of WASDE price projections for U.S. corn.	Hoffman, Linwood A.; Etienne, Xiaoli L.; Irwin, Scott H.;	Agricultural Economics
2015	corn, soybean, wheat	USDA's 10-year baseline projections	Long-Term Corn, Soybeans, and Wheat Price Forecasts and the Farm Bill Program Choice	Irwin, S., and D. Good.	farmdoc daily
2012	corn, soybean, wheat	WASDE, Prices	Evaluation of USDA Interval Forecasts Revisited: Asymmetry and Accuracy of Corn, Soybean, and Wheat Prices.	Isengildina-Massa, Olga; Sharp, Julia L.	Agribusiness
2011	corn, soybean, wheat	WASDE, Prices	Empirical Confidence Intervals for USDA Commodity Price Forecasts	Isengildina-Massa, Olga; Irwin, Scott; Good, Darrel L.; Massa, Luca	Applied Economics
2010	corn, soybean, wheat	WASDE, Prices	Quantile Regression Estimates of Confidence Intervals for WASDE Price Forecasts	Olga Isengildina-Massa; Scott H. Irwin; Darrel L. Good	Journal of Agricultural and Resource Economics
2004	corn, soybean	WASDE, Prices	Evaluation of USDA Interval Forecasts of Corn and Soybean Prices.	Isengildina, Olga; Irwin, Scott H.; Good, Darrel L.	American Journal of Agricultural Economics
1981	corn, wheat, soybean, soybean oil, soubean meal,	WASDE, Prices	Commodity Price Forecasting with Large-Scale Econometric Modles and the Futures Market	Just and Rousser	American Journal of Agricultural Economics

Table 3. Studies of the Accuracy of other USDA forecasts.

Year	Commodity	Report	Article Title	Author	Journal Title
2021	corn, soybean, wheat	baseline	Evaluating U.S. Department of Agriculture's Long-Term Forecasts for U.S. Harvested	Boussios, David, Sharon Raszap Skorbiansky, and	ERS Report Number 285
2017	corn, soybean, wheat	Grain Stocks, WASDE	USDA Forecasts Of Crop Ending Stocks: How Well Have They Performed?	Jinzhi Xiao; Hart, Chad E.; Lence, Sergio H.	Applied Economic Perspectives
2016	corn, soybean	Grain Stocks	Revisiting USDA Corn and Soybean Grain Stocks Estimates	Irwin, S., D. Good, and D. Sanders.	farmdoc daily
2015	corn, soybean, wheat	USDA's 10-year baseline	Long-Term Corn, Soybeans, and Wheat Price Forecasts and the Farm Bill Program	Irwin, S., and D. Good.	farmdoc daily
2014	corn	WASDE, ending stocks	Accuracy of USDA Forecasts of Corn Ending Stocks	Good, D. and S. Irwin	farmdoc daily
2014	corn, soybean	WASDE, Crop Production,	Evaluation of Selected USDA WAOB and NASS Forecasts and Estimates in Corn and	Irwin, S., D. Sanders, and D. Good.	farmdoc daily
2014	corn	Grain Stocks	Explanations for Recent Surprises in USDA Corn Stocks Estimates: How Well Do they Hold Up?	Irwin, S., D. Sanders, and D. Good.	farmdoc daily
2014	corn, soybean	Grain Stocks	Is There a Problem with USDA Grain Stocks Estimates in Corn?	Irwin, S., D. Sanders, and D. Good.	farmdoc daily
2014	corn	Grain Stocks	The Role of Sampling Errors in Explaining Recent Surprises in USDA Corn Stocks Estimates: Part I	Irwin, S., D. Sanders, and D. Good.	farmdoc daily
2014	corn, soybean	Grain Stocks	The Role of Sampling Errors in Explaining Recent Surprises in USDA Corn Stocks Estimates: Part II.	Irwin, S., D. Sanders, and D. Good.	farmdoc daily
2013	corn, soybean, wheat	WASDE	When do the USDA forecasters make mistakes?	Isengildina-Massa, Olga; Karali, Berna; Irwin, Scott H.	Applied Economics
2006	corn, soybeans	WASDE	Accuracy trends and Sources of Forecast Errors in WASDE Balance sheet categories for corn and Soybeans.	Botton, A., O. Isengildina, S.H. Irwin, and D. Good.	Selected paper at the AAEA meeting

Table 4. Studies of Market Reaction to USDA Report Releases

Year	Commodity	Report	Article Title	Author	Journal Title
2021	corn	WASDE	The Impact of Public Information on Commodity Market Performance: The Response of Corn Futures to USDA	Arnade, Carlos, Hoffman, Linwood, and Anne Effland	ERS Report Number 293
2021	corn, soybean, wheat, cotton, live	Prospective Plantings, Acreage, Crop Production, Crop Production Annual	When does USDA information have the most impact on crop and livestock markets?	Isengildina-Massa, Olga; Cao, Xiang; Karali, Berna; Irwin, Scott H.; Adjemian,	Journal of Commodity Markets
2019	corn, soybean	Acreage, Prospective Plantings, Crop Progress, Feed Outlook, Grain Stocks, WASDE, Cattle, Cattle on Feed, Oil Crops	Flexible Tests for USDA Report Announcement Effects in Futures Markets.	Ying, Jiahui; Chen, Yu; Dorfman, Jeffrey H	American Journal of Agricultural Economics
2016	corn, soybean	WASDE, Crop Assessment Report (Brazil)	Futures Price Response to Crop Reports in Grain Markets.	Mattos, Fabio L.; Silveira, Rodrigo L. F.	Journal of Futures Markets
2015	soybean, soybean meal,	Acreage, Prospective Plantings, Cattle, Cattle on Feed, Crop Progress,	A Nonparametric Search for Information Effects from USDA Reports.	Dorfman, Jeffrey H.; Karali, Berna	Journal of Agricultural & Resource Economics
2014	corn, soybean	Crop Progress	The Value of USDA Crop Progress and Condition Information: Reactions of Corn and Soybean Futures Markets.	Lehecka, Georg V.	Journal of Agricultural & Resource Economics
2012	corn, soybean meal, lean hogs, soybean, soybean oil	Prospective Plantings, Acreage, Cattle, Cattle on Feed, Crop Progress, Feed Outlook, Grain Stocks, Hogs and Pigs, Livestock, Dairy, and Poultry Outlook, Oil	Do USDA Announcements Affect Comovements Across Commodity Futures Returns?	Karali, Berna	Journal of Agricultural & Resource Economics
2008	corn, soybean	WASDE	The impact of situation and outlook information in corn and soybean futures markets: Evidence from WASDE reports	Isengildina, Olga; Irwin, Scott H.; Good, Darrel L, and J. Gomez	Journal of Agricultural and Applied Economics
2006	corn, soybean	Crop Production	Understanding USDA Corn and Soybean Production Forecasts: Methods, Performance and Market Impacts over 1970-2005	Darrel L. Good and Scott H. Irwin	AgMAS Project Research Report
1994	corn, soybean	Crop Production	USDA Crop Forecasts and a Price Anomaly in Futures Markets	Milonas, N. T.	REVIEW OF FUTURES MARKETS
1993	corn, soybean	Crop Production, WASDE	The Effects of USDA Reports in Futures and Options Markets.	Fortenbery, T. Randall; Sumner, Daniel A.	Journal of Futures Markets
1993	corn, soybean, wheat, cotton	Export Sales	USDA Export Sales Report: Is It News?	Paul M. Patterson; B. Wade Brorsen	Review of Agricultural Economics
1989	corn, soybean, wheat	Crop Production	The Effect of Scheduled Announcements on Futures Markets	French, K.R., R. Leftwich, and W. Uhrig	working Paper
1989	corn, soybean	Crop Production	Are Harvest Forecasts News? USDA Announcements and Futures Market Reactions	Daniel A. Sumner; Rolf A. E. Mueller	American Journal of Agricultural Economics
1985	corn, soybean	crop production	On the Relation Between Futures Price Movements and USDA Reports	Fackler, P.L.	NCR-134 Conference Proceedings
1983	corn, soybean, wheat	Export Sales	Grain Exports, Futures Markets, and Pricing Efficiency	Conklin, N.C.	Review of Research in Futures Markets

