USDA Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

Amber Waves

February **2025**

The Economics of Food, Farming, Natural Resources, and Rural America

YEAR IN REVIEW 2024

From the Administrator

Dear Friends and Colleagues:

Welcome to the third annual edition of Amber Waves Year in Review!

I am excited to bring you some of our most timely articles from ERS research in fiscal year 2024. We explored the economic intersections of agriculture and food through 46 published reports, as well as new and updated data products and other digital tools.

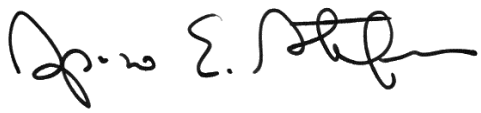
ERS' flagship magazine, Amber Waves, captured the work of our economists and staff in almost 60 articles posted to the ERS website during the year. They covered a wide range of subjects—from food insecurity to crop insurance and organic production, and rural life topics such as broadband access, farmer diversity, and climate change.

In this issue of Amber Waves Year in Review, you can read about food spending during the Coronavirus (COVID-19) pandemic, export markets for U.S. animal products, and a new ERS product that analyzes the ruggedness of the U.S. terrain and what that means for local residents—and much more!

We hope you enjoy this year's print recap of our digital magazine and find it useful in your work in the areas of agriculture, food, and rural America.

If you want to stay in touch with ERS research and data products, please visit us at ers.usda.gov. Make sure to subscribe to ERS email updates to receive Amber Waves articles delivered directly to your inbox. And subscribe to our popular daily data spotlight, Charts of Note.

Best Wishes,



Spiro Stefanou

ERS Administrator
Economic Research Service
United States Department of Agriculture
ers.usda.gov

Economics of food

Markets and trade

Resource and rural economics

Infographic

ECONOMICS OF FOOD

Food Spending Shifted in Response to Pandemic; Changes for Food Away From Home Continued Through 2022

January **2024**

By **Keenan Marchesi** and **Patrick W. McLaughlin**

HIGHLIGHTS

- Food-at-home (FAH) spending rose quickly across categories after the pandemic began in 2020—with several categories over 15 percent—but as of the end of 2022, changes represented about a 4.0 percent decline on average from the same time in 2021.
- As of October–December 2022, spending at quick-service restaurants remained about 4 percent lower than it was 3 years earlier, while full-service restaurant spending was still down about 20 percent.
- Restaurant spending via delivery services became far more common early in the pandemic and continued to be popular throughout 2022, while on-premises spending remained sluggish compared with prepandemic levels.

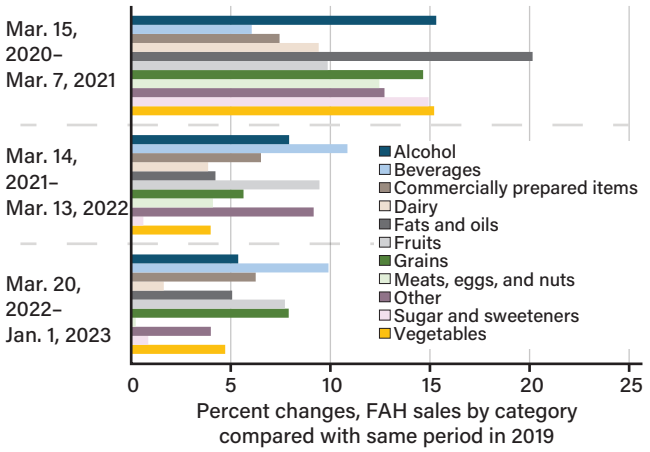
The Coronavirus (COVID-19) pandemic widely disrupted daily life, including which foods people bought and where they bought them. Following the pandemic declaration in March 2020, States and local governments across the country implemented public safety measures that limited access to in-person activities, closed or restricted businesses such as restaurants, and often invoked stay-at-home orders. At the same time, the United States experienced an economic downturn marked by an increase in unemployment rates. Supply-chain issues affected transportation of food from producers, consumers found it more difficult to safely access adequate food, and State and Federal Governments implemented multifaceted changes in food assistance. All these consequences of the pandemic meant unprecedented changes to spending on and acquisition of food at home (FAH) and food away from home (FAFH).

USDA, Economic Research Service (ERS) researchers used several proprietary datasets to document the shifts in food spending and acquisition behavior throughout the pandemic. They tracked changes in FAH and FAFH expenditures by comparing year-over-year percent changes in the inflation-adjusted dollars spent at food retailers such as grocery stores with year-over-year percent changes in FAFH transactions at restaurants on a weekly basis. While total annual food spending levels had recovered from pandemic-related shocks as of 2021, three ERS working papers documented that some pandemic-induced changes in what people were buying for food at home and where and how they were purchasing food away from home continued throughout 2022.

Food-at-Home Spending Differed by Food Category

U.S. consumers shifted their food purchases to food at home (FAH) during the first year of the pandemic, as evidenced by large increases in FAH sales. During the first year of the pandemic (March 15, 2020–March 7, 2021), average weekly FAH spending grew about 12.6 percent from the year earlier (March 16, 2019–March 8, 2020). While sales of all FAH categories rose at least 6 percent, some categories saw higher-than-average changes in sales, including vegetables (15.2 percent), sugar and sweeteners (14.9 percent), grains (14.7 percent), fats and oils (20.2 percent), and alcohol (15.3 percent).

Spending increased across nearly all food-at-home (FAH) categories in first year of pandemic, but returned to closer to prepandemic levels by end of 2022



Note: Changes based on real (inflation-adjusted) spending. Inflation adjustments made using food categories of the U.S. Bureau of Labor Statistics Consumer Price Index with January 2020 as the base period. The **other** category includes foods such as spices and infant food that do not readily fit in the specific categories. Data are as of July 2023.

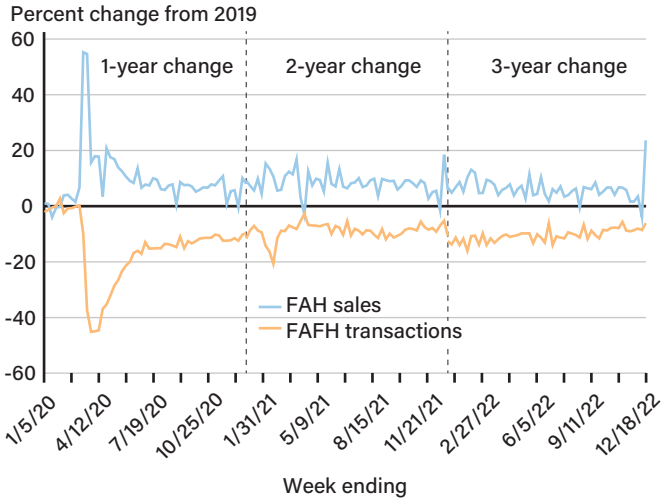
Source: USDA, Economic Research Service calculations using data from Circana (formerly Information Resources Inc. [IRI]) scanner data and the U.S. Bureau of Labor Statistics Consumer Price Index.

The changes in sales from March 14, 2021, to March 13, 2022, compared with 2 years before (prepandemic, March 16, 2019, to March 15, 2020) continued to show elevated inflation-adjusted spending at an average of about 6 percent. This shows that while some of the early pandemic-related changes had continued, overall FAH spending started to decrease after the first year of the pandemic. Most recently, comparing sales from March 20, 2022–January 1, 2023, to March 16, 2019–December 28, 2019, sales remain elevated, although less so than the changes observed from 2019 to 2020 (an average 4.9 percent compared with an average 12.5 percent). These changes reflect two phenomena. First, during this time, both the level and share of FAH expenditures increased compared with 2020 levels. Second, the composition of FAH spending returned to its prepandemic makeup. For example, each category's share of FAH sales (adjusted for inflation) in March–May 2022 was within 0.5 percentage point of the observed value in March–May 2020 except for beverages.

