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COVID-19 Working Paper: The Evolution of U.S. Farm Sector Profitability Forecasts in 2020

Tatiana Borisova, Carrie Litkowski, Jonathan Law, and Okkar Mandalay

Abstract

USDA, Economic Research Service (ERS) publicly releases forecasts and estimates of financial indicators that provide insights relevant to the financial health of the U.S. agricultural sector. Based on preliminary data and projections, the sector's income is forecast four times over a period spanning from February to the following February. Estimates are released later when more complete data are gathered, for example, from USDA's Agricultural Resource Management Survey. This report discusses the evolution of the 2020 farm sector income forecasts, illustrating how the Coronavirus (COVID-19) pandemic and related economic uncertainty affected the forecasts. USDA, ERS overestimated 2020 cash receipts and underestimated 2020 production expenses, generally resulting in an overprediction of the 2020 farm sector income relative to official estimates in all four forecasts. The first forecast (released in February 2020) was close to the estimated value because the dollar value of the overprediction of cash receipts nearly offset the underprediction of direct Government payments. In contrast, the last 2020 farm income forecasts (released in February 2021) significantly deviated from the later estimates (released in September 2021), contrary to the historical evidence showing the forecasts converge to the estimates over the forecasting cycle.

Keywords: farm sector, calendar year forecast, estimate, archive, deviation, absolute percent deviation, COVID-19, net cash farm income, net farm income

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About the Authors

Tatiana Borisova and Jonathan Law are agricultural economists, Carrie Litkowski is a senior economist and program leader, and Okkar Mandalay is formerly an agricultural economist with USDA, Economic Research Service.

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Summary

What Is the Issue?

The U.S. farm sector net cash farm income (NCFI) and net farm income (NFI) data released by USDA's Economic Research Service (ERS) are broad measures of U.S. farm sector profitability. These annual, calendar-year net income measures are initially released as forecasts four times across 13 months for any given year. Later, the measures are released as estimates when more complete data are available. NCFI and NFI forecasts for 2020 were made during a period of exceptional uncertainty related to the Coronavirus (COVID-19) pandemic. The analysis of the evolution of NCFI and NFI forecasts provides information on how expectations based on projected and preliminary data changed during the pandemic.

What Did the Study Find?

The forecasts released in February 2020, September 2020, December 2020, and February 2021 all overpredicted 2020 NFI when compared with the first estimated values for 2020 released in September 2021. The forecasts from all but the February 2020 release overpredicted 2020 NCFI. Further analysis of the data shows how forecasts for the major components of farm income contributed to this overprediction:

- All four forecasts overpredicted 2020 cash receipts (for NCFI) and the value of agricultural production (for NFI). The cash receipts and the value of production forecasts were revised throughout the forecasting cycle; however, they remained above the first published estimate (i.e., overly optimistic).
- All the forecasts underpredicted the 2020 production expenses, with a limited forecast correction over the forecasting cycle. This underprediction of expenses contributed to the overprediction of NCFI and NFI.
- The first 2020 forecast was released on February 5, 2020, when no funding programs in response to the pandemic had been signed into law. Therefore, direct Government payments received by farmers in 2020 were significantly unpredicted in the February 2020 forecast. The forecasts released in September 2020, December 2020 and February 2021 revised the February forecast up and were close to the realized total for direct Government payments.
- In the February 2020 release, the dollar value of the overprediction of cash receipts (or value of production for NFI) and the underprediction of Government payments nearly offset each other. This near offset in dollar value resulted in the NCFI and NFI forecasts from February 2020 being the closest forecasts to the estimated 2020 values released in September 2021.

Typically, the NCFI and NFI forecasts improve in relation to the estimated values throughout the forecasting cycle. However, NCFI and NFI reversed that trend, with the 2020 forecasts deviating further in each release from the estimated value. Other years for which farm income forecast evolution did not match the usual trend include calendar years (CYs) 1998–99, 2008–09, and 2019—that is, other years with extraordinary changes in agricultural commodity markets on the global scale.

How Was the Study Conducted?

U.S. farm sector NCFI and NFI forecasts for CY 2020 were compared with the first official estimated 2020 values (released in September 2021). Deviations and absolute percent deviations from the official estimates were calculated for each release. The absolute percent deviations were compared with deviations described by USDA, ERS (USDA, ERS, 2023a).

Three data sources were used to conduct the analysis. First, all releases containing 2020 forecasts and the first official estimates were obtained from the "All Data" comma-delimited files posted on the USDA, ERS Wealth and Statistics data product website (USDA, ERS, 2023b). Second, for historical comparisons, these data were supplemented with information from the USDA, ERS data file called "Archive of Selected Historical Farm Income and Wealth Statistics Forecast and Estimate Data" (USDA, ERS, 2023c). This archive is available online and contains estimates and forecasts from previous Farm Income and Wealth Statistics data releases beginning with the February 1977 release. However, the archive currently focuses only on cash receipts, NFI, and NCFI. When historical analysis of other NCFI and NFI components was needed, the authors relied on an internal USDA, ERS archive.

Introduction

As one of the 13 principal Federal statistical agencies in the United States, USDA, ERS produces forecasts and estimates of the U.S. farm sector income and finances. USDA's ERS data and analysis are used by USDA and other farm sector stakeholders, including lenders, agribusinesses, and farm organizations, to gain perspectives on the financial health of the U.S. agricultural economy. The U.S. Congress, the Secretary of Agriculture, and numerous public and private entities rely on USDA's ERS farm income forecasts and estimates for various uses— from aiding in legislation and USDA program development to helping States assess their local farm economies.

Two fundamental measures of U.S. farm sector finances and profitability are net cash farm income (NCFI) and net farm income (NFI). NCFI is a measure of cash flow in the U.S. farm sector, and it is calculated as gross cash income minus all cash expenses. Gross cash income includes cash receipts from sales of crops and animals/animal products, direct Government payments, and cash farm-related income. Cash expenses include feed, seed, fertilizer, labor, and other expenses. In turn, NFI is a broader measure of profitability that incorporates noncash items, such as changes in inventories, economic depreciation, and gross imputed rental income (appendix A). NCFI and NFI are among the most frequently cited USDA statistics (McGath et al., 2009).[1] NCFI and NFI forecasts and estimates are released by USDA's ERS three times in a calendar year: usually in early February, late August/early September, and late November/early December, in coordination with other key USDA data releases, such as the World Agricultural Outlook Board's *World Agricultural Supply and Demand Estimates* (*WASDE*; USDA, n.d.[a]). For example, Release 1 of calendar year (CY) 2020 represented the first forecast of NCFI and NFI for 2020 and was published on February 5, 2020 (figure 1). The forecast was then updated on September 2, 2020 (Release 2), December 2, 2020 (Release 3), and February 5, 2021 (Release 4). The first estimates of 2020 farm income were published on September 2, 2021 (Release 5), 8 months after the end of the calendar year.[2]

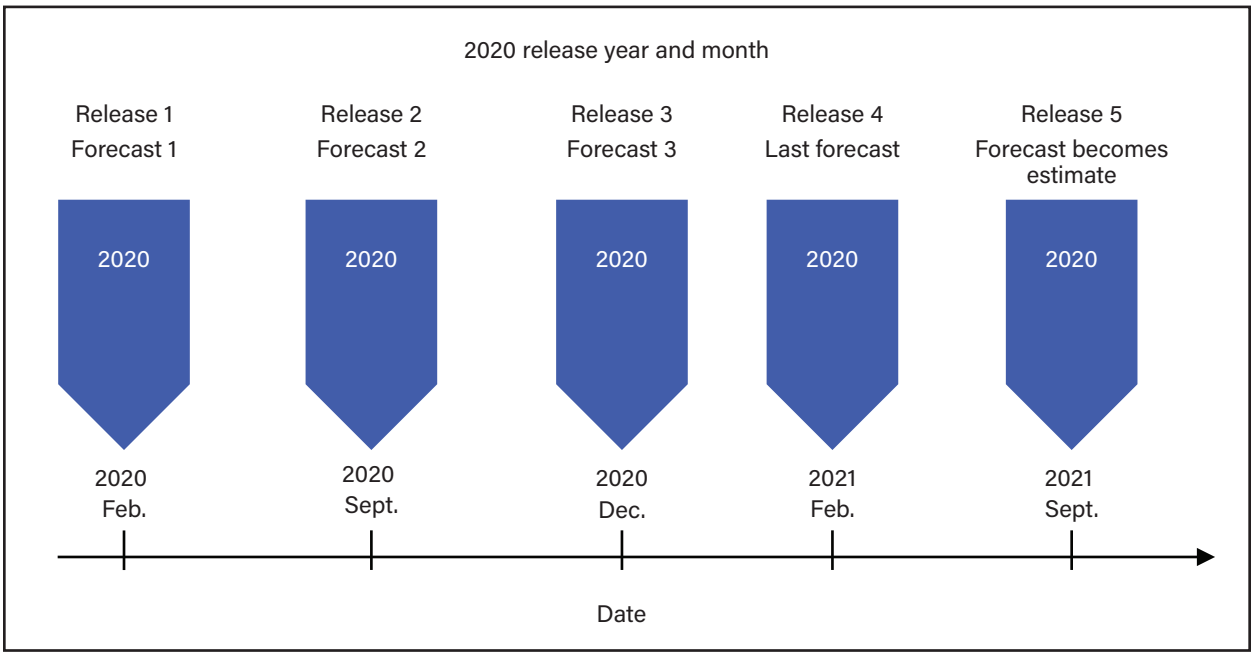
USDA's ERS forecasts are based on data and projections that may be updated as frequently as monthly, and the farm sector financial indicator forecasts can thus vary throughout the forecasting cycle. For example, the WASDE commodity price and production projections are updated monthly and used in forecasting farm sector cash receipts (or sales). Other data are released incrementally throughout the year, such as USDA's National Agricultural Statistics Service (NASS) monthly indexes of the prices paid by farmers that are used in forecasting production expenses (or costs). As the year progresses, each new release incorporates incrementally more observed information gathered via surveys and other means. Finally, USDA's ERS estimates primarily rely on survey data from USDA's NASS and data from other agencies collected through the administration of programs to farmers. Another important source for the estimates is USDA's Agricultural Resource Management Survey (ARMS).