Table 5. Studies of Market reaction to unanticipated information in USDA reports

Year	Commodity	Report	Article Title	Author	Journal Title
2020	corn, soybean, wheat	Crop Production	Supply Fundamentals and Grain Futures Price Movements.	Karali, Berna; Irwin, Scott H.; Isengildina-Massa, Olga	American Journal of Agricultural Economics
2019	corn, soybean, wheat	Prospective Plantings, Acreage, Crop	Are USDA Reports Still News to Changing Crop Markets?	Karali, Berna; Isengildina-Massa, Olga; Irwin, Scott H.;	Food Policy
2017	corn, soybean	WASDE	Inventory shocks and the oil-ethanol-grain price nexus	Plante, Michael; Dhaliwal, Navi	Economics Letters
2017	corn	Crop Production	Not Lost in Translation: The Impact of USDA Reports on International Corn Markets	Michael K. Adjemian and Carlos Arnade	Selected Poster prepared for presentation at the 2017
2008	corn	Crop Production	Pre-Harvest Price Expectations for Corn: The Information Content of USDA Reports and New Crop Futures.	McKenzie, Andrew M.	American Journal of Agricultural Economics
2006	corn, soybean	Crop Production	Understanding USDA Corn and Soybean Production Forecasts: Methods, Performance and Market Impacts over 1970-2005	Darrel L. Good and Scott H. Irwin	AgMAS Project Research Report
1997	corn, soybean	Crop Production	The value of public information in commodity futures markets	Garcia, Philip; Irwin, Scott H.; Leuthold, Raymond M.; Li Yang	Journal of Economic Behavior & Organization
1996	wheat, corn, soybean	Export Inspections	Reaction of Wheat, Corn, and Soybean Futures Prices to USDA "Export Inspections" Reports.	Colling, Phil L.; Irwin, Scott H.; Zulauf, Carl R.	Review of Agricultural Economics
1989	soybean	Crop Production	Measuring Market Responses to Error-Ridden Government Announcements	Orazem, Peter F.; Falk, Barry	Quarterly Review of Economics and Business
1985		Crop Production	A Theory of Future's Market Responses to Government Crop Forecasts	Falk, B., Orazem, P.F.	working Paper

Table 6. Studies of Options Market Reaction to USDA Reports.

Year	Commodity	Report	Article Title	Author	Journal Title
2022	corn, soybean	WASDE, Grain Stocks, Prospective Plantings, Acreage	Market uncertainty and sentiment around USDA announcements	An Cao, Michel A. Robe	Journal of Futures Markets
2021	corn, soybean	WASDE	The 2019 government shutdown increased uncertainty in major agricultural commodity markets	Goyal, Raghav; Adjemian, Michael K.	Food Policy
2018	corn, soybean	WASDE	Was the Missing 2013 WASDE Missed?	Adjemian, Michael K; Johansson, Robert; McKenzie, Andrew; Thomsen, Michael	Applied Economic Perspectives & Policy
2008	corn, soybean	WASDE	Impact of WASDE Reports on Implied Volatility in Corn and Soybean Markets	Isengildina-Massa, Olga; Irwin, Scott H.; Good, Darrel L.; Gomez, Jennifer K.	AGRIBUSINESS
1994	corn, soybean	Crop Production	The informational content of USDA crop reports: Impacts on uncertainty and expectations in grain futures markets.	McNew, Kevin P.; Espinosa, Juan Andres	Journal of Futures Markets
1993	corn, soybean	Crop Production, WASDE	The Effects of USDA Reports in Futures and Options Markets.	Fortenbery, T. Randall; Sumner, Daniel A.	Journal of Futures Markets

Table 7. Studies of Informational Value and Willingness to Pay for USDA Forecasts.

Year	Commodity	Report	Article Title	Author	Journal Title
2020	corn, soybean, wheat	Prospective Plantings, Acreage, Crop Production, Crop Production Annual Summary	Can Private Forecasters Beat the USDA? Analysis of Relative Accuracy of Crop Acreage and Production Forecasts.	Isengildina-Massa, Olga; Karali, Berna; Irwin, Scott H.	Journal of Agricultural & Applied Economics (Cambridge University Press)
2017	corn, soybean	WASDE	Trading Based on Knowing the WASDE Report in Advance	Milacek, Trent T.; Brorsen, B. Wade	Journal of Agricultural and Applied Economics
2016	Corn	WASDE	Valuing Public Information in Agricultural Commodity Markets:WASDE Corn Reports	Abbott, P., D. Boussios, and J. Lowenberg-DeBoer.	NCCC-134 paper
2012	corn, soybean	WASDE	Using USDA Forecasts to Estimate the Price Flexibility of Demand for Agricultural Commodities.	Adjemian, Michael K.; Smith, Aaron	American Journal of Agricultural Economics
2011	corn, soybean	Crop Production	Hedging Effectiveness around U.S. Department of Agriculture Crop Reports	McKenzie, Andrew; Singh, Navinderpal	Journal of Agricultural and Applied Economics
2008	corn	Crop Production	Pre-Harvest Price Expectations for Corn: The Information Content of USDA Reports and New Crop Futures.	McKenzie, Andrew M.	American Journal of Agricultural Economics
1997	corn, soybean	Crop Production	The value of public information in commodity futures markets	Garcia, Philip; Irwin, Scott H.; Leuthold, Raymond M.; Li Yang	Journal of Economic Behavior & Organization