Changes in Food-Away-From-Home Transactions and Food-at-Home Sales

In addition to changing the type of food at home they bought in response to the pandemic, consumers changed how much they spent at and how frequently they visited restaurants and other food service outlets. For the first year of the pandemic (March 15, 2020, through March 14, 2021), year-over-year changes in FAFH transactions moved in the opposite direction of year-over-year changes in FAH sales (inflation-adjusted). The increases in FAH sales also occurred sooner than the decreases in FAFH transactions following the onset of the pandemic. For example, during the week ending March 15, 2020, food retail sales were 55.3 percent higher than they were the year before, but the change in restaurant transactions was only 10 percent lower than the previous year. This difference may reflect consumers stocking up on food in addition to shifting more day-to-day food consumption to FAH. The levels of change in weekly restaurant transactions continued until April 12, 2020 (compared with the week ending April 14, 2019), when restaurant transactions were about 45 percent lower than the year before. At the same time, FAH sales were still about 17.8 percent higher than a year prior.

Changes in inflation-adjusted FAH sales mirrored changes in FAFH transactions since onset of pandemic



Note: **FAH** = Food at home. **FAFH** = Food away from home. Changes in spending based on inflation-adjusted dollars. Inflation adjustments made using food categories of the U.S. Bureau of Labor Statistics Consumer Price Index with January 2020 as the base period. Data current as of August 2023.

Source: USDA, Economic Research Service calculations using Circana (formerly Information Resources Inc. [IRI]) scanner data, Circana (formerly the NPD Group) Consumer Reported Eating Share Trends (CREST) Performance Alerts, and U.S. Bureau of Labor Statistics Consumer Price Index data.

Proprietary Datasets Formed Basis of Pandemic Food Acquisition Research

This research focuses on spending trends for food at home (FAH) and food away from home (FAFH) using several proprietary datasets from Circana (formerly Information Resources Inc. [IRI] and the NPD Group):

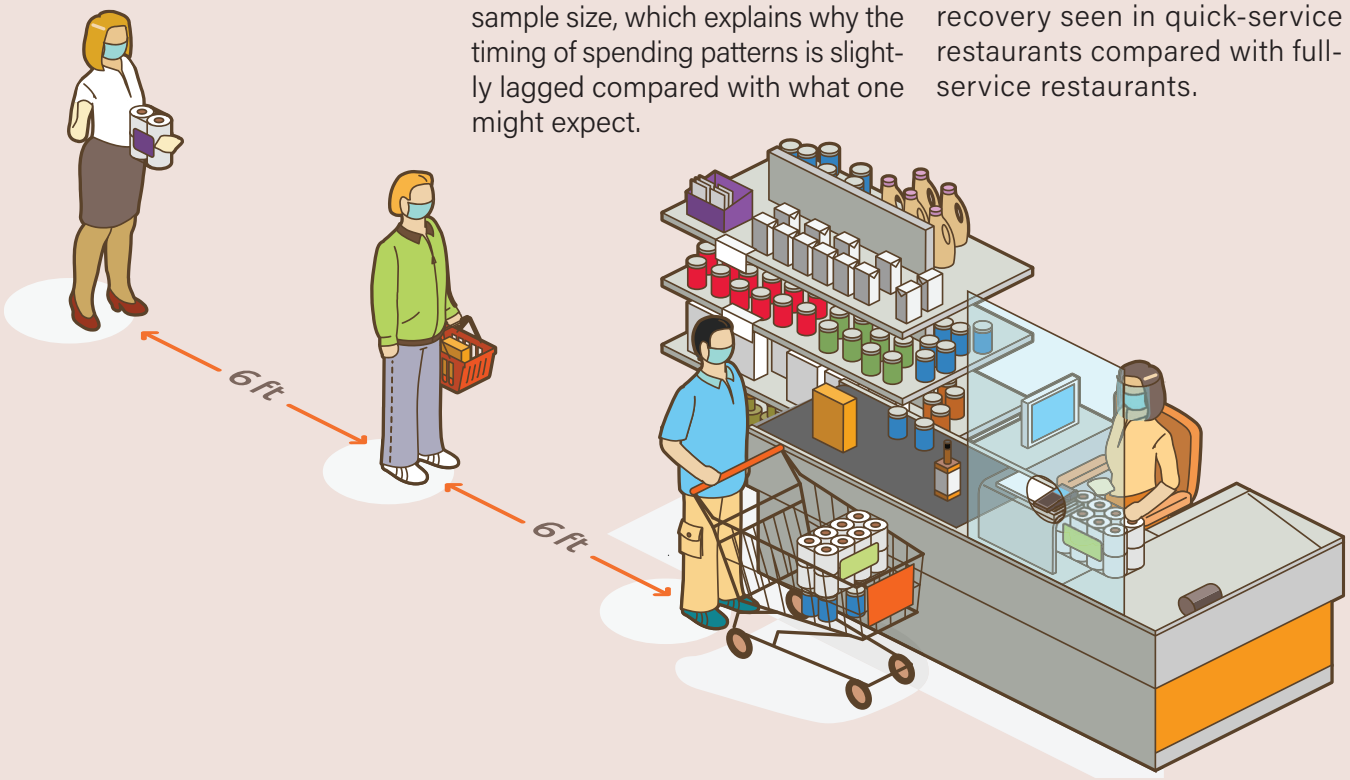
Circana Weekly Retail Household COVID-19 Response scanner data, which provide retailer-based information on weekly food retail sales that are representative at the national and State level and contain variables on the dollar value of food retail sales for each product during a given week. To gain a better understanding of changes in the sales and purchases of foods by type, each product is classified into broad categories and subcategories using USDA, Economic Research Service's (ERS) Methodology Behind the Quarterly Food-at-Home Price Database. These categories are alcohol; (non-alcoholic) beverages; commercially prepared items; dairy; fats and oils; fruits; grains; meats, eggs, and nuts; sugar and sweeteners; vegetables; and other (such as spices and infant foods).

Consumer Reported Eating Share Trends (CREST) Performance Alerts data, which report the nationally representative year-over-year changes in the weekly number of transactions at restaurants.

CREST data, which are national estimates of the dollar amount spent at restaurants by restaurant type (full- or quick-service restaurants) and acquisition methods (on-premises consumption, takeout, delivery, and drive-thru). These estimates are derived from online consumer surveys about food-away-from-home acquisition behaviors, and then projected and calibrated with other Circana data products to be nationally representative. Researchers used a 3-month rolling average of this dataset to maintain the underlying sample size, which explains why the timing of spending patterns is slightly lagged compared with what one might expect.

There is additional research that used data from the ERS Food Expenditure Series (FES) to explore food spending since the pandemic's onset. The FES is a comprehensive dataset that measures the U.S. food system to quantify the value of food acquired across the country by type of product, outlet, and purchaser (households, businesses, and government). As outlined in the FES documentation, the FES measures spending using a retail sales approach and relies primarily on food sales reported in the Economic Census and surveys from the U.S. Department of Commerce, Bureau of the Census.

Notably, the methodologies and data sources in FES compared with the consumer-based CREST data introduce the potential for divergent outcomes. This may manifest as disparities in year-over-year comparisons, yet may still reveal analogous trends, such as the quicker recovery seen in quick-service restaurants compared with full-service restaurants.



Read More From *Amber Waves*

Fiscal Year 2024

Satisfying Fruit and Vegetable Recommendations Possible for Under $3 a Day, Data Analysis Shows

Using Food-at-Home Monthly Area Prices Data To Track Food Prices Over Time and Across Areas

The changes in FAH sales and FAFH transactions were short-lived. By July 5, 2020, FAFH transactions were only about 13 percent lower than the year before, and FAH sales were about 7.7 percent higher. Each stayed relatively stable through March 7, 2021, with the average weekly year-over-year change in FAFH transactions around 12 percent lower, and FAH sales about 6.7 percent higher.