With significant uncertainty about the Coronavirus (COVID-19) pandemic's impact on the U.S. agricultural economy when USDA's ERS forecasts were being released, it is important to analyze how the USDA, ERS forecasts evolved in response to new information. An analysis can provide insights regarding the forecast reliability during times of significant turmoil in global agricultural markets, such as in 2020.

[1] Other financial indicators released as part of USDA's ERS Farm Income and Wealth Statistics include value added by U.S. agriculture, return to operators, farm sector balance sheet with selected financial ratios, and average farm-level net cash income (see USDA, ERS, 2023b).

[2] The estimates were further revised in subsequent releases, reflecting revisions in the underlying data. However, these revisions were minor. Specifically, NCFI was revised from $110.89 billion in Release 5 in September 2021 to $116.80 billion in Release 10 in February 2023, or by 5.06 percent (using Release 10 as 100 percent). In turn, NFI was revised from $94.58 billion in Release 5 to $94.41 billion in Release 10, or by –0.18 percent (using Release 10 as 100 percent). For discussion about Release 5–Release 15 revisions, see appendix B.

Figure 1
2020 calendar year farm income and wealth statistics data releases*



*Note that due to the data collection lag, complete data for the past calendar year are not generally available in February, and therefore, Release 4 is still referred to as a "forecast." Release 5 is the first release referred to as an "estimate" because of its reliance on more complete data, for example, from USDA's National Agricultural Statistics Service surveys and USDA's Agricultural Resource Management Survey.

Source: USDA, Economic Research Service.

Method and Data

This study focuses on the evolution of the NCFI and NFI forecasts and their main components: cash receipts and the value of production for crops and animal products, direct Government payments, expenses, and farm-related income. The authors compare the forecasts (Releases 1–4) with the official estimates (Release 5). Existing studies offer a variety of measures to examine the differences between the forecasts and the official estimates, and each measure has certain advantages (Shcherbakov et al., 2013; Davydenko & Fildes, 2016).[3] The forecast deviation measure was selected because it is expressed in actual units (e.g., billion dollars) and is therefore easy to interpret. The absolute percent deviation between the forecasts and the first official estimates is an alternative measure. Its advantage is that it is a relative measure, allowing researchers to examine the forecast reliability over time despite a sizable increase in the farm sector income (e.g., from $27.4 billion in 1977 to $149.5 billion in 2021 for NCFI in nominal terms based on the February 2023 release). The absolute percent deviation also prevents negative and positive deviations from canceling out when the mean percent deviation is calculated, making the mean sensitive to both positive and negative deviations. The mean absolute percent deviation was also used to examine farm income forecast reliability in the analysis of historical USDA, ERS Farm Income and Wealth Statistics releases summarized in one of the FAQs (USDA, ERS, 2023a). Utilizing this measure allows us to compare the 2020 forecast deviations with that analysis.

[3] Following statistical convention, the difference between the forecast and estimate is often referred to as the "deviation" or "error." In this paper, the authors use the words "difference," "deviation," and "error" interchangeably.

Denoting forecast release numbers with index i (i=1, 2, 3, and 4), the forecast deviation from the estimate can be calculated as follows:

$$Dev_i = F_i - S \qquad (1)$$

where F_i refers to the forecast, and S denotes the estimate published in Release 5. In turn, the absolute percent deviation, $|pe_i|$, is the difference between the forecast, F_i, and the estimate, S, divided by the estimate:[4]

$$|pe_i| = \left|\frac{F_i - S}{S}\right| \times 100 \qquad (2)$$

For the analysis, all releases containing 2020 and 2021 forecasts and the first official estimates were obtained from USDA's ERS Farm Income and Wealth Statistics data product webpage (USDA, ERS, 2023b). Where historical comparisons were made, additional data were obtained from the USDA, ERS archive (USDA, ERS, 2023c). The archive contained data on U.S.-level cash receipts, NCFI, and NFI, starting with the February 1977 release (USDA, ERS, 2023c; archive description in appendix C). When historical analysis required net income component data beyond that available in the public archive, an unpublished internal ERS data archive was used. All the analysis was completed in the SAS Enterprise Guide (SAS Institute Inc., 2020).

Analysis and Results

After a brief overview of economic conditions in 2020, this section describes the evolution of the 2020 U.S. farm sector income forecasts, including NFI, NCFI, and their main components. The 2020 farm income forecast evolution is then compared with that observed historically. Finally, the 2020 farm income forecasts are compared with those for 2021, the second year of the COVID-19 pandemic.

COVID-19 Pandemic and the U.S. Economy: A Brief Overview

The SARS-CoV-2 virus was declared a public health emergency by the Secretary of the U.S. Department of Health and Human Services on January 31, 2020 (CDC, 2023). Protective measures, such as social distancing, were taken to slow virus transmission, causing an abrupt decline in economic activities (Board of Governors of the Federal Reserve System, 2021). As a result, the second quarter of 2020 was a period of economic recession (National Bureau of Economic Research [NBER], n.d.), with a sharp contraction in the gross domestic product (GDP; figure 2) and a historic increase in unemployment (Board of Governors of the Federal Reserve System, 2021).

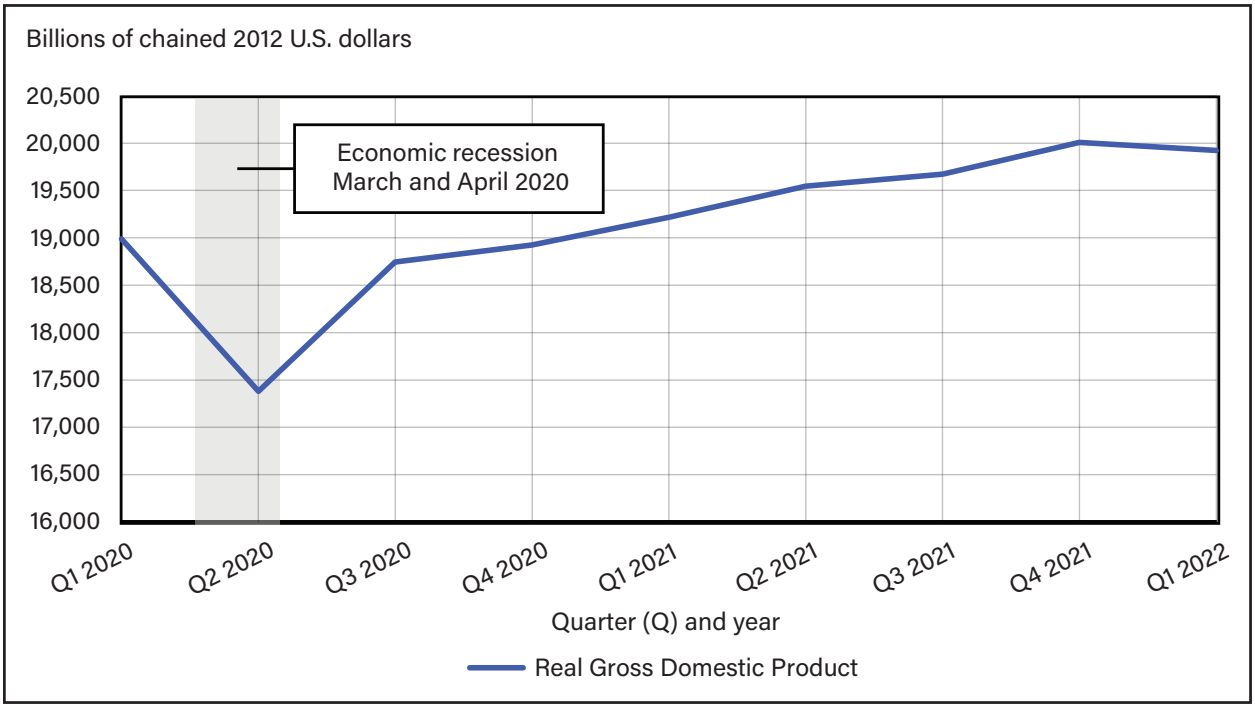
To support the public and businesses during a period when economic activities had to be restricted to protect public health, six major laws were passed by the U.S. Congress, including the Coronavirus Aid, Relief, and Economic Security (CARES) Act and USDA's Coronavirus Food Assistance Program (CFAP) targeting farm operations (USDA, n.d. (b); USDA, Office of Chief Economist [OCE], n.d.; Weinstock, 2021).[5] Together with the Federal Reserve Bank's actions, such as Federal funds rate reductions (Board of Governors of the

[4] Some studies suggest using the forecast value in the denominator instead of the estimated value. However, the study by Green and Tashman (2008) surveyed 61 memberships of the International Institute of Forecasters (IIF), and 56 percent of the respondents preferred the use of the actual value (i.e., the estimate) rather than the forecast value in the denominator.

[5] An up-to-date summary of USDA pandemic assistance programs is available on the USDA webpage "USDA Pandemic Assistance for Producers." Giri et al. (2021) discusses the total direct Government assistance to farm operations and farm households in 2020 (from COVID-19 related programs, the Market Facilitation Program, and other existing Farm Bill programs).

Federal Reserve System, 2021) and other efforts, these actions helped mitigate the effects of economic decline (Weinstock, 2021). Economic growth resumed in the third quarter of 2020, and by the first quarter of 2021, GDP returned to the pre-pandemic levels (figure 2).

Figure 2
U.S. Gross Domestic Product in quarter 1, 2020–quarter 1, 2022 (in billions of inflation-adjusted U.S. dollars), with the economic recession period highlighted



Note: Real Gross Domestic Product is the inflation-adjusted value of goods and services produced by labor and property located in the United States.

Source: USDA, Economic Research Service using data from the Federal Reserve Economic Data, Federal Reserve Bank of St. Louis.