Table 8. Studies of Intraday dynamics of market response to USDA reports

Year	Commodity	Report	Article Title	Author	Journal Title
2021	corn, soybean	Acreage, Crop Production, Grain Stocks, Prospective Plantings, WASDE	New evidence on market response to public announcements in the presence of microstructure noise.	Bian, S., T. Serra, P. Garcia, S.H. Irwin	European Journal of Operational Research
2021	corn	Crop Production, WASDE	The Value of USDA Announcements in the Electronically Traded Corn Futures Market: A Modified Sufficient Test with Risk Adjustments.	Huang, Joshua; Serra, Teresa; Garcia, Philip	Journal of Agricultural Economics
2021	corn	Prospective Plantings, Acreage, Grain Stocks, Crop Production, WASDE	To batch or not to batch? The release of USDA crop reports	Huang, Joshua; Serra, Teresa; Garcia, Philip; Irwin, Scott H.	AGRICULTURAL ECONOMICS
2021	corn, wheat, soybean	WASDE, Grain Stocks, Prospective Plantings, Acreage	The impact of the change in USDA announcement release procedures on agricultural commodity futures	Indriawan, Ivan; Martinez, Valeria; Tse, Yiuman	Journal of Commodity Markets
2020	corn	WASDE, Grain Stocks	Are Corn Futures Prices Getting "Jumpy"?	Couleau, Anabelle; Serra, Teresa; Garcia, Philip	American Journal of Agricultural Economics
2020	corn	Prospective Plantings, Acreage, Grain Stocks, Crop Production, Crop Production Annual Summary	The Market Response to Government Crop News under Different Release Regimes	Adjemian, Michael K.; Irwin, Scott H.	Journal of Commodity Markets
2019	corn, soybean, wheat	WASDE, Grain Stocks, Prospective Plantings, Acreage	Surprise and dispersion: informational impact of USDA announcements.	Fernandez-Perez, Adrian; Frijns, Bart; Indriawan, Ivan; Tourani-Rad, Alireza	Agricultural Economics
2018	corn, soybean, wheat	Prospective Plantings, Acreage, Crop Production, Crop Production Annual Summary, Grain Stocks	USDA Announcement Effects in Real-Time.	Adjemian, Michael K; Irwin, Scott H	American Journal of Agricultural Economics
2018	corn	WASDE, Crop Progress, Grain Stocks, Prospective Plantings, Acreage	The components of the bid-ask spread: Evidence from the corn futures market.	Shang, Quanbiao; Mallory, Mindy; Garcia, Philip	Agricultural Economics
2014	corn	Crop Production, Grain Stocks, Prospective Plantings, Acreage, WASDE	Gone in Ten Minutes: Intraday Evidence of Announcement Effects in the Electronic Corn Futures Market.	Lehecka, Georg V.; Wang, Xiaoyang; Garcia, Philip	Applied Economic Perspectives & Policy
2014	corn	Crop Production, WASDE, Crop Progress,Grain Stocks	The Behavior of Bid-Ask Spreads in the Electronically-Traded Corn Futures Market.	Wang, Xiaoyang; Garcia, Philip; Irwin, Scott H.	American Journal of Agricultural Economics
2013	corn	WASDE	Have Extended Trading Hours Made Agricultural Commodity Markets Riskier?	Kauffman, Nathan	Economic Review

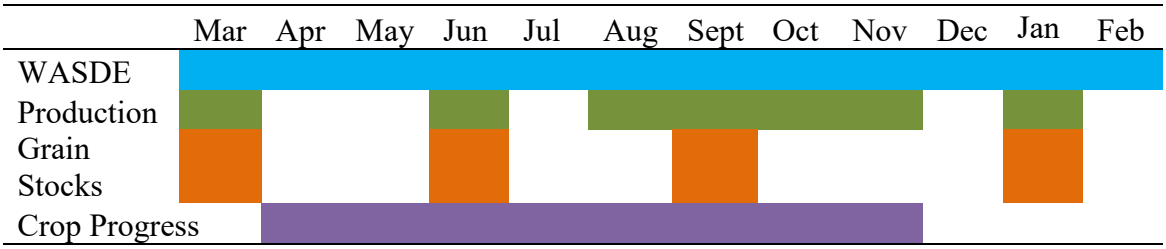

Figure 1. Release schedule of main USDA reports

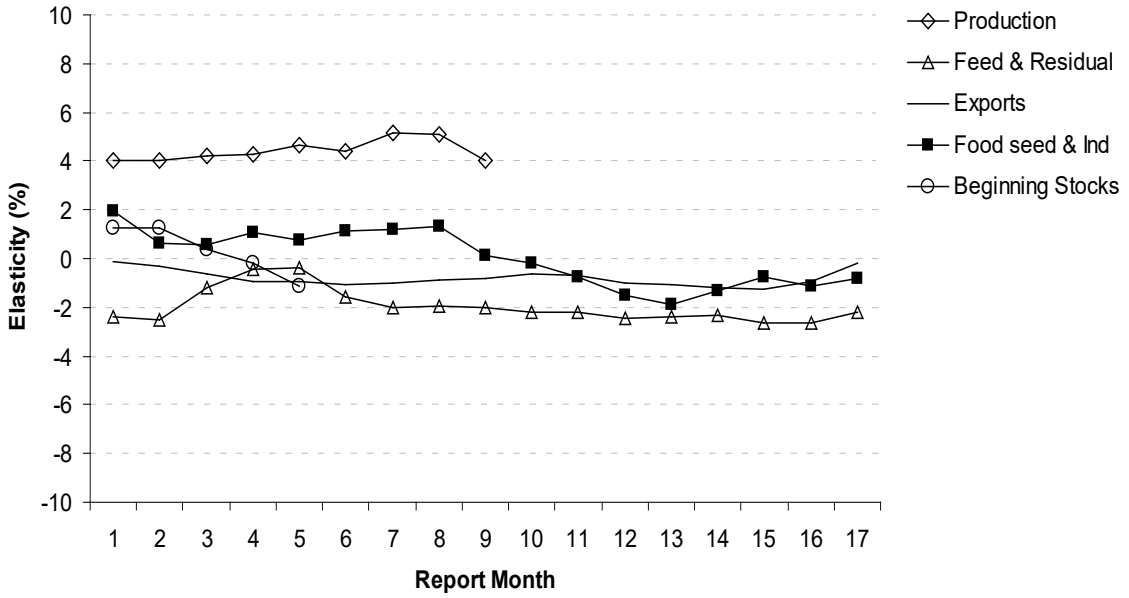

Figure 2. WASDE Supply and Use Forecast Error Elasticities for Corn Ending Stocks Forecast Errors, 1980/81-2003/04.