Even 2 years after the official onset of the pandemic, changes in FAH sales and FAFH transactions relative to prepandemic levels continued to move in opposite directions. As of March 20, 2022, there were still 11.6 percent fewer restaurant transactions than at the same time in 2019, and FAH sales were 9 percent higher. As of the last week of 2022, restaurant transactions remained about 6 percent lower than they were the last week of 2019. As of the last week of 2022, FAH sales were 23.6 percent higher than the last week of 2019. This indicates the moderate shifts away from FAFH transactions in favor of increased FAH spending may be more long term. However, there was variation in the type of restaurants at which consumers spent money and how they acquired those meals.

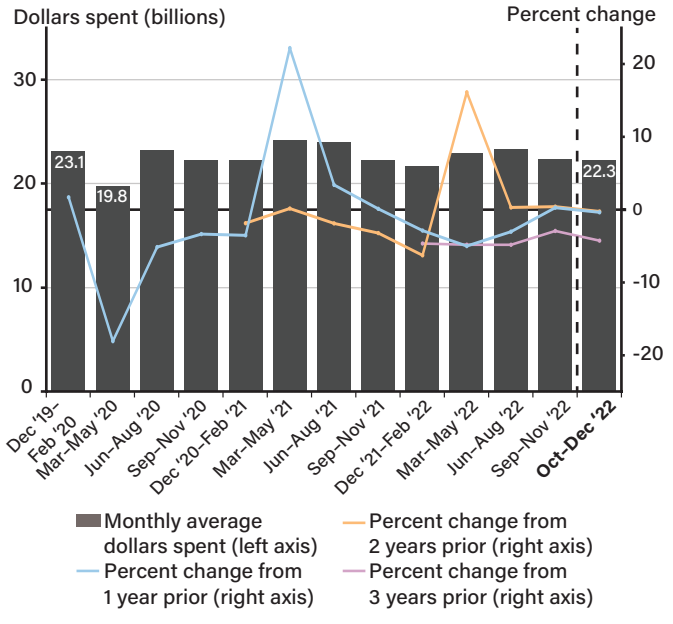
Consumer Spending Varied at Quick- and Full-Service Restaurants

At the end of 2022, FAFH transactions were below prepandemic levels, but changes in spending (inflation-adjusted) differed by restaurant type. For instance, during the first year of the pandemic, total consumer spending at restaurants was down from the year before, but the drop was smaller at quick-service establishments, where customers order and pay at a counter before eating, than at full-service restaurants, which typically offer table service to a room full of seated diners. During the pandemic, health policies across the country restricted sit-down restaurant service, which was the primary service mode for full-service restaurants, but quick-service restaurants could offer other options, such as drive-thru or carryout, for ordering food.

In the first observable period during the pandemic (March–May 2020), spending at quick-service restaurants dropped roughly 18 percent below that of the year before. However, spending began to increase the following period and generally stayed the same during the October–December periods of 2020, 2021, and 2022: about 4 percent lower than the same period in 2019. That continuity showed persistent demand for quick-service meals.

While spending at quick-service restaurants was quicker to rebound to near prepandemic levels and generally remained there throughout 2022, spending at full-service restaurants continued to lag at the end of 2022. From December 2019 to February 2020, consumers spent an average of $14 billion

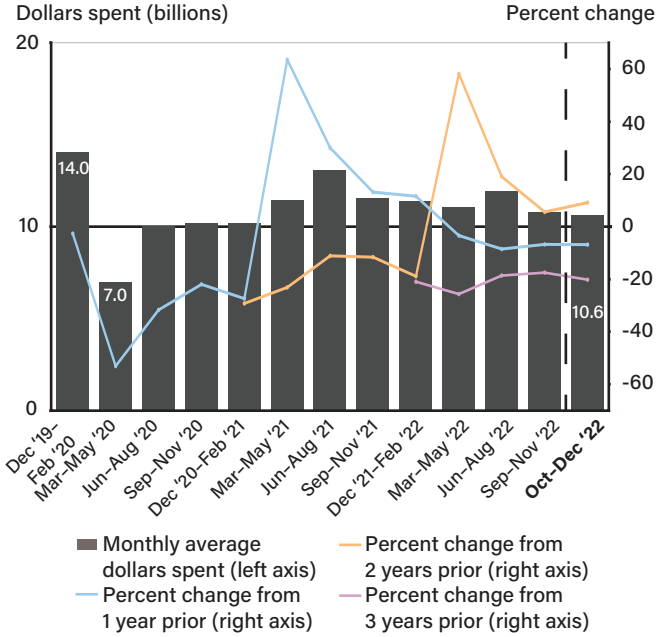
By the end of 2022, spending at quick-service restaurants had almost returned to prepandemic levels ...



Note: Results based on 3-month rolling average of total inflation-adjusted dollars spent during the period listed compared with the same period 1, 2, or 3 years prior. Data current as of May 2023.

Source: USDA, Economic Research Service using data from the Circana (formerly the NPD Group) Consumer Reported Eating Share Trends (CREST) Performance Alerts and the U.S. Bureau of Labor Statistics Consumer Price Index.

.... but spending at full-service restaurants remained much lower than it had been before the pandemic



Note: Results based on 3-month rolling average of total inflation-adjusted dollars spent during the period listed compared with the same period 1, 2, or 3 years prior. Data current as of May 2023.

Source: USDA, Economic Research Service using data from the Circana (formerly the NPD Group) Consumer Reported Eating Share Trends (CREST) Performance Alerts and the U.S. Bureau of Labor Statistics Consumer Price Index.

at full-service restaurants; by the first full period of the pandemic (March–May 2020), average spending had dropped to $7 billion. While consumer spending at full-service restaurants has increased since the initial drop, it has yet to return to prepandemic levels. As of October–December 2022, average spending totaled about $10.6 billion. This was 9 percent higher than October–December 2020 but 20 percent lower than it was in October–December 2019.

How People Acquired Their Food

The decrease in total FAFH spending and the shift toward quick-service restaurants at the beginning of the pandemic coincided with major changes in how consumers acquired food away from home. For instance, before the pandemic (December 2019–February 2020), spending at quick-service restaurants at the drive-thru, for carryout, and for eating in the restaurant was nearly equal, with the total inflation-adjusted 3-month average spending ranging between $5.9 billion and $8.5 billion. Delivery was the least popular method of acquiring restaurant food at quick-service restaurants, with $1.6 billion in spending. For full-service restaurants in the same period, consumers spent $12.1 billion eating on the premises (86 percent of all spending at full-service restaurants), compared with $1.6 billion for carryout.

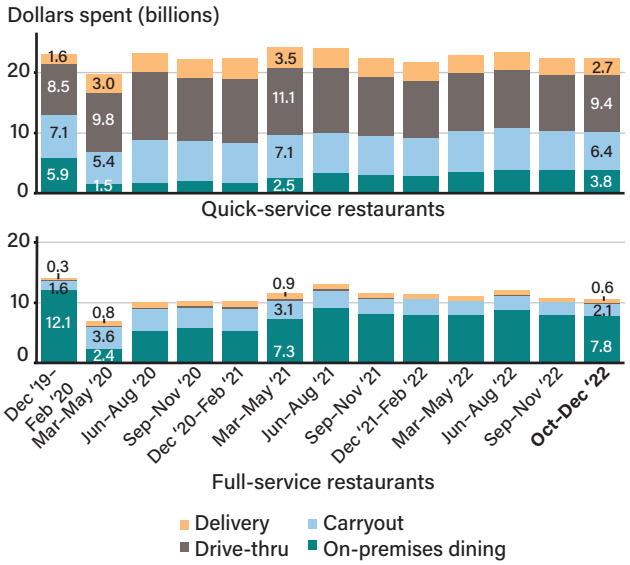
Dining methods involving face-to-face interactions became increasingly less common after the pandemic was declared, from March–May 2020, and spending for on-premises dining at full-service restaurants dropped to $2.4 billion. Carryout rose to only about $3.6 billion, not compensating for the nearly $10 billion loss in on-premises spending. At quick-service establishments, spending for on-premises dining and for carryout declined $1.5 billion and $5.4 billion, respectively, over the same period, while spending at drive-thrus and for delivery rose $9.8 billion and $3.0 billion, offsetting more of the losses for that type of restaurant.