The pandemic and related protective measures led to rapid changes in the agricultural economy, including supply chain disruptions and changes in demand for certain commodities. Consumer food purchasing behavior rapidly shifted from food-away-from-home consumption to in-home consumption, which severely impacted the food distribution system (Hobbs, 2020). There were also widespread concerns about the impacts of the temporary immigration restrictions on the farm labor supply (Charlton & Castillo, 2021). Other factors affecting agriculture in 2020 included pest and disease pressures, weather, strong international demand (particularly by China), and Government policies.

Ultimately, these changes in the economy contributed to a reduction in 2020 farm sector cash receipts compared with the pre-pandemic 2019 estimates and an increase in production expenses (USDA, ERS, 2023b). Direct Government payments to farmers increased significantly in 2020, exceeding the historical average level and offsetting both higher production expenses and lower commodity cash receipts (USDA, ERS, 2023b).

Evolution of the Forecasts of 2020 NCFI and NFI and Their Components

The first U.S. farm sector income forecast for 2020 (Release 1) was published by USDA's ERS on February 5, 2020. The forecast did not include any information on the potential pandemic impacts or directly-related

Government payments (Litkowski & Law, 2021); as of that date, no planned outlays or any other funding programs in response to the Coronavirus pandemic had yet been implemented.

The second and subsequent USDA, ERS forecasts included considerably more information about the pandemic effects, Government responses, and other economic factors. Yet uncertainties remained, and even the last forecast for 2020 (released in February 2021) was markedly different from the first official estimate for 2020 (released in September 2021; table 1). The first 2020 NCFI forecast was close to the September 2021 estimate, with only a 1.18 absolute percent deviation (table 1). In contrast, Release 2 had a deviation of 3.91 percent relative to the September 2021 estimate. The forecasts' deviations from the estimate increased further in subsequent releases, reaching 22.86 percent in Release 4 (table 1). A similar pattern of increasing absolute percent deviation from release to release is observed for the 2020 NFI. These deviations are different from those reported in FAQ of USDA, ERS' Farm Income and Wealth Statistics (USDA, ERS, 2023a). Based on a historical review of forecasts for 2002–2021, the average absolute percent deviation for the first NCFI forecast is 13.3 percent (15.8 percent for NFI). The arrival of new data throughout a given year generally leads to a reduction in the forecast deviation from the estimate, and by the fourth forecast, the average absolute percent deviation for NCFI falls to 6.8 percent (10.9 percent for NFI, see USDA, ERS, 2023a).

Table 1
2020 NCFI and NFI forecasts, estimates, deviations, and absolute percent errors, by release

Release number	Forecast or estimate	Release date	NCFI			NFI		
			NCFI in U.S. dollars (billions)	Deviation from the estimate in U.S. dollars (billions)*	Absolute percent deviation *	NFI in U.S. dollars (billions)	Deviation from the estimate in U.S. dollars (billions)*	Absolute percent deviation *
1	Forecast 1	Feb. 2020	109.59	–1.30	1.18	96.67	+2.09	2.21
2	Forecast 2	Sept. 2020	115.23	+4.34	3.91	102.69	+8.12	8.58
3	Forecast 3	Dec. 2020	134.12	+23.23	20.95	119.62	+25.04	26.48
4	Forecast 4	Feb. 2021	136.24	+25.35	22.86	121.13	+26.55	28.07
5	Estimate	Sept. 2021	110.89	NA	NA	94.58	NA	NA

NCFI = net cash farm income; NFI = net farm income; NA = not applicable.

* The deviation and absolute percent deviation are calculated by comparing the forecasts with the Release 5 estimates. Note that Release 5 estimates were revised in subsequent USDA, Economic Research Service Farm Income and Wealth Statistics data releases. The revisions are generally small. For example, appendix B shows that historically, average revisions to net cash farm income (NCFI) and net farm income (NFI) estimates between Release 5 and Release 15 were less than 8 percent (in absolute value).

Source: USDA, Economic Research Service (ERS) calculations using data from historical USDA, ERS Farm Income and Wealth Statistics releases, February 1977 to most recent vintage (USDA, ERS, 2023c).

To explore the drivers of NCFI and NFI revisions over the forecasting cycle, the authors considered the evolution of the following aggregate components of NCFI and NFI: cash receipts and the value of production, direct Government payments, production expenses, and farm-related income (table 2, table 3, and figure 3).[6] The discussion below provides details, but overall, pandemic and other factors affecting U.S. economy in 2020 lowered the value of agricultural production and raised input costs relative to the early expectations (e.g., see Litkowski & Law, 2021). This resulted in overpredicting cash receipts and underpredicting production expenses in all forecast releases. The forecast deviations reflect deviations in the data inputs (such as the

[6] Note that the authors exclude farm-related income from the value of agricultural sector production for crops and animal/animal products. Similarly, farm-related income is displayed as a separate item in figure 3.

price and quantity forecasts incorporated into the USDA, ERS farm income forecast model) and forecasting methods.

Cash receipts and the value of farm sector production for crops and animal/animal products were the largest components of NCFI and NFI, respectively. Cash receipts and the value of farm sector production were forecast at a higher level than the September 2021 estimates in all four forecast releases. The first forecasts had the largest deviation from the September 2021 estimates compared with the following forecasts, illustrating optimistic expectations for the U.S. farm sector before the start of the pandemic. These expectations were revised in the subsequent forecasts, though not enough to match the September 2021 estimated value in Release 5.

Table 2
Aggregate components of 2020 NCFI, by release

Release number	Cash receipts			Direct Government payments		
	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*
1	384.43	27.27	7.63	15.0	(30.71)	-67.22
2	358.30	1.14	0.32	37.2	(8.50)	-18.60
3	366.51	9.35	2.62	46.5	0.79	1.73
4	370.38	13.22	3.70	46.3	0.58	1.26
5	357.16	NA	NA	45.7	NA	NA

Release number	Cash production expenses			Cash farm-related income		
	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*
1	321.3	(4.95)	-1.52	31.50	(2.81)	-8.20
2	313.5	(12.73)	-3.90	33.28	(1.03)	-3.01
3	313.0	(13.30)	-4.08	34.12	(0.20)	-0.58
4	314.6	(11.71)	-3.59	34.16	(0.16)	-0.46
5	326.3	NA	NA	34.31	NA	NA

NCFI = net cash farm income; NA = not applicable.

* The deviation and absolute percent deviation are calculated by comparing the forecasts with the Release 5 estimates. Note that Release 5 estimates were revised in subsequent USDA, ERS Farm Income and Wealth Statistics data releases. The revisions are generally small. For example, appendix B shows that historically, average revisions to net cash farm income (NCFI) and net farm income (NFI) estimates between Release 5 and Release 15 were less than 8 percent (in absolute value).

Source: USDA, Economic Research Service (ERS) calculations using the files in section "Download All Data in CSV File Format (ZIP)" in "Data Files: U.S. and State-Level Farm Income and Wealth Statistics" (USDA, ERS, 2023b).

Table 3
Aggregate components of 2020 NFI, by release

Release number	Value of production			Direct Government payments		
	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*
1	384.54	30.57	8.64	15.0	(30.71)	-67.22
2	357.67	3.69	1.04	37.2	(8.50)	-18.60
3	363.58	9.60	2.71	46.5	0.79	1.73
4	366.67	12.69	3.59	46.3	0.58	1.26
5	353.97	NA	NA	45.7	NA	NA

Release number	Production expenses			Farm-related income		
	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*
1	354.7	(2.72)	-0.76	51.80	(0.49)	-0.93
2	344.2	(13.22)	-3.70	51.99	(0.30)	-0.58
3	343.6	(13.80)	-3.86	53.14	0.85	1.62
4	345.2	(12.18)	-3.41	53.39	1.10	2.10
5	357.4	NA	NA	52.29	NA	NA

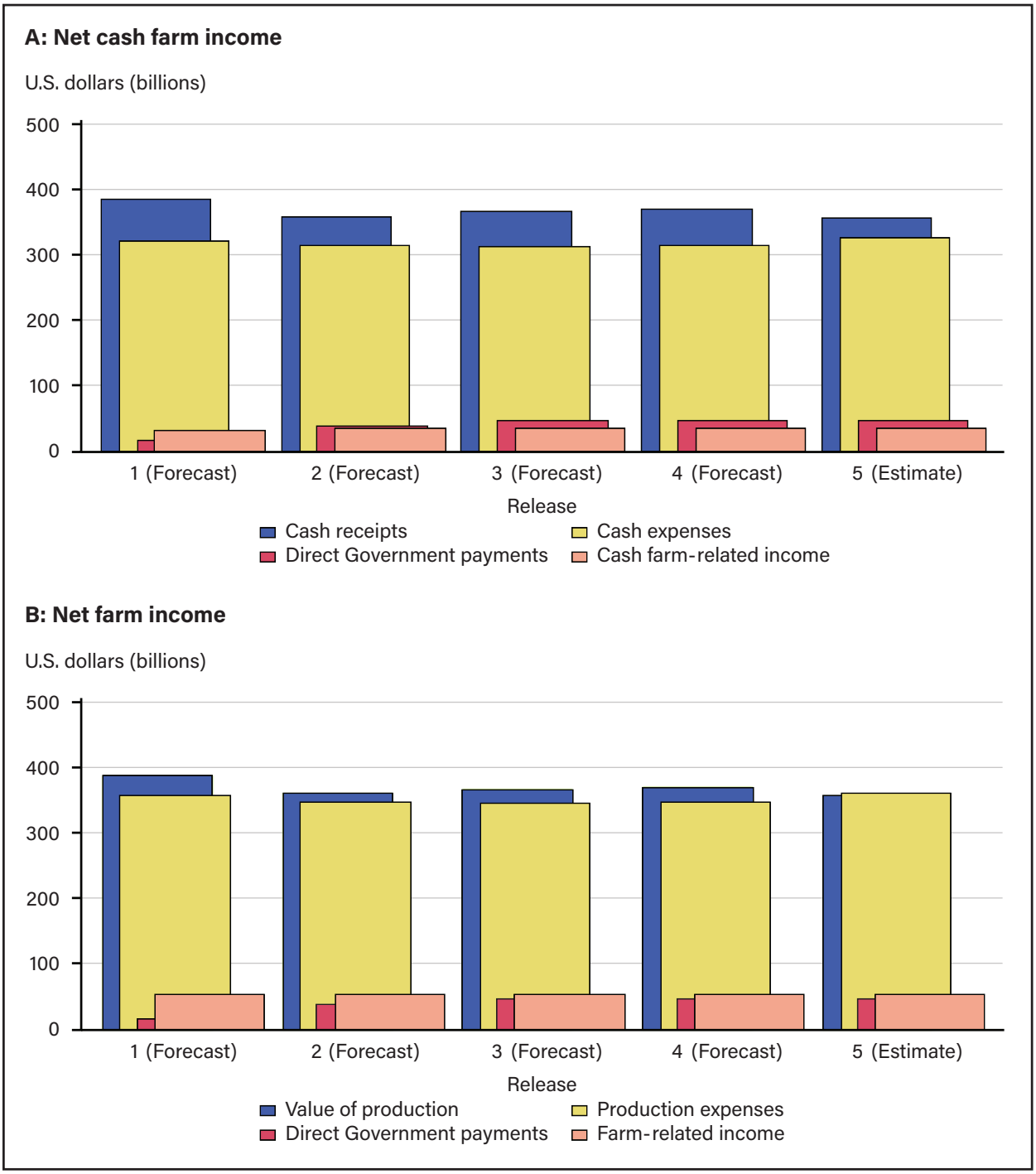
NFI = net farm income; NA = not applicable.