Source: Botto et al., 2006

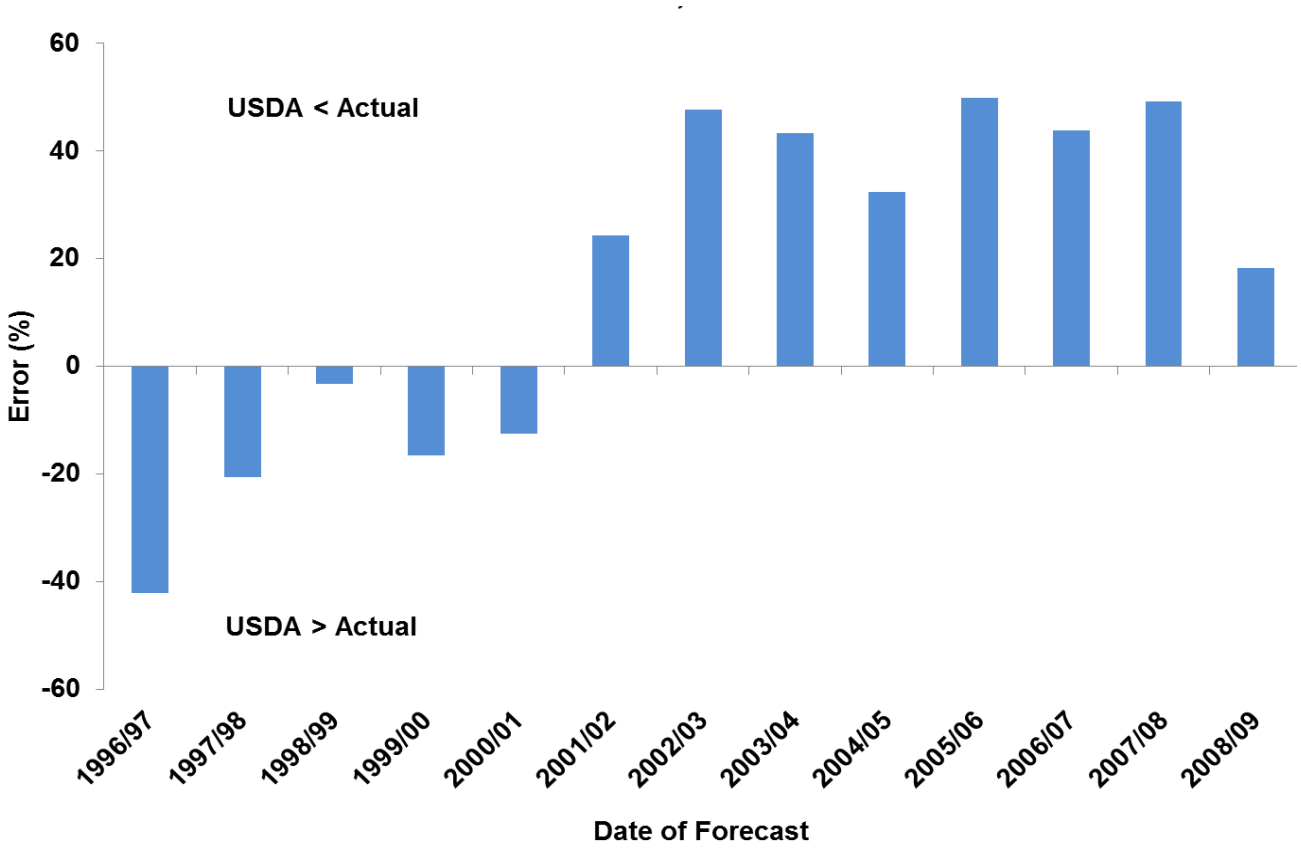

Figure 3. Percentage Errors for USDA 5-year Ahead Baseline Corn Price Forecasts, 1996/97 - 2008/09

Source: Irwin and Good, January 14, 2015

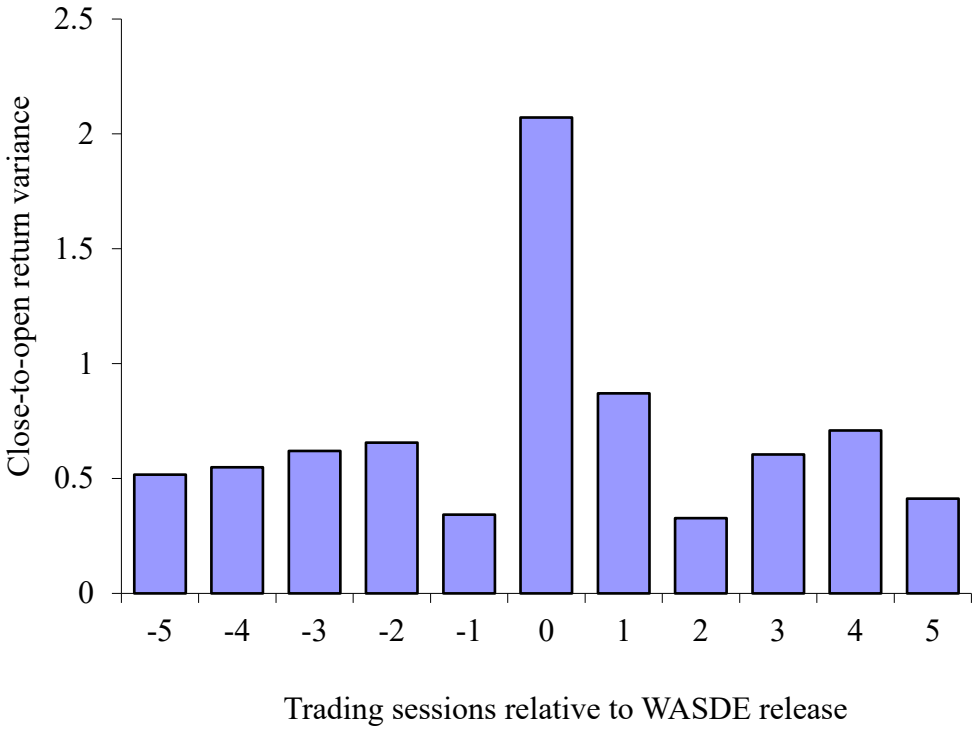

Figure 4. Corn close-to-open return variance around all WASDE report release months, January 1985-December 2006
Source: (Isengildina-Massa et al. 2008)

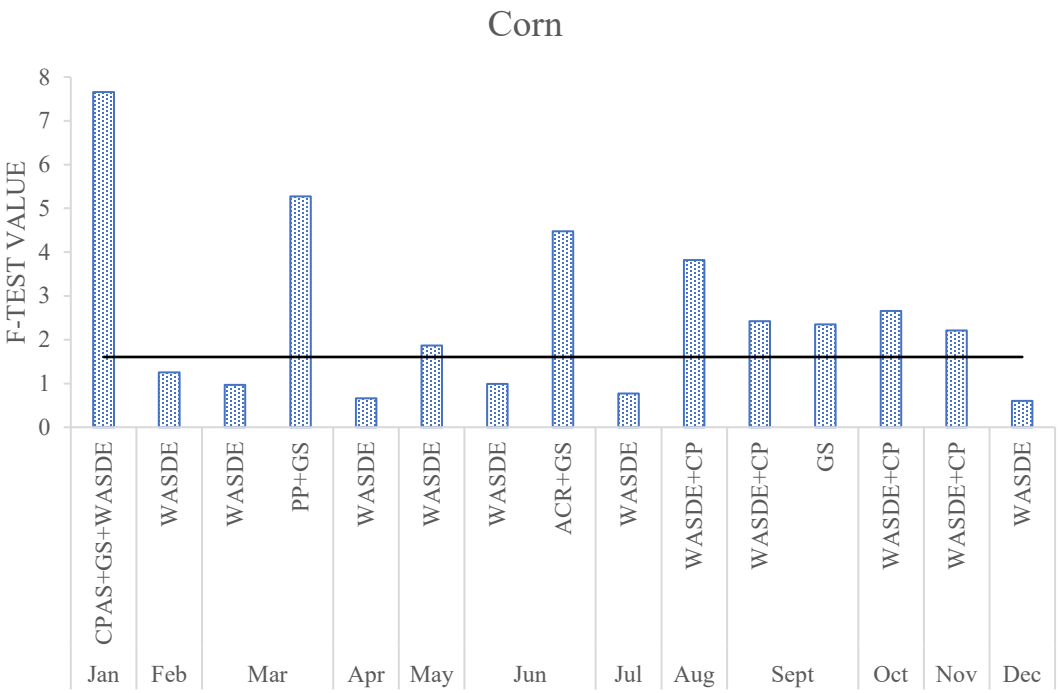

Figure 5. Crop Market Reaction to USDA Reports, 1985-2018

Notes: The bars represent the ratios of report day variance to non-report day variance. WASDE=World Agricultural Supply and Demand Estimates, PP=Prospective Plantings, ACR=Acreage, CP=Crop Production, CPAS=Crop Production Annual Summary, GS=Grain Stocks, WWS=Winter Wheat Seedings. Solid black line shows the critical value for the F-test at 90 percent level.