From the beginning of the pandemic in 2020 through the end of 2022, how people acquired food, measured by dollars spent per service mode, at quick-service restaurants did not fluctuate much. By May–July 2021, on-premises quick-service spending nearly matched spending on delivery and eventually surpassed it around January–March 2022. As of October–December 2022, drive-thru spending continued to be the dominant way to buy food at quick-service restaurants ($9.4 billion) and remained higher than prepandemic spending levels. Delivery spending, although declining, was also higher than prepandemic at $2.7 billion during the same period. On-premises spending remained about a third lower than prepandemic levels, highlighting the slow return to this choice by consumers.

At full-service restaurants, on-premises spending was clearly the preferred method throughout the pandemic and into 2022. However, it remained lower than prepandemic levels as of the end of 2022. As of October–December 2022, on-premises spending averaged about $7.8 billion, which was much higher than it was early in the pandemic (March–May 2020) at $2.4 billion, but lower than prepandemic levels ($12.1 billion). Although the average total spending on delivery from full-service restaurants typically is not more than 6 percent of total full-service spending, the $0.6 billion observed as of October–December 2022 was double prepandemic levels and consistent for most of 2022. The expansion of delivery and carryout options during the pandemic led to shifts in how consumers bought food away from home, which lasted longer than the policies that initiated them.

As in-person restrictions were lifted and vaccinations became available, consumers returned to a more familiar way of life. Even so, changes in food spending persist. New trends emerged in the way consumers purchased food at home and food away from home, but the FAFH changes were more pronounced. For instance, consumer spending by service mode at restaurants remained slightly more diverse than before the pandemic. While on-premises spending remained the most common spending method at full-service restaurants, it was lower than prepandemic levels and continued to contribute to the lower overall full-service spending.

Drive-thru and carryout spending increased at quick-service restaurants early in pandemic; on-premises spending at full-service restaurants continues to lag prepandemic levels



Note: Results based on 3-month rolling average of total inflation-adjusted dollars spent during the period listed. Data are as of May 2023.

Source: USDA, Economic Research Service using data from the Circana (formerly the NPD Group) Consumer Reported Eating Share Trends (CREST) Performance Alerts and the U.S. Bureau of Labor Statistics Consumer Price Index.

This article is drawn from...

Marchesi, K., & McLaughlin, P. W. (2023). ***COVID-19 Working Paper: Food-away-from-home acquisition trends throughout the COVID-19 pandemic*** (Report No. AP-113). U.S. Department of Agriculture, Economic Research Service.

McLaughlin, P. W., Stevens, A., Dong, X., Chelius, C., Marchesi, K., & MacLachlan, M. (2022). ***COVID-19 Working Paper: National trends in food retail sales during the COVID-19 Pandemic: Findings from Information Resources, Inc. (IRI) retail-based scanner data*** (Report No. AP-108). U.S. Department of Agriculture, Economic Research Service.

Marchesi, K., & McLaughlin, P. W. (2022). ***COVID-19 Working Paper: The impact of COVID-19 pandemic on food-away-from-home spending*** (Report No. AP-100). U.S. Department of Agriculture, Economic Research Service.

You may also be interested in...

McLaughlin, P. W., Carlson, A., Marchesi, K., Rhone, A., & Zeballos, E. (2023). ***Using proprietary data*** [Topic page]. U.S. Department of Agriculture, Economic Research Service.

Zeballos, E., & Sinclair, W. (2023, September 25). U.S. consumers spent more on food in 2022 than ever before, even after adjusting for inflation. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.

Marchesi, K. (2022, April 4). Spending gap between full-service and quick-service restaurants widened during Coronavirus (COVID-19) pandemic. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.

Marchesi, K. (2024, January 23). Pandemic-related increase in consumer restaurant spending using mobile apps continued through 2022. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.

SNAP Spending Rose and Fell With Pandemic-Era Changes to Benefit Amounts

June **2024**

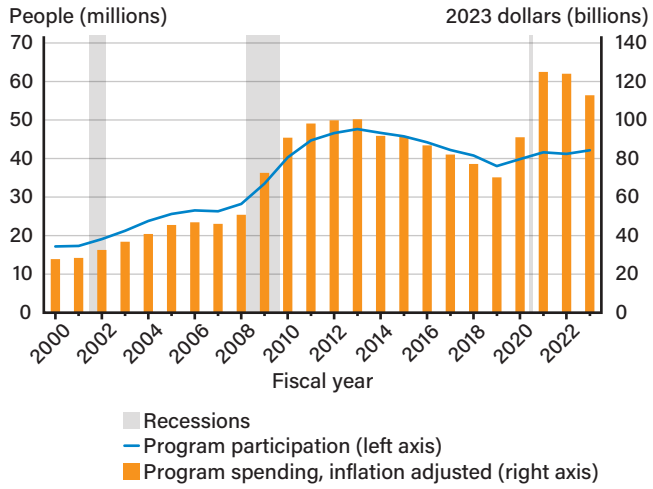
By **Jordan W. Jones**

USDA's Supplemental Nutrition Assistance Program (SNAP), which provides benefits for low-income households to buy groceries, is the Nation's largest nutrition assistance program and USDA's largest program by spending. In fiscal year (FY) 2023, 42.1 million people received SNAP benefits per month, on average, amounting to 12.6 percent of the U.S. resident population. Federal spending on SNAP totaled $112.8 billion in FY 2023, or 67.8 percent of total USDA domestic nutrition assistance spending that year.

SNAP eligibility and benefit size are means-tested, so when net household income falls such as with a job loss, households may become eligible and/or receive larger benefits. This means SNAP participation and spending historically have grown following economic recessions. In past economic downturns, policymakers have temporarily expanded the program to alleviate hardship and stimulate the economy. For instance, maximum benefits were increased by 13.6 percent in response to the Great Recession from 2009–13. Increased participation from FY 2007 to 2013 along with policy responses led to a prepandemic spending peak of $100.4 billion in FY 2013, adjusted for inflation to 2023 dollars.

From FY 2020 to 2023, during the Coronavirus (COVID-19) public health emergency, SNAP participation also increased, but not enough to wholly account for the sharp increase in spending in FY 2020 and 2021. The spending change during this period is largely attributable to three increases to maximum benefit amounts and the issuance of emergency allotments. In January 2021, maximum benefits were temporarily increased through June 2021 by 15 percent of the initial FY 2021 amounts. This was later extended through September 2021. The monthly cost of regular ongoing benefits increased from about $5.3 billion in December 2020 to $6.4 billion in February 2021. Then, maximum benefits were permanently increased by about 23 percent above FY 2021 levels in October 2021 following the June 2021 Thrifty Food

SNAP average monthly participation and annual spending increased following recessions



Note: **SNAP** = Supplemental Nutrition Assistance Program. Figure based on preliminary data from the September 2023 Program Information Report (Keydata) released by USDA, Food and Nutrition Service (FNS) in December 2023. Program spending is adjusted to 2023 dollars using the Personal Consumption Expenditures price index, U.S. Department of Commerce, Bureau of Economic Analysis. Fiscal year 2019 average monthly participation excludes January and February counts, which were affected by a partial Federal Government shutdown. The shaded gray areas represent periods of U.S. economic recession: March 2001 to November 2001, December 2007 to June 2009, and February 2020 to April 2020.

Source: USDA, Economic Research Service using USDA, Food and Nutrition Service data.