* The deviation and absolute percent deviation are calculated by comparing the forecasts with the Release 5 estimates. Note that Release 5 estimates were revised in subsequent USDA, ERS Farm Income and Wealth Statistics data releases. The revisions are generally small. For example, appendix B shows that historically, average revisions to net cash farm income (NCFI) and net farm income (NFI) estimates between Release 5 and Release 15 were less than 8 percent (in absolute value).

Source: USDA, Economic Research Service (ERS) calculations using the files in section "Download All Data in CSV File Format (ZIP)" in "Data Files: U.S. and State-Level Farm Income and Wealth Statistics" (USDA, ERS, 2023b).

Figure 3

2020 net income component forecasts and estimates, by release (U.S. dollars [billions], not adjusted for inflation)



Source: USDA, Economic Research Service (ERS) calculations using USDA, ERS Farm Income and Wealth Statistics data (USDA, ERS, 2023e).

The 2020 forecasts were generally overly optimistic for most of the categories in crop and animal/animal products cash receipts (table 4). For crops, the cash receipt forecast deviated from the September 2021 estimate by $6.46 billion in the first forecast, but the deviation increased to $11.76 billion in the final forecast. This increase in the deviations over the forecasting cycle was mainly due to the cash receipt forecasts for fruits/nuts, vegetables/melons, and soybeans. Fruits/nuts and vegetables/melons are aggregate commodity groups that include a range of specialty crops such as almonds, apples, grapes, oranges, strawberries, and tomatoes. With the uncertainty caused by the pandemic, the cash receipts for these diverse specialty crop categories were especially hard to predict.

Similarly, the cash receipt forecast for soybeans was revised up in Releases 3 and 4. This followed revisions to the projections for average prices received by farmers for marketing year (MY) 2020/21. The USDA projection of soybean prices from the USDA Agricultural Projections to 2029 (released in February 2020) was $8.85 per bushel (USDA, OCE, 2020). In January 2021, the projection from the *WASDE* report was higher, at $11.15 per bushel. By September 2021, when the 2020 cash receipts data were labeled "estimates," the MY 2020/21 price was revised slightly down to $10.9 per bushel. The change in the price forecast drew revisions in the soybean cash receipt forecast (since the revisions to soybean production quantities were relatively small).[7]

[7] Note that the soybean price used in the February 2020 release was from internal forecasts developed by USDA, ERS analysts; however, these forecasts were comparable to forecasts in the USDA baseline projections. In this report, the authors cite the USDA baseline projections because they are publicly available.

Table 4

2020 cash receipt forecasts, estimates, and deviations, by release (U.S. dollars [billions], not adjusted for inflation)

Variable description total	Release 1 forecast in U.S. dollars (billions)		Release 2 forecast in U.S. dollars (billions)		Release 3 forecast in U.S. dollars (billions)		Release 4 forecast in U.S. dollars (billions)		Release 5 estimate in U.S. dollars (billions)
	Value	Deviation*	Value	Deviation*	Value	Deviation*	Value	Deviation*	
Cash receipts value, all commodities	384.43	27.27	358.30	1.14	366.51	9.35	370.38	13.22	357.16
Including:									
Cash receipts value, crops, all	198.63	6.46	196.61	4.45	200.20	8.04	203.92	11.76	192.16
Selected key crops:									
Corn	49.83	3.15	46.99	0.31	46.87	0.19	47.96	1.28	46.68
Cotton, all	7.10	0.41	6.59	(0.10)	6.62	(0.07)	6.50	(0.20)	6.69
Fruits/nuts	30.99	2.87	33.62	5.50	33.41	5.29	33.46	5.33	28.12
Soybeans	34.61	(2.05)	33.91	(2.75)	36.76	0.11	38.57	1.91	36.66
Vegetables/melons	20.05	1.78	19.42	1.15	19.63	1.36	20.44	2.16	18.27
Wheat	8.61	(0.22)	8.37	(0.46)	8.59	(0.25)	8.83	0.00	8.83
Cash receipts value, animal and animal products, all	185.80	20.81	161.69	(3.31)	166.30	1.31	166.45	1.46	165.00
Selected key livestock and products:									
Cattle and calves	69.05	5.96	61.16	(1.93)	62.28	(0.81)	62.01	(1.08)	63.09
Chicken and chicken eggs	7.93	(0.75)	8.69	0.02	8.98	0.30	8.64	(0.04)	8.67
Dairy products	42.48	1.93	39.61	(0.94)	40.41	(0.14)	40.62	0.07	40.55
Hogs	27.06	7.89	18.52	(0.65)	20.88	1.71	21.08	1.91	19.17

* The deviation and absolute percent deviation are calculated by comparing the forecasts with the Release 5 estimates. Note that Release 5 estimates were revised in subsequent USDA, Economic Research Service Farm Income and Wealth Statistics data releases. The revisions are generally small. For example, appendix B shows that historically, average revisions to net cash farm income (NCFI) and net farm income (NFI) estimates between Release 5 and Release 15 were less than 8 percent (in absolute value).

Source: USDA, Economic Research Service (ERS) using USDA, ERS U.S. and State-Level Farm Income and Wealth Statistics data (USDA, ERS, 2023b).

Another component of the U.S. net farm income is production expenses (table 2, table 3, and figure 3). All four (cash) production expense forecasts for CY 2020 were overly optimistic, expecting lower expenses than the estimate released in September 2021. Forecasts for several expense categories were lowered over the forecasting cycle before being increased in the September 2021 estimate (table 5). For example, labor expenses were forecast at $38.36 billion before the pandemic (Release 1), but these expenses were reduced to $35.64 billion by the last forecast in Release 4 (with the September 2021 estimate being $36.97 billion). Similar downward revisions after the start of the pandemic were observed for livestock purchases, interest expenses, petroleum fuel/oil expenses, and marketing/storage/transportation expenses, resulting in the Release 4 forecast to be below the September 2021 production expense estimates. In other words, the downward revisions in expenses expected as late as Release 4 did not occur.

Table 5

2020 production expenses: Forecasts, estimates, and deviations, by release (U.S. dollars [billions], not adjusted for inflation)*

Variable description total*	Release 1 forecast in U.S. dollars (billions)		Release 2 forecast in U.S. dollars (billions)		Release 3 forecast in U.S. dollars (billions)		Release 4 forecast in U.S. dollars (billions)		Release 5 estimate in U.S. dollars (billions)
	Value	Deviation***	Value	Deviation***	Value	Deviation***	Value	Deviation***	
Production expenses, all**	354.65	(2.72)	344.15	(13.22)	343.57	(13.80)	345.19	(12.18)	357.37
Including:									
Interest expenses**	18.01	(0.95)	15.06	(3.90)	15.31	(3.65)	15.39	(3.57)	18.96
Feed	59.62	2.78	60.26	3.42	59.66	2.82	60.11	3.27	56.84
Fertilizer, lime, and soil condi tioner	23.12	(1.32)	23.61	(0.83)	23.47	(0.97)	23.58	(0.85)	24.44
Livestock purchases	29.07	0.07	26.52	(2.48)	26.72	(2.28)	26.74	(2.25)	28.99
Marketing, stor age, and transportation	12.11	1.02	9.94	(1.16)	9.76	(1.33)	9.85	(1.25)	11.09
Pesticide	14.96	(1.56)	15.18	(1.33)	15.53	(0.98)	15.63	(0.88)	16.52
Petroleum fuel and oil	12.66	0.68	11.36	(0.62)	11.30	(0.69)	11.40	(0.59)	11.98
Repair and maintenance**	16.02	(1.41)	15.80	(1.63)	15.80	(1.63)	15.82	(1.61)	17.43
Seed	20.70	(2.31)	21.43	(1.59)	21.25	(1.76)	21.27	(1.75)	23.02
Labor expenses, all, contract and hired	38.36	1.39	36.16	(0.81)	35.66	(1.31)	35.64	(1.33)	36.97
Net rent, all landlords	15.56	(3.88)	17.79	(1.65)	18.11	(1.33)	18.20	(1.24)	19.44
Property taxes, all**	15.03	0.12	15.14	0.24	15.15	0.24	15.16	0.25	14.91

* This list of expense categories is not comprehensive; instead, the largest expense categories and expenses with the most significant forecast deviations are included. ** Includes operator dwellings. *** The deviation and absolute percent deviation are calculated by comparing the forecasts with the Release 5 estimates. Note that Release 5 estimates were revised in subsequent USDA, Economic Research Service Farm Income and Wealth Statistics data releases. The revisions are generally small. For example, appendix B shows that historically, average revisions to net cash farm income (NCFI) and net farm income (NFI) estimates between Release 5 and Release 15 were less than 8 percent (in absolute value).