Source (Isengildina-Massa et al, 2021)

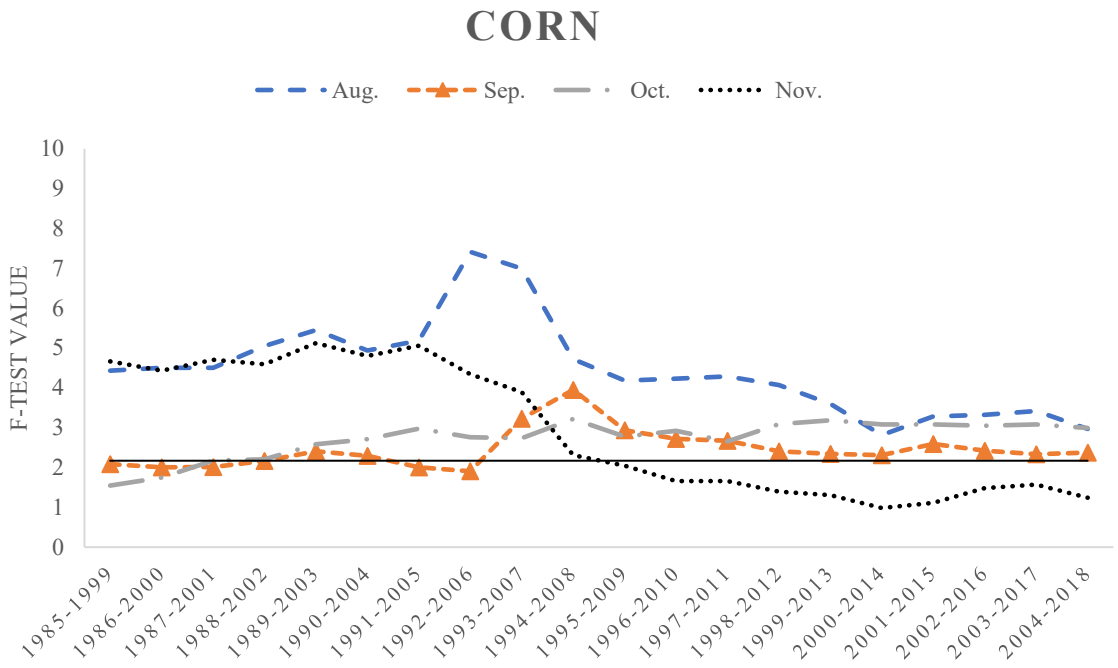

Figure 6. 15-year rolling analysis of changes in crop market reaction to Crop Production reports released in different months. Solid black line shows the critical values for the F-test at 90 percent confidence level.

Source (Isengildina-Massa et al, 2021)

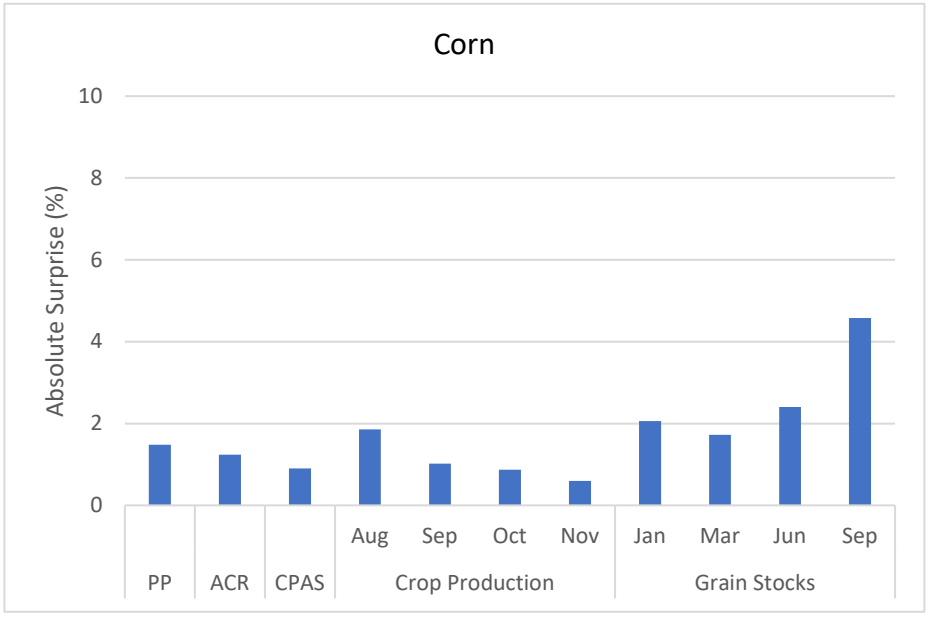

Figure 7. Average absolute market surprises

Note: Sample period is 1984/85-2016/17 marketing years. PP=Prospective Plantings, ACR=Acreage, CPAS=Crop Production Annual Summary, and WWS=Winter Wheat Seedings report.
Source: Karali et al, 2019