Read More From *Amber Waves*

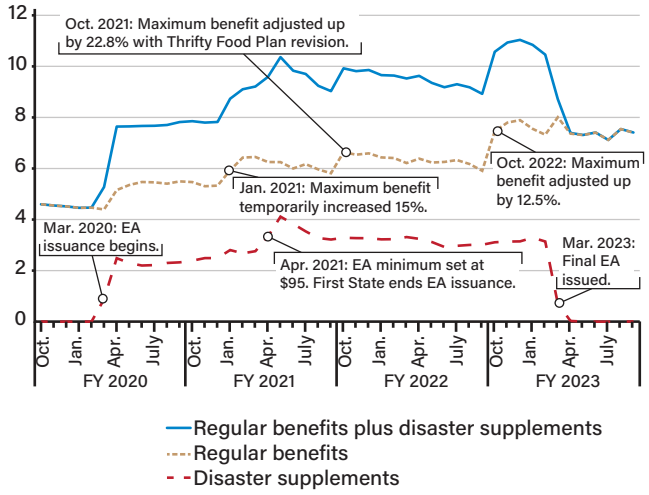
Fiscal Year 2024

State Universal Free School Meal Policies Reduced Food Insufficiency Among Children in the 2022–2023 School Year

New Metric Gauges How Much SNAP Benefits Support Lowest-Income Households

Plan revision. However, the actual increase from September 2021 benefit levels was smaller because of the expiration of the temporary 15-percent increase. Spending on regular SNAP benefits increased from $5.8 billion in September 2021 to $6.6 billion in October 2021. Finally, high food inflation resulted in a larger-than-average inflation adjustment the following year of 12.5 percent. Regular benefit spending subsequently increased from $5.9 billion in September 2022 to $7.5 billion in October 2022.

SNAP benefit spending varied with changes to maximum benefit amounts and emergency allotments from FY 2020–23



Note: **SNAP** = Supplemental Nutrition Assistance Program. **FY** = fiscal year. **EA** = emergency allotment(s). Figure based on preliminary data from the September 2023 Program Information Report (Keydata) released by USDA, Food and Nutrition Service (FNS) in December 2023. SNAP benefit totals shown include only regular ongoing benefits and disaster supplements issued to ongoing recipients. Emergency allotments made up almost all the disaster supplements issued to ongoing SNAP recipient households during this time period.

Source: USDA, Economic Research Service using USDA, Food and Nutrition Service data.

In addition to maximum benefit changes, States issued temporary emergency allotments during the pandemic public health emergency to supplement household benefits. At first, emergency allotments were sized to "fill in" the gap between a recipient household's maximum possible benefit and their regular benefit, meaning all households would receive the maximum benefit regardless of net income. Monthly issuance began in most States in March or April 2020. In April 2020, spending on disaster supplements—almost all of which were emergency allotments during the public health emergency—totaled $2.5 billion. In April 2021, USDA altered emergency allotments so that recipients would receive at least $95 per month in addition to regular benefits, allowing some households to exceed the maximum regular benefit. Following this change, the monthly cost of disaster supplements peaked at $4.1 billion in May 2021. From April 2021 through the end of September 2022, 17 States stopped issuing emergency allotments. Monthly disaster supplement issuance fell to about $3.1 billion by October 2022. South Carolina ended emergency allotments after the January 2023 issuance, and the remaining States, Washington, DC, and territories ended them after the February 2023 benefit (issued in February or March depending on issuance schedule). By April 2023, disaster supplement spending dropped to negligible amounts. Overall, during the period from April 2020 through February 2023 in which emergency allotment issuance was in effect, spending on regular SNAP benefits and disaster supplements averaged $8.9 billion a month, with emergency allotments and other minor disaster supplements accounting for 28 percent.

Together, these benefit increases explain a large part of increased SNAP spending in the period after the pandemic's onset in 2020. Total benefit spending fell in FY 2023 alongside the expiration of the Federal public health emergency in May 2023 and the end of emergency allotments but remained above spending levels before the pandemic. By FY 2023, the maximum regular benefit for a family of four was $939 per month—45 percent higher than the maximum of $646 per month in FY 2020.

This article is drawn from...

Jones, J. W., & Toossi, S. (2024). *The food and nutrition assistance landscape: Fiscal year 2023 annual report* (Report No. EIB-274). U.S. Department of Agriculture, Economic Research Service.

You may also be interested in...

Ver Ploeg, M. (2023, April 10). *Food & nutrition assistance* [Topic page]. U.S. Department of Agriculture, Economic Research Service.

Jones, J. W. (2024, February 23). *Supplemental Nutrition Assistance Program (SNAP)* [Topic page]. U.S. Department of Agriculture, Economic Research Service.

Jones, J. W., Jones, K., Leschewski, A. M., & Melo, G. (2024, April 16). SNAP Online Purchasing Pilot reduced food insufficiency among low-income households during early pandemic. *Amber Waves*, U.S. Department of Agriculture, Economic Research Service.

Jones, J. W., & Toossi, S. (2023, August 21). U.S. food and nutrition assistance programs continued to respond to economic and public health conditions in fiscal year 2022. *Amber Waves*, U.S. Department of Agriculture, Economic Research Service.

ERS Food Dollar's Three Series Show Distributions of U.S. Food Production Costs

December **2023**

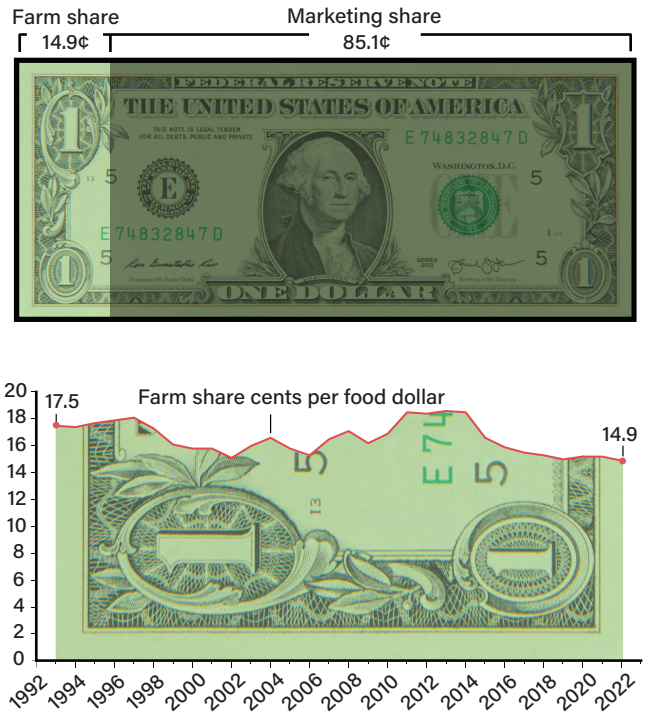
By **Quinton Baker** and **James Chandler Zachary**

The USDA, Economic Research Service's Food Dollar Series measures annual spending by U.S. consumers on domestically produced food with three series that help answer the question "where does the money spent on food go?" Using different models of the same food supply chain, the three series break down the distribution of a representative $1 of annual consumer food expenditures (a food dollar) on purchases for eating at home and away from home. First, the **marketing bill series** shows how much farm establishments receive for the sale of farm commodities as a proportion of total food sales. Second, the **industry group series** shows how the costs of producing and marketing food are distributed across 12 links in the supply chain. Lastly, the **primary factor series** shows how the value added in food production is split among people, capital assets, and other factors in food production.

One way to show how the three series can be useful is to examine how much money spent on food in the United States goes back to farm establishments under each model.

Farm share shows proportion of U.S. food spending that pays for U.S. farm commodities

2022 Food Dollar Series: Marketing bill series



Note: The marketing bill series of the USDA, Economic Research Service's Food Dollar Series shows the average farm share and marketing share of each nominal, or unadjusted for inflation, dollar spent on domestically produced food in a year.

Source: USDA, Economic Research Service, Food Dollar Series.

Marketing Bill Series: Farm Share and Marketing Share

The marketing bill series is divided into two components: the farm share and the marketing share. The farm share represents the value of total raw commodity sales by U.S. farm establishments (excluding farm-to-farm transactions) as a proportion of the total amount U.S. consumers spent on domestically produced food. In 2022, the farm share was 14.9 cents of each dollar spent. The revenues represented in the farm share pay the costs of farm production (such as labor and farm operator expertise), and agribusiness establishments for inputs such as land, seed, and machinery. While most of the farm share comes from food commodity sales, a portion of

it comes from the sale of farm commodities that are used as nonfood inputs throughout the agricultural-food supply chain. An example of this would be the purchase of cotton towels by restaurants. Finally, the farm share also pays establishments for nonagricultural goods and services used in farm operations such as bookkeeping, electricity and fuel to power equipment, and transportation.