Source: USDA, Economic Research Service (ERS) using USDA, ERS U.S. and State-Level Farm Income and Wealth Statistics data (USDA, ERS, 2023b).

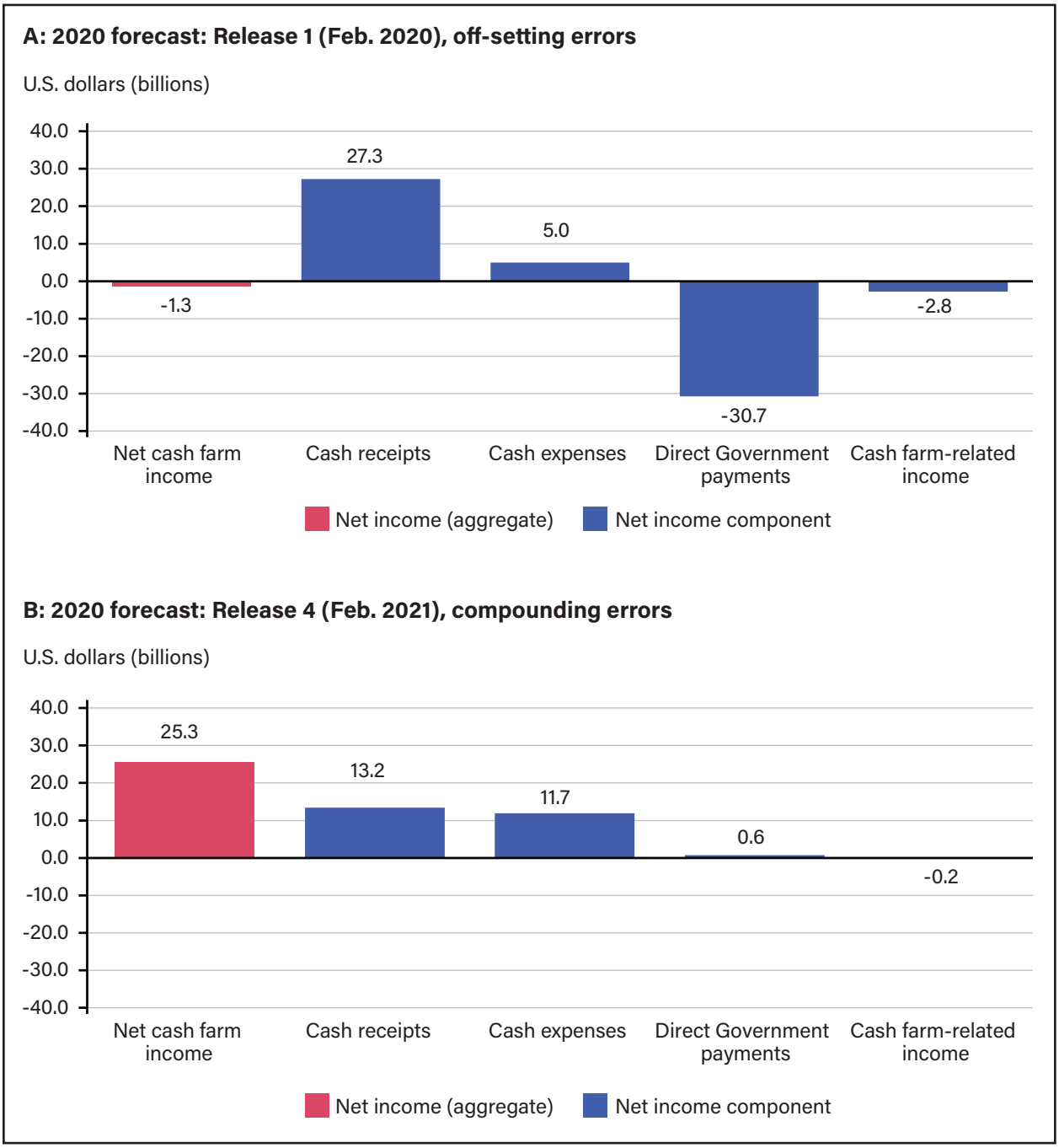
In aggregate, the cash receipt forecasts did show significant improvement between Release 1 and Release 4, with approximately a $14.1 billion reduction in the difference between the forecast and September 2021 estimate (in U.S. dollar terms). The cash expenses difference between the forecast and estimate, however, increased significantly by Release 4, with cash expenses forecast lower than they would be estimated in September 2021. This increase in forecast deviation is atypical; for example, Isengildina-Massa et al. (2021) reported the convergence of cash production expense forecasts to the estimate (on average). The reduced reliability of the 2020 production expense forecast may be linked to the forecast methodology. As described in McGath et al. (2009), the forecast for several expense categories relies on the historical trends in input prices, along with other drivers. Therefore, sudden shifts in price trends may impact the forecast reliability. An alternative explanation could be that producers' input decisions in 2020 were not explained by the factors

underlying the forecast methodology. For example, it would be logical to expect that the reduction in anticipated cash receipts would correlate with a decline in expenses to reflect farmers' adjustments to market conditions, but that was not the case for 2020. The September 2021 estimates also showed that relative to 2019, production expenses rose in 2020 despite a decline in cash receipts. It is possible that the record-high levels of Government payments in 2020 lessened producers' need to reduce expenses. Payments from some of the COVID-19 relief programs were partly designed to compensate for higher marketing and labor expenses during the pandemic. It is also possible that producers had limited flexibility in reducing their expenses.

Overall, the first 2020 NCFI forecast was closest to the September 2021 estimate; however, the forecasts' deviations from the estimate increased in subsequent releases, reaching 22.86 percent in Release 4. As shown in figure 4A, the 2020 NCFI forecast error was approximately -$1.3 billion in Release 1 due to large but offsetting forecast errors in cash receipts and direct Government payments. Total error due to cash receipts and production expenses forecast errors totaled $32.2 billion for Release 1; yet these were mostly canceled out by an underprediction of $30.7 billion in Government payments. The first forecast released in February 2020 did not anticipate the elevated Government program payments to farmers from COVID-19 relief programs in 2020, which were affected by policy decisions made after the forecast was released (table 2, table 3, and figure 3). Additionally, the USDA, ERS farm income forecasts do not account for or incorporate any potential or pending farm policy changes.

Figure 4

Forecast deviations (errors) by component help explain differences in 2020 forecast performance by release number (U.S. dollars [billions], not adjusted for inflation)



Note: Each forecast value is compared with its corresponding Release 5 estimate (September 2021). Cash expenses are underestimated in both releases, but the figure shows the effect as positive because an underestimate of expenses contributes to an overestimate of net income.

Source: USDA, Economic Research Service (ERS) calculations using USDA, ERS Farm Income and Wealth Statistics data (USDA, ERS, 2023e).

In contrast, for Release 4, the Government payments were largely known, and the 2020 NCFI forecast and estimate difference of $25.3 billion was attributed to compounding errors from an overestimate of cash receipts and an underestimate in production expenses. Total error due to cash receipts and (negative) production expenses errors totaled about $24.9 billion for this release, as cash receipts were overpredicted by $13.2 billion and expenses were underpredicted by $11.7 billion (see figure 4B). The September 2021 estimate of 2020 reduced the cash receipts forecast from Release 4 by almost 4 percent. While figure 4 focuses on 2020 NCFI, a similar pattern of absolute percent deviations is observed for 2020 NFI and its components.

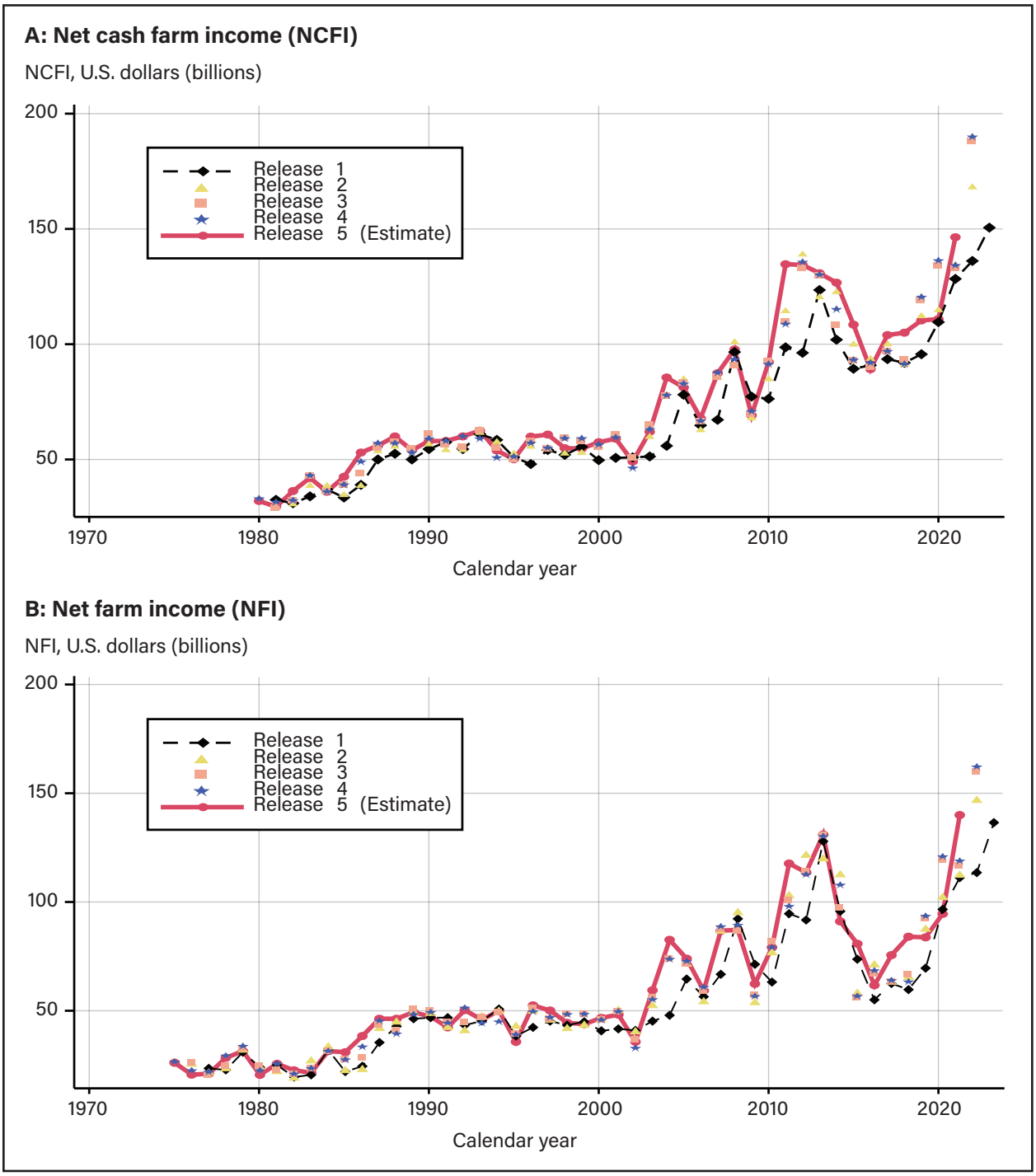
2020 Forecasts Compared With Historical Forecast Releases