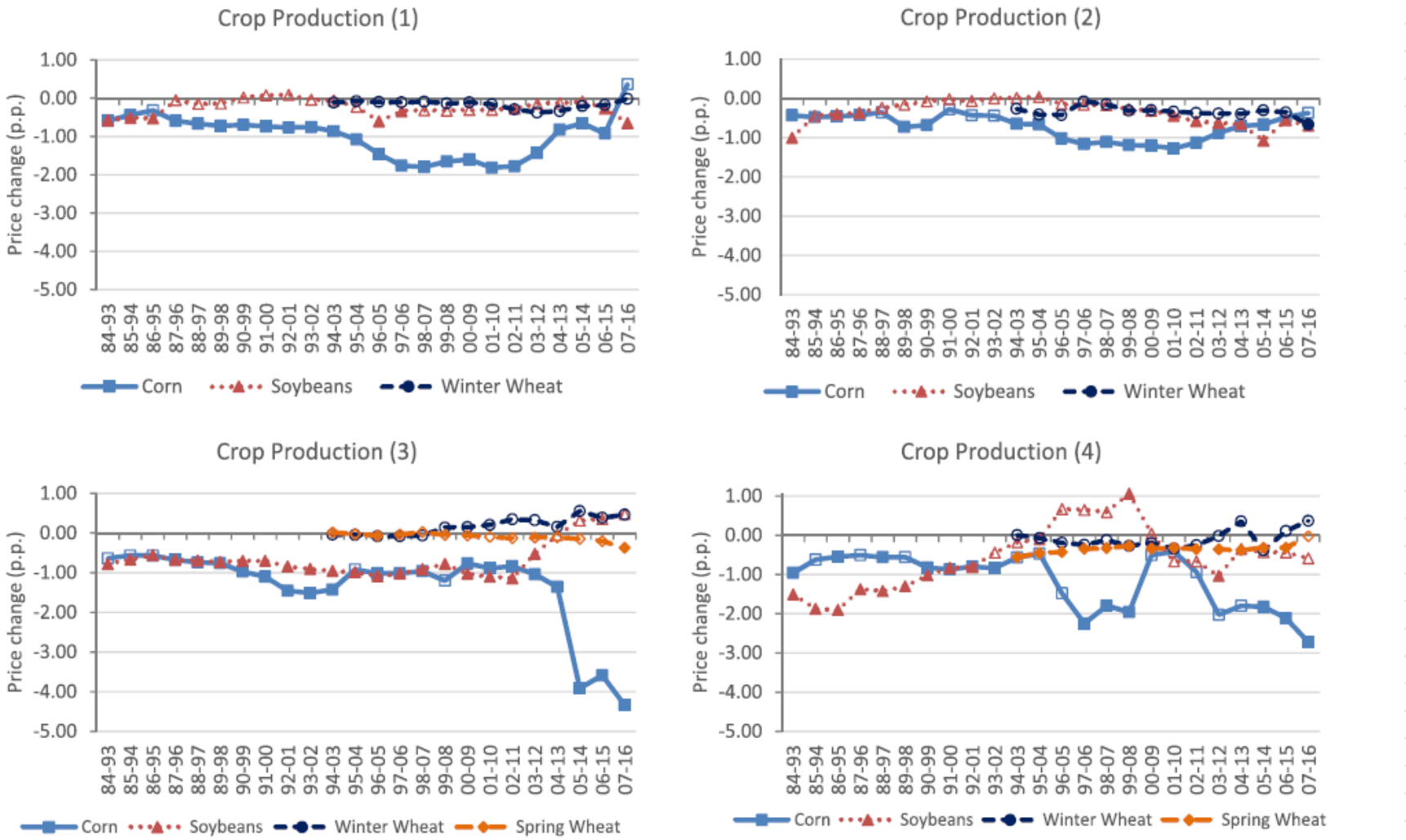

Figure 8. Changes in crop price reaction to market surprises in Crop Production Reports based on 10-year rollig regressions.

Note: 1 = August for corn and soybeans, May for wheat; 2 = September for corn and soybeans, June for wheat; 3 = October for corn and soybeans, July for wheat; 4 = November for corn and soybeans, August for wheat. Results are obtained by the estimation of the DCC MGARCH-X(1,1) model using a 10-year rolling sample period. Coefficient estimates that are statistcally significant at the 10% level are plotted with a filled market symbol, whereas insignificant estimates are indicated with an open marker.

Source: Karali et al, 2019

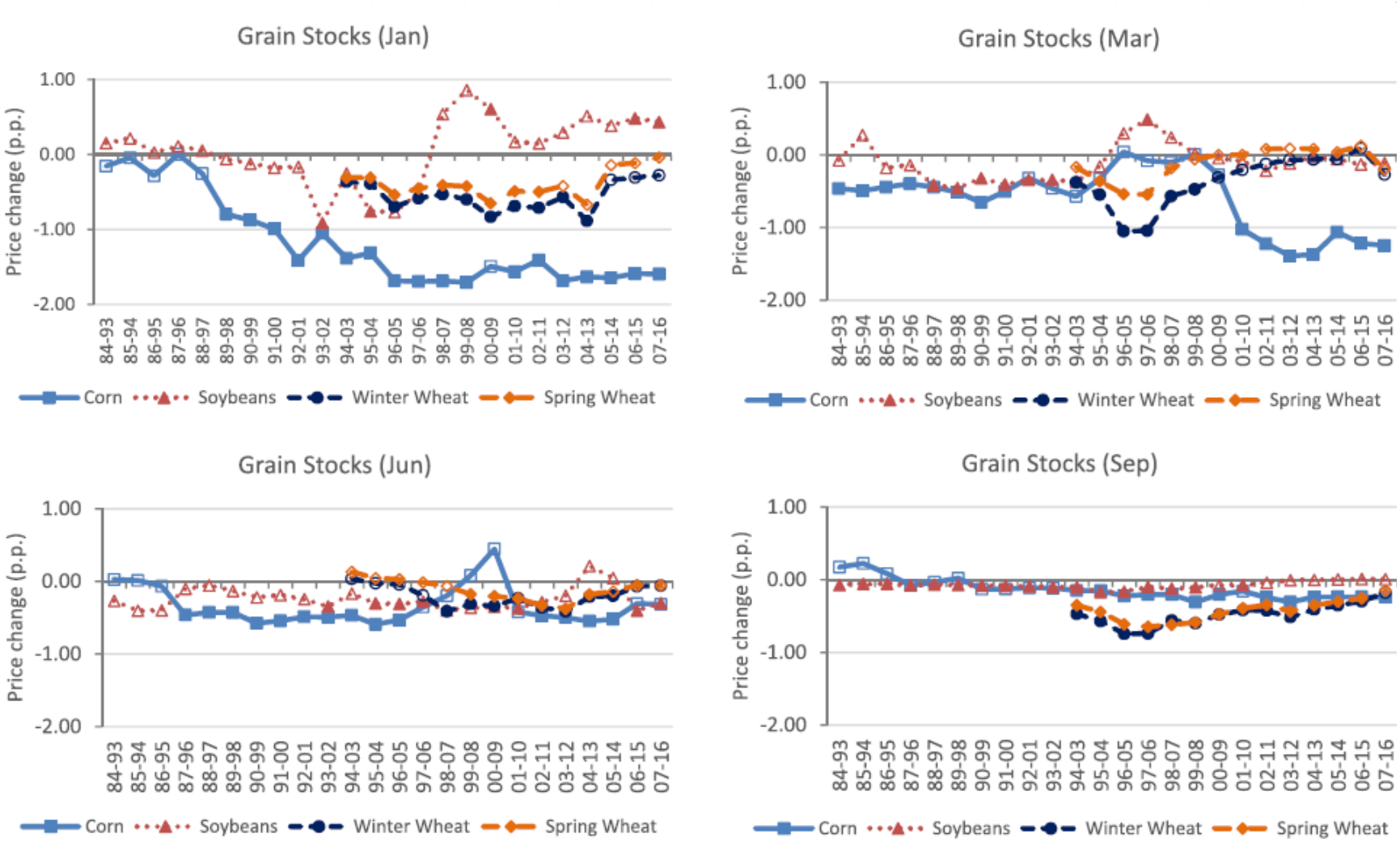

Figure 9. Changes in crop price reaction to market surprises in Grain Stocks reports based on 10-year rolling regressions.
Note: Results are obtained by the estimation of the DCC MGARCH-X(1,1) model using a 10-year rolling sample period. Coefficient estimates that are statistcally significant at the 10% level are plotted with a filled market symbol, whereas insignificant estimates are indicated with an open marker.
Source: Karali et al, 2019