The portion of the marketing bill left after subtracting the farm share is the marketing share. This is the share of total food purchases that pays the other industries that bring food to various points of purchase. In 2022, the marketing share was 85.1 cents.

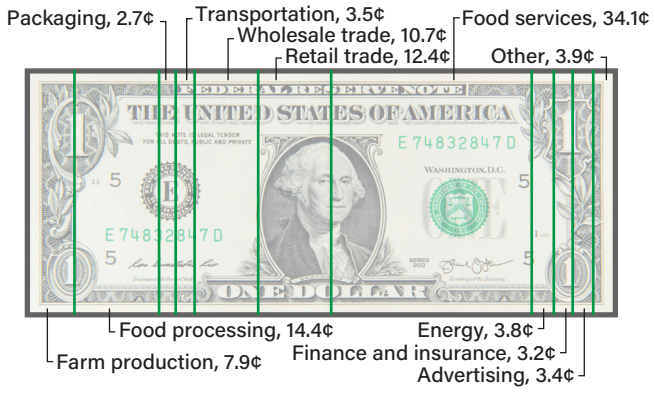
Farm Production Share of Industry Bill Series

Another way to measure how much food spending goes back to the farm is the farm production share, which is included in the industry group series. This series matches a dollar of food spending with the distribution of food production costs among 12 industries that make up the domestic food supply chain. A key difference between the farm production share in the industry group series and the farm share in the marketing bill series is that the farm production share does not include costs from agribusinesses and nonagricultural establishments that supply goods and services to farms. The farm production share of the food dollar was 7.9 cents in 2022. This means that, per food dollar spent, about 8 cents went to farms for producing food.

Included in the "other" industry group category is the agribusiness share, which represents the industry group that supplies inputs such as seed, fertilizer, and farm machinery to farm production. It accounted for 2.1 cents per food dollar in 2022.

Farm production receives fifth largest share of U.S. food dollar among industries along supply chain

2022 Food Dollar Series: Industry group series

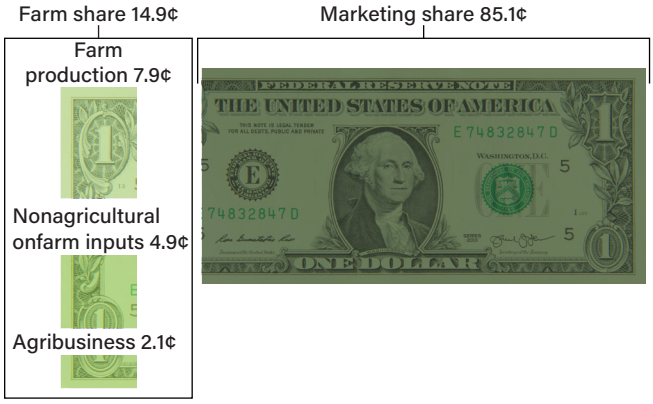


Note: These food dollar estimates reflect shares of each nominal, or unadjusted for inflation, dollar spent on domestically produced food in a year. **Other** includes two industry groups: Agribusiness (2.1 cents) and Legal and accounting (1.8 cents). Agribusiness includes establishments producing farm supplies (except those described in other industry groups) such as seed, fertilizer, and farm machinery.
Source: USDA, Economic Research Service, Food Dollar Series.

Three Components to Farm Share

Most of the farm share of the food dollar goes to farm production and agribusiness. The rest covers costs from other industry groups that do not primarily support agriculture but still supply goods and services to farms for commodity production, such as energy and transportation. The 2022 value for these other costs was 4.9 cents. Since 1993, the earliest year measured in the current Food Dollar Series, they have ranged from 4.6 to 6.3 cents and averaged about 5.4 cents.

Farm share includes expenses paid to nonfarm establishments

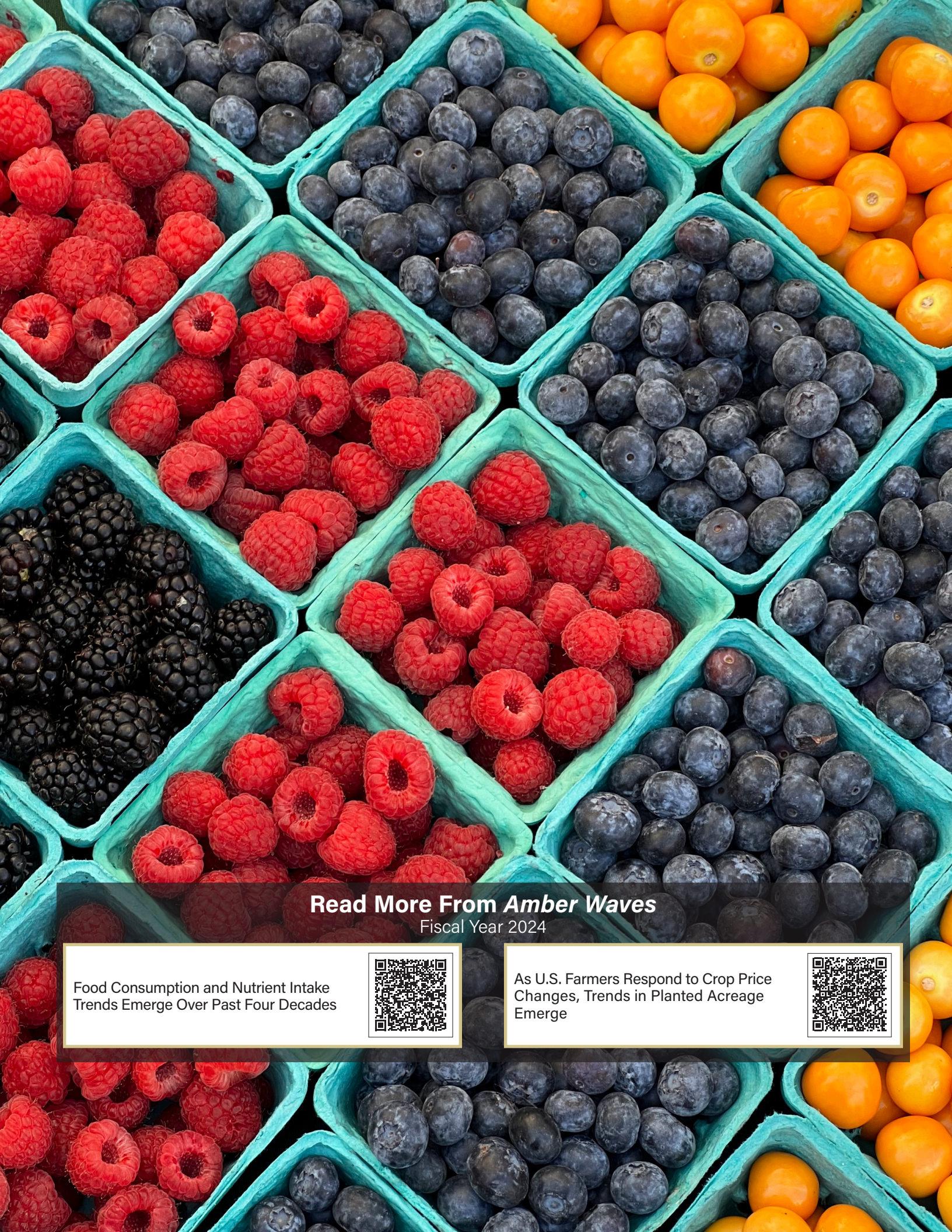


Note: **Nonagricultural** onfarm inputs are materials and services used in farm commodity production purchased from nonfarm industry groups in the food supply chain. For example, they include energy and transportation used on farms or services for financing and insuring farm and ranch operations.
Source: USDA, Economic Research Service, Food Dollar Series.