Past studies that examined USDA's ERS farm income forecast performance in relation to the estimates show the first farm income forecast to be overly conservative (or biased), typically underpredicting the net farm income values published in USDA's official ERS estimates (e.g., Isengildina-Massa et al., 2021; Kuethe et al., 2021; Bora et al., 2020; Isengildina-Massa et al., 2019). Figure 5 illustrates the history of the NCFI and NFI forecasts and estimates (Releases 1–5) for all calendar years included in USDA's ERS data archive as of February 2023 (USDA, ERS, 2023c), and figure 5 also shows that February forecasts (Release 1) generally tend to be lower than the estimates (Release 5). Specifically, past studies suggested that, on average, realized U.S. net farm income value is approximately 11 percent higher than the first USDA, ERS forecast and about 2 percent higher than the last forecast for the calendar year.[8] However, in periods of economic recession, such as in 2020, USDA's ERS forecasts of NFI and NCFI can be higher than their estimated totals. While the aforementioned studies have shown that USDA's ERS forecasts underpredict net income on average, forecast users should note that this relationship seems less likely to hold in years of economic recession or turmoil.

[8] These were the average percent deviations reported in Isengildina-Massa et al. (2021).

Figure 5

Calendar year U.S. net cash farm income and net farm income: Four consecutive forecasts and the August/September estimate (U.S. dollars [billions], not adjusted for inflation)*



NCFI = net cash farm income; NFI = net farm income.

* In these graphs, the horizontal axis indicates calendar years (CYs), and the vertical axis shows NCFI or NFI forecast or estimated for each CY. The first forecast is released in February of the CY (Release 1, the blue dashed line with diamond markers). The forecast is then revised at the end of August or early September (Release 2) and in late November or early December (Release 3). The final forecast is released in February of the following year (Release 4), and the estimate follows in August/September (Release 5, solid gold line). The figures show that frequently the estimated values in Release 5 are higher than the first forecast in Release 1.

Source: USDA, Economic Research Service (ERS) calculations using data from historical USDA, ERS Farm Income and Wealth Statistics releases, February 1977 to most recent vintage (USDA, ERS, 2023c).

Overall, the 2020 farm income forecast error has different drivers than those typically observed. First, past studies identified persistent underestimation in crop and livestock cash receipts as the key source of the bias in Release 1 (Isengildina-Massa et al., 2019; 2021). The authors of this 2023 USDA, ERS report examined historical farm income and wealth statistics forecast and estimate data (USDA, ERS, 2023c) and found that only 28 percent of Release 1 forecasts overpredicted cash receipts, while the other 72 percent underpredicted them (based on 43 years for which both Release 1 and Release 5 cash receipts were available). Cash receipts for 2020 were overpredicted in all four forecasts. Only 6 years in the available history[9] showed a similar cash receipt forecast peculiarity with all four forecasts overpredicting cash receipts: 1981, 1998, 1999, 2002, 2016, and 2019. All these years were particularly challenging for the U.S. farm economy due to such factors as economic recessions and recovery (1981 and 2002; NBER, n.d.), abrupt declines in agricultural commodity prices (1998–99 and 2016; Shields & Westcott, 1998; Food and Agriculture Organization of the United Nations [FAO], 2023), and trade tariff changes that some refer to as a trade war with China (2019; Hopkinson, 2018). The impacts of such events on cash receipts can be dramatic and larger than anticipated by all four of USDA's ERS forecast releases.

Second, past literature reported that the direct Government payments forecast deviation is generally a minor factor in the total NCFI forecast deviation (Isengildina-Massa et al., 2019). However, for 2020, the underprediction in the Government payments in Release 1 significantly impacted the overall NCFI and NFI forecast deviations. In 2020, the massive pandemic-related direct Government payments were decided after USDA's ERS released its first calendar year forecast. Therefore, the direct Government payment estimate was three times larger than the first forecast (table 2). This revision to direct Government payments between Release 1 and Release 5 was the largest on record. The second-largest revision on record was in 1999 when Release 1 forecast $10.20 billion in direct Government payments, and the official estimate in Release 5 was $20.60 billion (102 percent higher). The next highest revision was in 2019, when the Release 1 forecast was $11.45 billion, and the Release 5 estimate was $22.45 billion (96 percent higher). As noted, 1999 and 2019 were incredibly challenging years for the U.S. farm sector, affected by sharp price declines in international markets and retaliatory tariffs.

Third, in the 2020 forecasts, the overprediction of cash receipts (and the value of production in NFI), combined with the underprediction of the expenses, resulted in a substantial overall deviation of the NCFI and NFI forecasts from the estimates. Such compounding deviations in cash receipts and expenses are infrequent in USDA's ERS forecasts. Specifically, the authors examined USDA's internal USDA, ERS archive of historical forecasts for U.S. farm sector cash production expenses and cash receipts for 37 years (1982–2019). Only 3 years showed such compounding deviations in Release 1—1998, 1999, and 2009—and these were the years with either large price reductions in the international agricultural commodity markets (1998–99) or the years of the Great Recession (2008–09).[10]

Finally, the reliability of 2020 NCFI and NFI forecasts did not improve throughout the forecasting cycle, contrary to the typical forecast evolution when the forecasts converge to the estimate. For example, USDA's ERS (2023a) states that across 2002–2021, the first NCFI forecast differed from the first published estimate (in August/September) by an average of 13.3 percent, but by the fourth forecast, the difference fell to an average of 6.8 percent. In contrast, 2020 forecasts showed a 1.2 absolute percent deviation in Release 1 and a 22.9-percent deviation in Release 4. Of the 41 years of history available in USDA's ERS archive (1981–2019),

[9] The history includes 40 years for which cash receipt values are recorded for the first five releases (USDA, ERS, 2023c).

[10] Note that this example was for the first calendar year forecasts (i.e., Release 1). The authors also examined the last calendar year forecasts (i.e., Release 4). For 9 years of the 40 years of available history, there were compounding deviations that showed cash receipts were overpredicted and production expenses underpredicted: 1992, 1998, 1999, 2001, 2005, 2009, 2013, 2019, and 2020. In other words, such compounding errors occurred in 22.5 percent of past Release 4 forecasts, which is still relatively infrequent.

only 3 years exhibited similar forecast errors, with the Release 1 forecast error smaller than that in Release 3 and Release 4: 1998, 1999, and 2008.[11]

This historical review shows that 2020 forecast characteristics were in some respects similar to those observed in other critical periods when extraordinary circumstances impacted the U.S. and the global economy. USDA's ERS forecast methodology largely relies on historical trends and patterns (McGath et al., 2009). Therefore, it cannot reliably predict unprecedented events like the COVID-19 pandemic that resulted in extraordinary policy measures. Some recent publications referred to the COVID-19 pandemic as a "black swan" event, one that was outside regular expectations and led to extreme outcomes (e.g., Yarovaya et al., 2022; Ahmad et al., 2021).[12] Table 6 discusses other extraordinary periods when USDA's ERS farm income forecasts underperformed (i.e., the forecast deviations in the last forecast releases were higher than usual, and the forecast deviation did not improve across the forecasts). These periods are characterized by turmoil in international agricultural commodity markets. The United States is a major international trading partner for commodities such as oilseed, grains, cotton, and meat, and the U.S. farm sector income is highly dependent on international agricultural trade (Peters et al., 2009). The years that exhibited some of the forecast features similar to those observed in 2020, but that did not fall into the clearly identified critical periods for the U.S. economy, include 1981, 1993, 1995, 2002, 2016, and 2018.

Table 6
Historical periods exhibiting forecast evolution similar to 2020

Period	Description
1998–99	"A 15-percent depreciation of Thailand's baht on July 2, 1997, has cascaded into a series of declines in currencies and stock prices in Asia….The Asian countries most directly affected by the crisis—Thailand, Indonesia, Malaysia, the Philippines, and South Korea— accounted for about 12 percent of U.S. agricultural exports in 1997. Taiwan and Japan, where the problems are somewhat different, accounted for nearly 25 percent of U.S. agricultural exports in 1997." (Gajewski & Langley, 1998). "…farm prices for several major crops have dropped sharply and are much lower than at any time in the recent past….From August 1997 to August 1998, the average farm price fell nearly a third for wheat (the lowest monthly price in 7 years) and one-fourth for corn (lowest in 10 years) and for soybeans (lowest in 4 years)." (Shields & Westcott, 1998).
2008–09	"The global economic crisis that started in late 2008 has led to a sharp curtailment of international trade, including a short-term decline in the value of global agricultural trade of around 20 percent….The value of U.S. exports also fell during the first 2 months of 2009 by 22 percent, compared with 2008 exports' value….The (15-percent) appreciation of the U.S. dollar creates a competitive advantage in global markets for other major agricultural exporters, such as the EU, Australia, Canada, and Brazil." (Peters et al., 2009).
2019	"In 2018, the United States imposed Section 232 tariffs on steel and aluminum imports from major trading partners and separately Section 301 tariffs on a broad range imports from China. In response, Canada, China, the European Union (EU), India, Mexico, and Turkey imposed retaliatory tariffs on many U.S. exports, including a wide range of agricultural and food products. Individual product lines experienced tariff increases ranging from 2 to 140 percent…. The retaliatory tariffs led to a significant reduction in U.S. agricultural exports to retaliating partners. Nationally, direct U.S. agricultural export losses due to retaliatory tariffs totaled more than $27 billion during 2018 through the end of 2019." (Morgan et al., 2022).