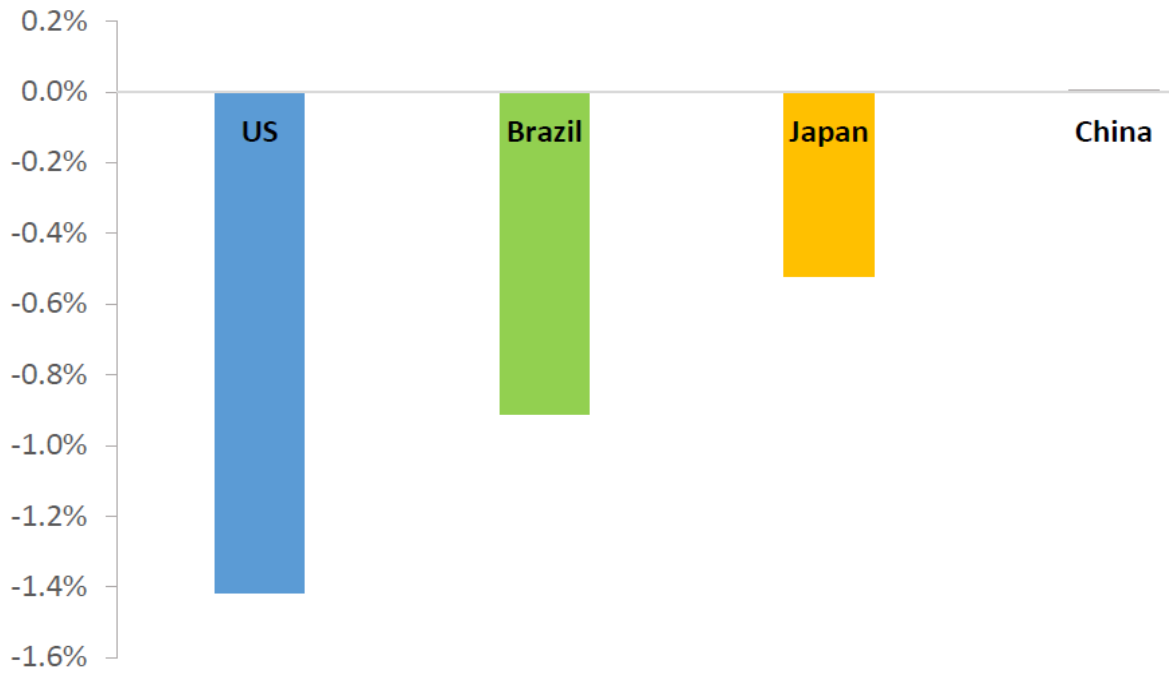

Figure 10. Direct effect of a +1-percent USDA corn crop surprise
Source: Adjemian and Arnade, 2017.

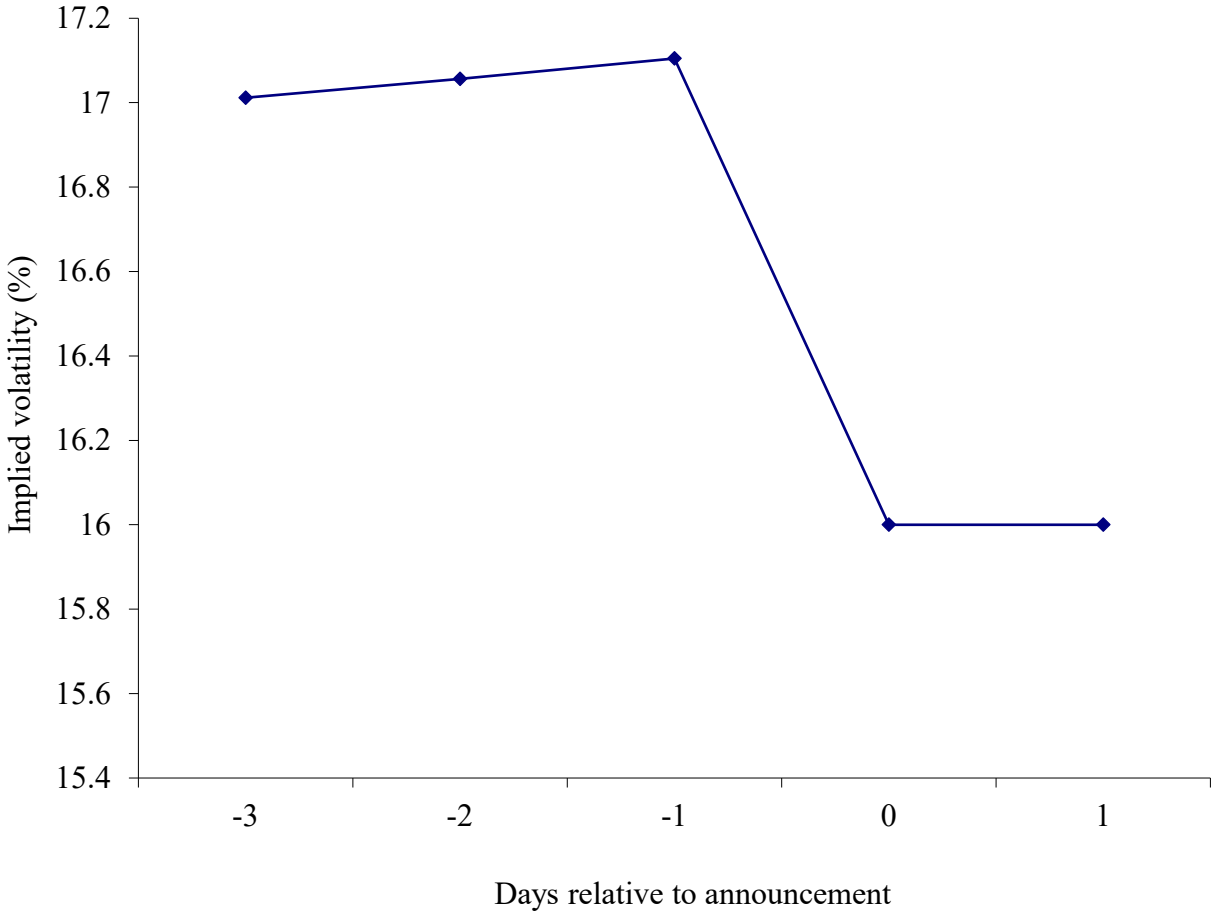

Figure 11. Evolution of Implied Volatility around News Announcements.
Source: (Isengildina-Massa et al. 2008)