Primary Factor Series: Measuring Market Value Added

Primary factors are resources such as labor and capital used to transform intermediate materials into products purchased by other establishments or final sales to consumers. Value added is the dollar value of the contributions of these factors to the market value of products and services throughout the economy. The Food Dollar Series sums the value added by all industry groups contributing to the U.S. food supply to create the primary factor series, which shows how a dollar of food expenditures is distributed among four components:

- Salary and benefits — compensation to employees in the form of pretax salaries and employee benefits.
- Output taxes — excise, sales, and other taxes and fees levied on production, less subsidies.
- Imports — the cost of imported materials, ingredients, and equipment used in domestic food production.
- Property income, sometimes called "gross operating surplus" or the return to capital assets —the portion of an industry group's revenues remaining after operatingcosts have been paid but before costs such as depreciation and interest have been paid.



Read More From *Amber Waves*

Fiscal Year 2024

Food Consumption and Nutrient Intake Trends Emerge Over Past Four Decades

As U.S. Farmers Respond to Crop Price Changes, Trends in Planted Acreage Emerge

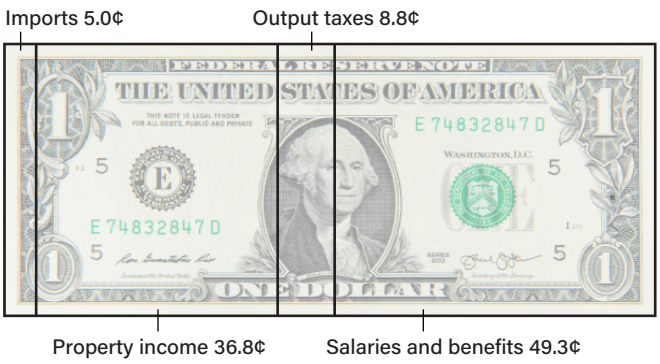
For example, the value added by food processors is the value of their sales (such as to wholesalers and distributors) less the costs of raw food commodities and other intermediate production inputs such as energy and water. This dollar amount pays salaries and wages, taxes on production, imported inputs for production, and operating surplus for their contributions to the market value of the food processors products.

The third way to measure how much food spending goes back to the farm is by breaking down the components of value added at the farm level into primary factors. This allows, as an example, the ability to differentiate how much food spending goes back to farm labor versus to the owners of farm capital assets. For instance, when food processors acquire raw farm commodities, their purchase price compensates farm operators for the primary factors that were used up to the purchase point, and the processors' outputs then become input costs for industries at the next stage.

The Food Dollar Series shows the breakdown of payments to the four production factors by each industry group. For example, in 2022, of the 7.9 cents per dollar spent on food received by the farm production industry group, 1.5 cents paid salaries and benefits, 5.4 cents paid property income, and 1.0 cent paid for imports used in domestic production. Output taxes amounted to 0.0 cent, indicating that taxes paid were equal to subsidies received.

Value is added by four primary production factors across supply chain

2022 Food Dollar Series: Primary factor series



Note: These food dollar estimates reflect shares of each nominal, or unadjusted for inflation, dollar spent on domestically produced food in a year. In the **primary factor series**, shares are value added by each of the primary factors used by all 12 industry groups in the food supply chain. Cents do not add to $1 because of rounding.
Source: USDA, Economic Research Service, Food Dollar Series.

Breakdown of the farm share of the food dollar, 2022

Farm share	
Raw farm commodity sales	14.9 cents
Total value added at farmgate	**14.9 cents**
Purchases by farm establishments	
Agricultural inputs	2.1 cents
Other onfarm, nonagricultural inputs	4.9 cents
Total cost of inputs	**7.0 cents**
Value added by farm establishments	
Salaries and benefits	1.5 cents
Output taxes less subsidies	0.0 cent
Imports	1.0 cent
Property income	5.4 cents
Total farm production costs	**7.9 cents**

Source: USDA, Economic Research Service, Food Dollar Series.

This article was drawn from...

Baker, Q. & Zachary, J. C. (2023). *Food Dollar Series* [Data product]. U.S. Department of Agriculture, Economic Research Service.

You may also be interested in...

Sweitzer, M., MacLachlan, M., Sinclair, W., Stevens, A., Stewart, H., Zachary, J. C., & Zeballos, E. (2023, July 10). ERS data products show food-at-home price inflation from producers to consumers. *Amber Waves*, U.S. Department of Agriculture, Economic Research Service.

Canning, P. (2011). *A revised and expanded Food Dollar Series: A better understanding of our food costs* (Report No. ERR-114). U.S. Department of Agriculture, Economic Research Service.

Rehkamp, S. & Canning, P. (2015, July 6). Accounting for direct and embedded imports in the U.S. food and beverage dollar. *Amber Waves*, U.S. Department of Agriculture, Economic Research Service.

Canning, P. (2013, July 1). ERS Food Dollar Series allows an indepth look at farm level components of the U.S. food dollar. *Amber Waves*, U.S. Department of Agriculture, Economic Research Service.

Canning, P. (2011, June 16). A new look at where our food dollars go. *Amber Waves*, U.S. Department of Agriculture, Economic Research Service.

MARKETS AND TRADE

Global Food Security Improves in 2024 With Higher Incomes and Lower Inflation

September **2024**

By **Lila Cardell** and **Yacob Abrehe Zereyesus**

HIGHLIGHTS

- Food security in the 83 low- and middle-income countries covered in the International Food Security Assessment (IFSA) was estimated to improve in 2024, associated with 3.4 percent growth in per capita GDP and relative easing of international and domestic food commodity price levels, in particular, vegetable oils, wheat, and corn.
- In 2024, 313 million fewer people were estimated to face food insecurity than in 2023, a 27.5-percent reduction from 2023.
- While easing, prices of international wheat, maize, sorghum, and vegetable oils were projected to remain above long-term averages because of inflation, severe weather events such as El Niño, and supply chain disruptions caused by conflicts in shipping lanes in the Black and Red Sea regions.
- By 2034, 66.7 percent fewer people were projected to be food insecure, dropping to 5.5 percent of the IFSA population.

Food insecurity is an ongoing challenge to millions of people around the world, particularly in lower income countries where consumers spend more of their income on food. Since 2020, a series of events has affected both income and prices. Supply chain bottlenecks began during the Coronavirus (COVID-19) pandemic and were exacerbated in 2022 by Russia's invasion of Ukraine, leading to uncertainty around the passage of grain supplies from the Black Sea region. These events led to higher food prices, which meant food was less accessible and available to many people, and a worsening of food insecurity.

In 2023, however, factors affecting food availability and access were projected to improve for the first time since the pandemic's onset. Central bank interest rate increases were associated with the easing of price inflation and slower growth in Gross Domestic Product (GDP) globally. In 2024, international commodity prices, other than for rice, were projected to continue declining as a result of lower inflation, higher production, and supply chain improvements. As a result, 313.0 million fewer people in the world's most vulnerable countries were projected to be food insecure in 2024, a 27.5-percent decrease from the 2023 estimate. This decrease in food insecurity is associated with projected growth in per capita incomes and lower prices for wheat, corn, and vegetable oils.

USDA's Economic Research Service (ERS) uses the International Food Security Assessment (IFSA) model to assess food security trends in 83 low- and middle-income countries—41 in Sub-Saharan Africa, 8 in the Middle East and North Africa, 11 in Latin America and the Caribbean, 14 in Asia, and 9 in the Former Soviet Union. Using data on food availability, food prices, and per capita income, economists estimate food insecurity for the current year and 10

years out. Per capita food demand estimates are compared to a global nutritional threshold of 2,100 calories per person per day, an average caloric intake necessary to sustain a healthy and active lifestyle, according to the United Nations. The prevalence of food insecurity is determined by the share of people in each country who are unable to afford sufficient calories to meet their dietary needs for an active and healthy life.

Per Capita Incomes Projected To Improve in 2024

In 2024, per capita GDP—a proxy for income—was projected to improve in 80 of the 83 countries studied in the IFSA. On average, per capita GDP growth of 3.4 percent was projected across all IFSA countries, lower than 2023 per capita growth of 3.7 percent but above pandemic-era growth of 3.0 percent between 2021 and 2023.