Source: USDA, Economic Research Service.

[11] Note that when the authors compared Release 1 and Release 4 only, absolute percent deviation for Release 1 was smaller than that in Release 4 for 8 years (or 20 percent of available history): 1993, 1995, 1998, 1999, 2002, 2008, 2016, and 2018.

[12] Note that some of the cited authors disagreed about referring to COVID-19 as a "black swan" event, since researchers had previously examined potential impacts of a pandemic on economy and finance. Therefore, the COVID-19 pandemic cannot be defined as completely unforeseeable (Goodell, 2020).

The Second Year of the COVID-19 Pandemic: 2021 Forecasts

Despite still being a pandemic year, the forecast for 2021 generally returned to the typical forecast evolution pattern. Additional information received through the forecasting cycle resulted in lower forecast deviations in Releases 2–4, compared with Release 1. For NCFI, the absolute percent deviation fell from 12.33 percent in Release 1 to 8.34 percent in Release 4. For NFI, the reduction was from 20.67 percent to 15.15 percent (table 7).

Table 7
Farm sector income forecasts and estimates for 2021, by release

Release number	Forecast or estimate	Release date	NCFI			NFI		
			NCFI in U.S. dollars (billions)	Deviation from the estimate in U.S. dollars (billions)*	Absolute percent deviation*	NFI in U.S. dollars (billions)	Deviation from the estimate in U.S. dollars (billions)	Absolute percent deviation*
1	Forecast 1	Feb. 2021	128.35	-18.05	12.33	111.35	-29.02	20.67
2	Forecast 2	Sept. 2021	134.73	-11.67	7.97	113.03	-27.34	19.48
3	Forecast 3	Dec. 2021	133.01	-13.39	9.15	116.82	-23.55	16.78
4	Forecast 4	Feb. 2022	134.19	-12.21	8.34	119.11	-21.26	15.15
5	Estimate	Sept. 2022	146.40	NA	NA	140.37	NA	NA

NCFI = net cash farm income; NFI = net farm income; NA = not applicable.

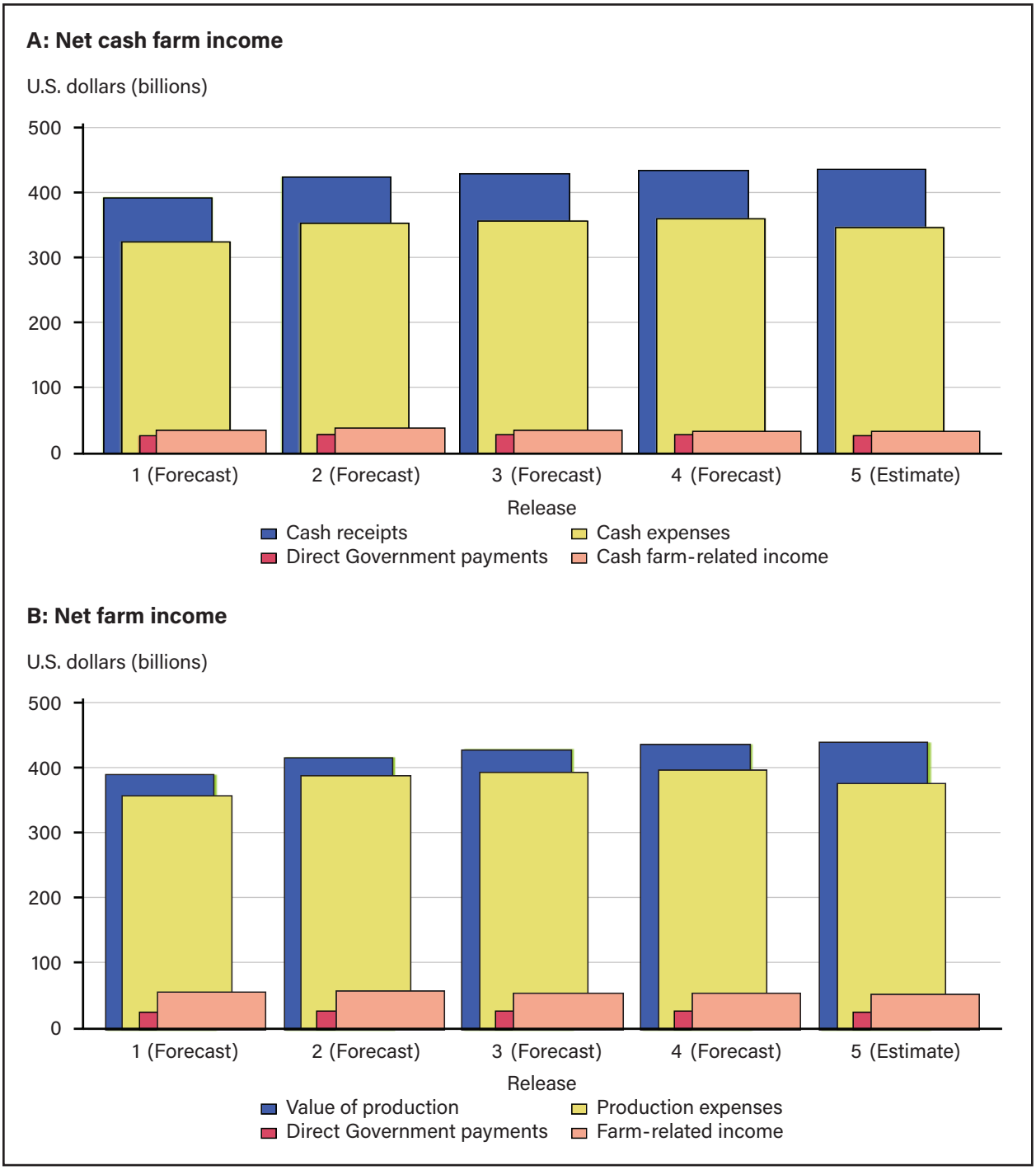
* The deviation and absolute percent deviation are calculated by comparing the forecasts with the Release 5 estimates. Note that Release 5 estimates were revised in subsequent USDA, ERS Farm Income and Wealth Statistics data releases. The revisions are generally small. For example, appendix B shows that historically, average revisions to NCFI and NFI estimates between Release 5 and Release 15 were less than 8 percent (in absolute value).

Source: USDA, Economic Research Service (ERS) calculations using data from historical USDA, ERS Farm Income and Wealth Statistics releases, February 1977 to most recent vintage (USDA, ERS, 2023c).

While cash receipts and the value of production were underpredicted in the first release, the deviation from the estimate decreased over the forecasting cycle (table 8, table 9, and figure 6). The deviations in Release 4 forecasts were still relatively large. USDA, ERS (2023a) reports an average absolute percent deviation for Release 4 in 2002–21 of 6.8 percent for NCFI and 10.9 percent for NFI. For comparison, Release 4 forecasts for 2021 had absolute percent deviations of 8.3 percent for NCFI and 15.2 percent for NFI. This deviation was again due to the compounding errors in the cash receipts (and the value of production) and production expenses in Releases 2–4. Recall that 2020 forecasts were overly optimistic since cash receipts were overpredicted and production expenses were underpredicted. In contrast, the 2021 forecasts were overly conservative, with most underpredicting cash receipts and overpredicting production expenses.

Figure 6

Forecasts and estimates of major components for 2021 NCFI and NFI (U.S. dollars [billions], not adjusted for inflation)



* For net farm income, the farm-related income is reported separately from the value of agricultural sector production.

Source: USDA, Economic Research Service (ERS) calculations using USDA, ERS Farm Income and Wealth Statistics data (USDA, ERS, 2023e).

Table 8

2021 NCFI components: Forecasts, estimates, and deviations, by release

Release number	Cash receipts			Direct Government payments		
	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*
1	390.78	(42.78)	9.87	25.29	(0.52)	2.01
2	421.51	(12.06)	2.78	28.03	2.22	8.61
3	427.28	(6.29)	1.45	27.21	1.40	5.41
4	432.59	(0.98)	0.23	27.14	1.33	5.14
5	433.57	NA	NA	25.81	NA	NA

Release number	Cash production expenses			Cash farm-related income		
	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*
1	322.63	(22.63)	6.56	34.90	2.61	8.09
2	351.64	6.38	1.85	36.84	4.55	14.09
3	354.89	9.63	2.79	33.42	1.13	3.50
4	358.26	13.00	3.76	32.72	0.44	1.36
5	345.27	NA	NA	32.29	NA	NA

NCFI = net cash farm income; NFI = net farm income; NA = not applicable.

* The deviation and absolute percent deviation are calculated by comparing the forecasts with the Release 5 estimates. Note that Release 5 estimates were revised in subsequent USDA, Economic Research Service Farm Income and Wealth Statistics data releases. The revisions are generally small. For example, appendix B shows that historically, average revisions to NCFI and NFI estimates between Release 5 and Release 15 were less than 8 percent (in absolute value).

Source: USDA, Economic Research Service (ERS) calculations using the files in section "Download All Data in CSV File Format (ZIP)" in "Data Files: U.S. and State-Level Farm Income and Wealth Statistics" (USDA, ERS, 2023b).