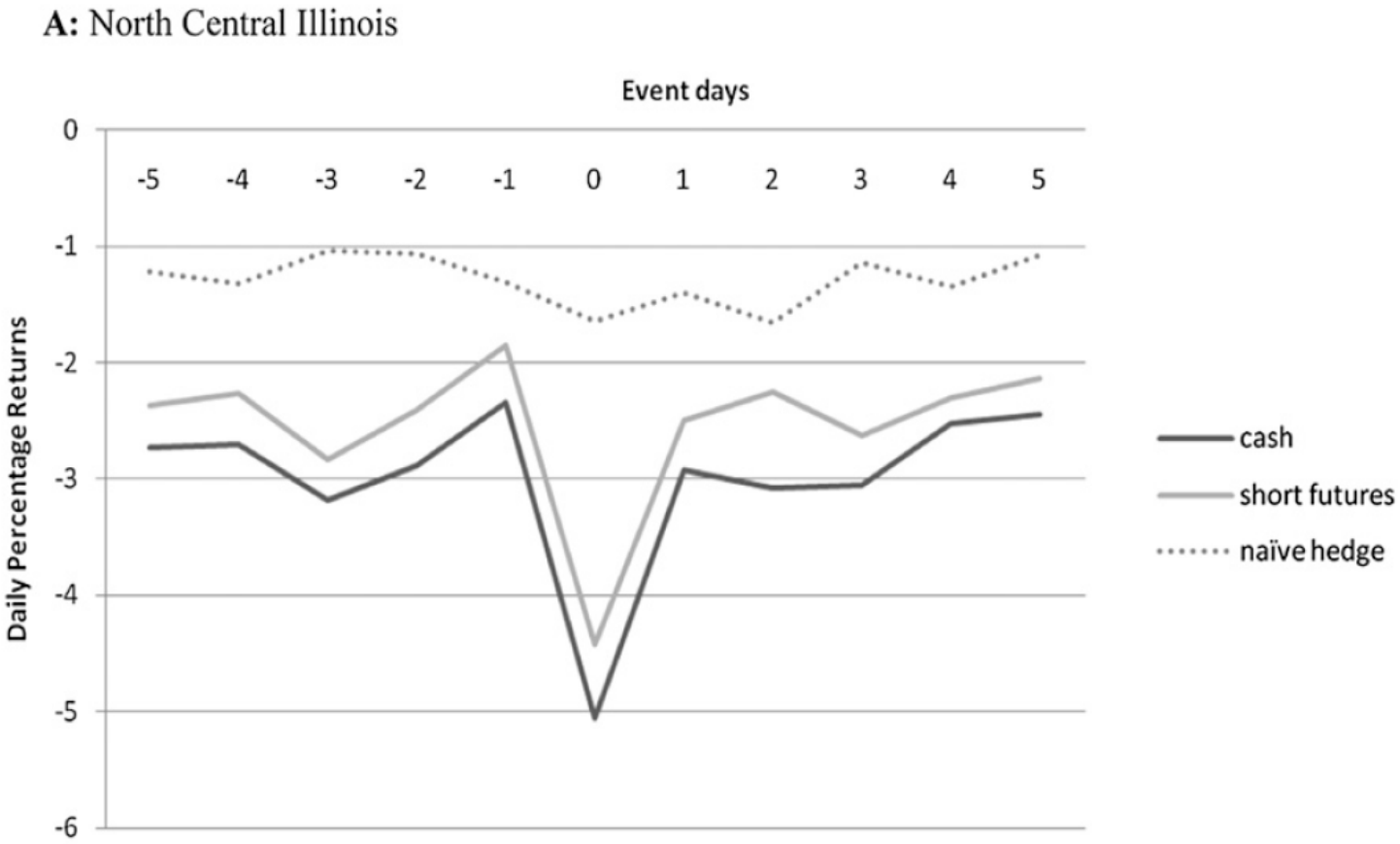

Figure 12. VAR Corn losses 5%.
Source: McKenzie and Singh, 2011

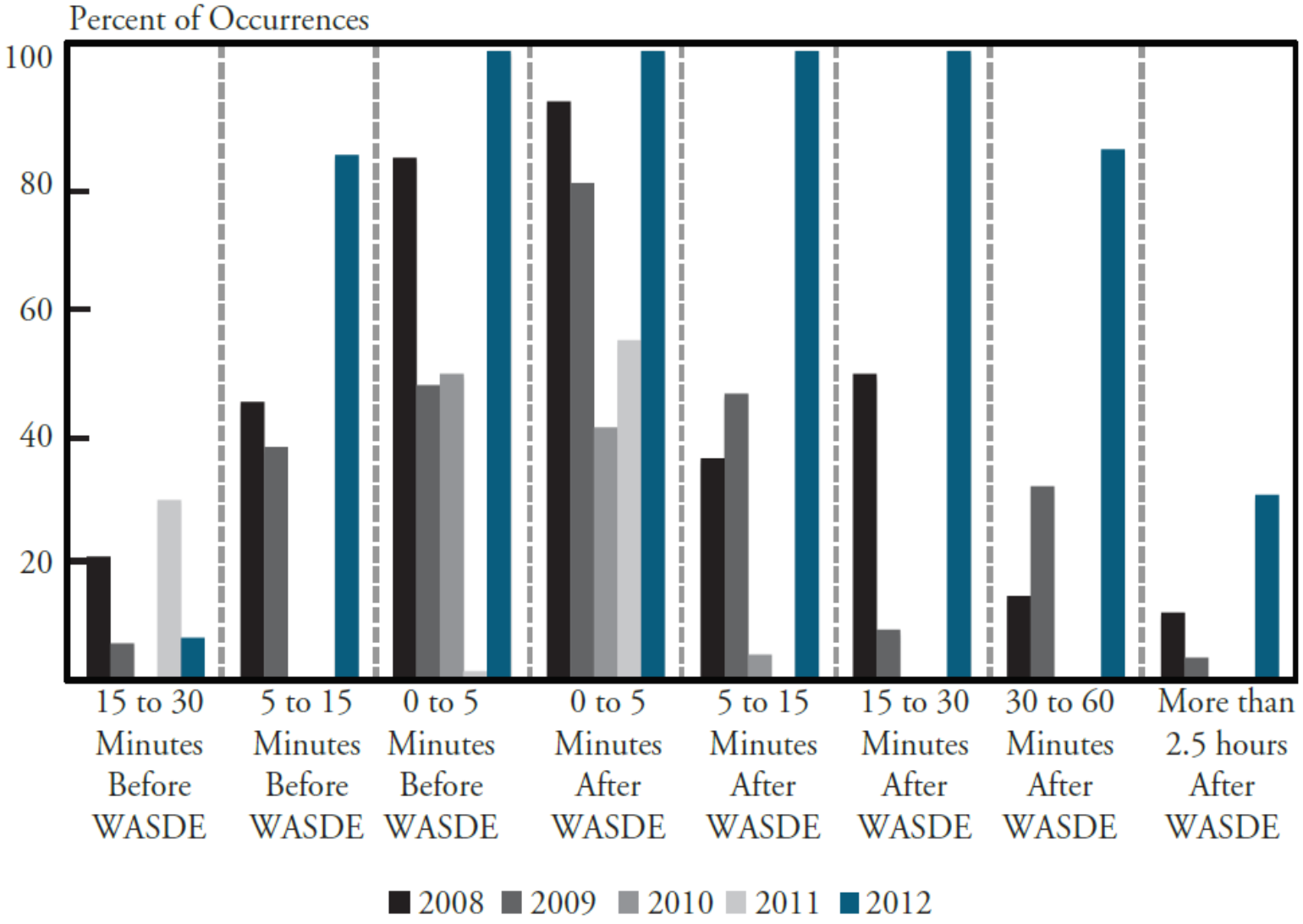

Figure 13. Elevated Volatility on WASDE Release Days Relative to Non-WASDE Baseline.

Source: Kaufmann, 2012