Table 9
2021 NFI components: Forecasts, estimates, and deviations, by release

Release number	Value of production			Direct Government payments		
	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*
1	384.27	(49.04)	11.32	25.29	(0.52)	2.01
2	411.03	(22.28)	5.14	28.03	2.22	8.61
3	422.88	(10.43)	2.41	27.21	1.40	5.41
4	429.80	(3.51)	0.81	27.14	1.33	5.14
5	433.31	NA	NA	25.81	NA	NA

Release number	Production expenses			Farm-related income		
	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*	Value in U.S. dollars (billions)	Deviation in U.S. dollars (billions) (forecast *i* minus estimate)*	Absolute percent deviation*
1	353.74	(17.43)	4.70	55.53	3.10	5.92
2	383.48	12.30	3.31	57.45	5.02	9.57
3	387.61	16.43	4.43	54.34	1.91	3.65
4	391.48	20.31	5.47	53.65	1.22	2.33
5	371.18	NA	NA	52.43	NA	NA

NCFI = net cash farm income; NFI = net farm income; NA = not applicable.

* The deviation and absolute percent deviation are calculated by comparing the forecasts with the Release 5 estimates. Note that Release 5 estimates were revised in subsequent USDA, Economic Research Service Farm Income and Wealth Statistics data releases. The revisions are generally small. For example, appendix B shows that historically, average revisions to NCFI and NFI estimates between Release 5 and Release 15 were less than 8 percent (in absolute value).

Source: USDA, Economic Research Service (ERS) calculations using the files in section "Download All Data in CSV File Format (ZIP)" in "Data Files: U.S. and State-Level Farm Income and Wealth Statistics" (USDA, ERS, 2023b).

Conclusion

This report examined the evolution of the USDA's ERS farm sector income forecast during 2020, the first year of the COVID-19 pandemic. The analysis of the net income components showed that the initial expectations for cash receipts, released before the start of the pandemic, were overly optimistic. The cash receipt forecast was subsequently revised down, but it remained higher across all USDA, ERS forecasts, relative to the first official estimate. While cash receipts were forecast at higher levels, production expenses were underpredicted in all 2020 forecasts, compounding the net income forecast deviation from the official estimate. Finally, direct Government payments were underpredicted in the initial forecasts. Direct Government payments to farmers in response to the pandemic were not envisioned in Release 1 but were captured in subsequent forecast releases. It may not be realistic to expect more accurate Government payment forecasts in the face of major events such as the COVID-19 pandemic or economic recession because the USDA, ERS forecasts are not aimed at forecasting policy decisions. Moreover, policymakers may use USDA, ERS net income forecasts along with other information provided by other sources to inform decisions on direct Government payment.

Despite the deviations in cash receipt, expense, and government payment forecasts, the initial 2020 NCFI forecast (released in February 2020) was close to the official 2020 NCFI estimate (released in September

2021). This small deviation in the initial NCFI forecast was because of offsetting deviations in the forecasts for cash receipts and Government payments. Later NCFI forecasts showed more significant deviations from the September 2021 estimates. However, because such significant forecast deviations from the estimate are rare and are associated with unprecedented events such as the COVID-19 pandemic or global financial crisis, forecast deviations observed during this period do not necessarily warrant changes in forecast methodology. Anticipating such events is very difficult, and changing the farm income forecast methodology to do so could also impact model reliability during other periods.

Evaluation of forecast reliability should continue, aiming to identify periods and factors that may increase forecasting errors. Understanding how such events affect forecast reliability could help improve and interpret forecasts during similar events in the future. Awareness about forecast deviations in USDA's ERS farm income measures can be helpful for stakeholders in interpreting and understanding the data.

Furthermore, past studies found a systematic underprediction of cash receipts in the initial USDA, ERS forecast (e.g., see Isengildina-Massa et al., 2021). This report examines the historical frequency of under- and overprediction of cash receipts and confirms this conclusion. Past studies also show evidence of underprediction of production expenses (e.g., Isengildina-Massa et al., 2021). These findings suggest that continued analysis of forecast reliability could identify the causes of forecast deviations, examining extraordinary years like 2020 and more-typical years. Understanding the drivers of the USDA, ERS net income forecast deviations is a critical area of future research.

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Appendix A: Accounting Equations for Net Cash Farm Income and Net Farm Income

Equation A1 below describes the aggregate components of net cash farm income (NCFI). NCFI is calculated as gross cash income (including cash receipts, direct Government payments, and cash farm-related income) minus all cash expenses (such as feed, seed, fertilizer, property taxes, interest on debt, wages to hired labor, contract labor, and rent to nonoperator landlords):

$$\begin{aligned} Net\ Cash\ Farm\ Income &= Gross\ Cash\ Income\ - Cash\ Production\ Expenses \\ &= (Cash\ Receipts\ for\ Crops\ and\ Animals/Products \\ &+ Direct\ Government\ Payments + Cash\ Farm\text{-}Related\ Income) \\ &- Cash\ Production\ Expenses \end{aligned} \tag{A1}$$

Note that cash farm-related income includes forest products sold, machine hire and custom work, and other noncommodity income related to the operation of the farm.

$$\begin{aligned} Net\ Farm\ Income &= Value\ of\ Crop\ and\ Animals/Products\ Production + Farm\text{-}Related\ Income \\ &+ Direct\ Government\ Payments\ - Production\ Expenses \end{aligned} \tag{A2}$$

NFI is a broader measure that represents the net value added to the U.S. economy by the agricultural sector, and includes noncash transactions such as changes in inventories, capital replacement, and implicit rent and expenses related to the farm operators' dwelling. In equation (A2), the value of crop and animal/animal product production is different from cash receipts in that it reflects production in the year the products were produced rather than in the year in which they were sold. It also accounts for the value of agricultural products consumed on the farm. Farm-related income in equation (A2) accounts for noncash farm-related income (such as the gross imputed rental value of farm dwellings). Similarly, production expenses include noncash production expenses, such as expenses associated with operator dwellings, noncash employee compensation, and a measure of economic depreciation (capital consumption).

Additional discussion of NCFI and NFI is available in USDA, ERS (2023d).

Appendix B: Revisions to the USDA, ERS Farms Sector Estimates of NCFI and NFI

The data archive from USDA, ERS (2023c) allows researchers to examine the evolution of both the forecasts and estimates for each calendar year (CY). The authors' analysis shows that the revisions to NCFI and NFI estimates are relatively small, with the mean absolute error between the first and 11th official estimates (i.e., Releases 5 and 15) below 8 percent for both NCFI and NFI (table B1). The estimates can be revised, for example, to be consistent with the data from the Census of Agriculture when the Census data become available.[13]

Table B1

Mean and median absolute percent deviation for Releases 5–14 when compared with Release 15*

Release number	Net cash farm income			Net farm income		
	Number of observations	Mean absolute percent deviation from Release 15	Median absolute percent deviation from Release 15	Number of observations	Mean absolute percent deviation from Release 15	Median absolute percent deviation from Release 15
5	39	6.12	4.87	40	7.69	4.32
6	39	4.92	3.27	40	6.95	4.13
7	38	4.59	3.31	39	6.82	3.89
8	39	2.56	1.36	39	4.74	2.09
9	40	2.25	1.40	39	3.71	1.87
10	37	2.20	1.38	38	3.53	1.85
11	39	1.89	1.06	40	3.26	1.56
12	40	1.38	0.43	40	2.44	1.01
13	37	1.40	0.41	38	2.20	0.72
14	39	1.13	0.00	40	1.83	0.02

*Years considered: 1977–2019.

Source: USDA, Economic Research Service (ERS) calculations using data from historical USDA, ERS Farm Income and Wealth Statistics releases, February 1977 to most recent vintage (USDA, ERS, 2023c).

[13] Also see the section "Q: How did the release of the 2017 Census of Agriculture impact the Farm Income and Wealth Statistics data product?" in USDA, ERS, Update and Revision History, FAQs (USDA, ERS, 2023a).

Appendix C: USDA, ERS Farm Income and Wealth Statistics Data Archive: Data Sources

The archive of selected historical Farm Income and Wealth Statistics forecast and estimate data (USDA, ERS, 2023c) includes the first forecast values and the values from the subsequent 14 releases. This encompasses releases over 5 years for each calendar year (CY). In the archive, the cash receipts and NFI data start with the February 1977 release, and NCFI data start with the February 1981 release. The archive contains U.S.-level CY data only.

The archive was compiled from a variety of sources. Data from releases starting with August 2014 were retrieved from the All Data comma-delimited (CSV) files posted on USDA's ERS Wealth and Statistics data page (USDA, ERS, 2023c). For each release, there is a separate file with all the data from that release. For releases prior to August 2014, the authors had to build the archive from available sources such as USDA's ERS publications. From February 1975 to December 2002, USDA's ERS Agricultural Outlook (AO) reports featured tables with select farm income forecasts and estimates. Farm income data were also available from the Agricultural Income and Finance Situation and Outlook (AI) reports, which were published intermittently from December 1984 to December 2011 before being renewed in 2022. The authors were not able to access the contemporaneous farm income releases prior to the first AO report in 1975, even though measures of cash receipts, NCFI, and NFI go all the way back to 1910.

Missing data points in the archive may indicate that data were not released at the time or that the authors could not locate the data. Furthermore, to be consistent with the present USDA, ERS accounting format, the archive only includes CY annual values. In the earlier publications of USDA reports, only monthly, quarterly, or year-to-date farm income data were presented. Data from such reports were listed as missing.

Missing data are discussed in detail in the Readme file attached to the archive, which also lists other data challenges, such as the following:

- For releases prior to August 2014, data were assumed to be released three times a year, in February, August, and November. However, there may be instances where there were more or fewer than three data releases in a year and/or where new or updated data were not released in those months.
- Where possible and as needed, the data values were adjusted to ensure the data items remained conceptually consistent over time.
- Between 1981 and 1996, USDA's ERS released interval forecasts rather than point forecasts. For those years, the midpoint of the interval was used in the archive.
- Differences in the level of precision across releases may suggest revisions to values when the differences are only due to rounding.

Currently, the archive is the best source of the long-term history of USDA's ERS farm income releases for cash receipts, NCFI, and NFI available to the public.

The archive is updated with each Farm Income and Wealth Statistics data release. This analysis is based on the February 2023 update of the archive.