Income growth varied regionally. From 2023 to 2024, per capita GDP growth estimates in Asia and the Former Soviet Union regions are estimated to be among the highest at rates of 4.7 percent and 5.1 percent, respectively, while Sub-Saharan Africa was estimated to have the lowest growth rate at 1.4 percent during the same period. Only three countries, Angola, Sudan, and Syria, were projected to have lower per capita income in 2024 than in 2023.

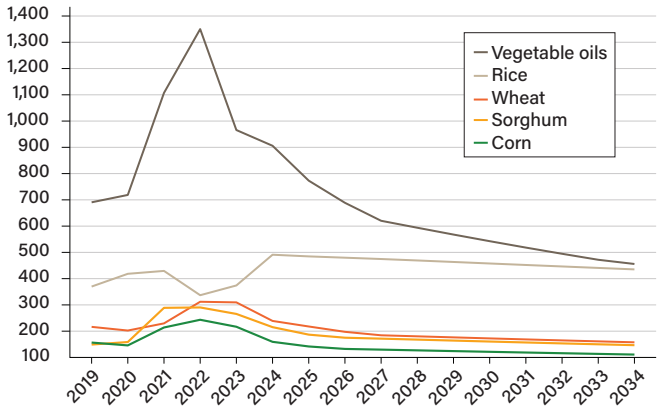
Food Price Inflation Eased in 2024

Inflation, severe weather events such as El Niño, and supply chain disruptions related to conflicts in the Black Sea and Red Sea regions contributed to higher prices during 2021–23. USDA estimated that international agricultural commodity prices would decline in 2024, providing relief to global food insecurity. Prices of crop inputs, including fuel, oil, and fertilizer were projected to decrease from their pandemic highs. Wheat, corn, sorghum, and vegetable oils prices also have fallen from pandemic highs and were estimated to continue declining through 2034. However, rice prices were projected to remain elevated in 2024 associated with India's export restrictions.

Although most consumers were likely to face lower domestic food prices in 2024, inflation was estimated to remain above prepandemic levels. In addition, weak currencies were expected to reduce purchasing power for countries that rely on imports, including many countries in the Sub-Saharan Africa region.

Over the next 10 years, global food and feed supply was projected to exceed demand. International agricultural commodity prices were projected to decline and remain relatively stable. Only rice prices were projected to stay above prepandemic levels through 2034 as Sub-Saharan population growth drives high global demand for rice.

Food price increases were projected to decrease through 2034 for major commodities other than rice



Source: USDA, Economic Research Service, International Food Security Assessment, 2024-2034.

Per capita GDP was projected to grow the fastest in the Asia and Former Soviet Union regions in 2024

Region	Per capita GDP			Annual growth rate	
	2021–23 (average)	2024	2034	2023–24	2024–34
	U.S. dollars, 2015			Percent	
IFSA total	**2,337**	**2,483**	**3,472**	**3.4**	**3.4**
Asia	2,338	2,548	3,982	4.7	4.6
Former Soviet Union	3,167	3,375	5,194	5.1	4.4
Latin America and the Caribbean	5,520	5,727	7,425	1.8	2.6
Middle East and North Africa	3,657	3,787	4,777	1.9	2.3
Sub-Saharan Africa	1,355	1,387	1,610	1.4	1.5

Note: IFSA = International Food Security Assessment. GDP = Gross Domestic Product. Regions include only countries covered by the IFSA.
Source: USDA, Economic Research Service, International Food Security Assessment, 2024–34.

Read More From *Amber Waves*

Fiscal Year 2024

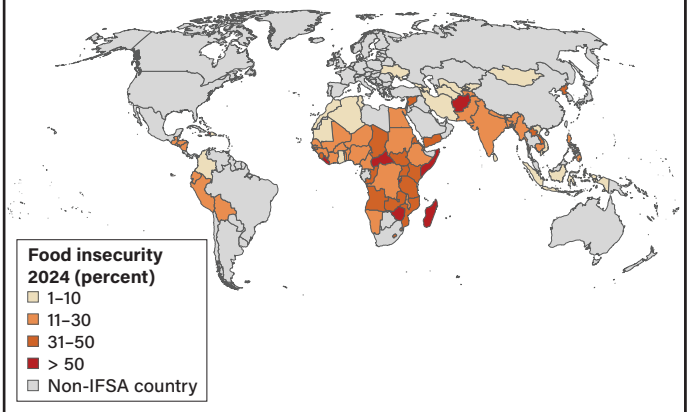
New Methods Can Help Predict Food Security Risk for Smaller Population Groups and at Substate Levels

Patterns of Global Food Consumption Expected to Shift in Next Quarter Century as Population, Incomes Rise

Food Security Challenges Persisted in 2024

Food security was estimated to improve in 2024 for most of the 83 countries covered by the IFSA. Average per capita GDP growth of 3.4 percent coupled with the easing of most international and domestic food prices were estimated to contribute to lower food insecurity estimates for 2024. About 28 percent fewer people (313.0 million) in IFSA countries were expected to be food insecure in 2024 than in 2023. Even so, 824.6 million people—19.0 percent—were estimated to lack access to sufficient food needed for a healthy and active lifestyle in 2024.

Sub-Saharan Africa had the highest prevalence of food insecurity in 2024 of the five IFSA regions



Note: **IFSA** = International Food Security Assessment.

Source: USDA, Economic Research Service, International Food Security Assessment, 2024-2034.

Estimated levels of food insecurity for 2024 varied regionally. Asia (383.6 million people) and Sub-Saharan Africa (351.4 million people) accounted for 89 percent of the total number of food insecure people in 2024. Latin America and the Caribbean (29.9 million people), Middle East and North Africa (52.8 million people), and Former Soviet Union countries (7.1 million people) accounted for the remaining 11 percent. In 2024, Sub-Saharan Africa was estimated to have the highest estimated share of the population that is food insecure at 29.3 percent, followed by Latin America and the Caribbean (16.6 percent), Asia (15.4 percent), and Middle East and North Africa (14.9 percent). The Former Soviet Union region (6.0 percent), comprised primarily of middle-income countries, was estimated to have the lowest prevalence of food insecurity in 2024.

Food Security Projected to Improve in All IFSA Countries by 2034

Despite facing near-term challenges, food security was projected to improve significantly in the next decade across all assessed countries. This outlook was driven by projected gains in per capita income and lower food prices. By 2034, the number of people facing food insecurity in the 83 IFSA countries was projected to decline by 66.7 percent, dropping to 274.6 million people, or 5.5 percent of the population. This improvement was fueled especially by projected economic growth, particularly in the Former Soviet Union and Asia regions.

This article is drawn from...

Cardell, L., Zereyesus, Y. A., Ajewole, K., Farris, J., Johnson, M. E., Lin, J., Valdes, C., & Zeng, W. (2024). ***International food security assessment, 2024–34*** (Report No. GFA-35). U.S. Department of Agriculture, Economic Research Service.

You may also be interested in...

Zereyesus, Y. A., Cardell, L., Ajewole, K., Farris, J., Johnson, M. E., Kee, J., Valdes, C., & Zeng, W. (2023). ***International food security assessment, 2023–2033*** (Report No. GFA-34). U.S. Department of Agriculture, Economic Research Service.

Zereyesus, Y. A., & Cardell, L. (2022, November 28). Global food insecurity grows in 2022 amid backdrop of higher prices, Black Sea conflict. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.

ERS Research Models Future Effects of Climate Change on Corn and Soybean Yields, Production, and Exports

March **2024**

By **Noé J. Nava** and **Jayson Beckman**

HIGHLIGHTS

- A recent study by USDA's Economic Research Service (ERS) modeled how climate-linked changes in temperatures and precipitation might affect future corn and soybean yields and what that would mean for markets and trade through the middle of the next decade.
- U.S. corn yields were estimated to increase, but at a historically slow rate, and a decline was projected for soybean yields by 2036.
- During the same period, corn exports were expected to rise slightly, and soybean exports were expected to fall more than 1 percent for a total decrease for the two crops of as much as $256 million by 2036.

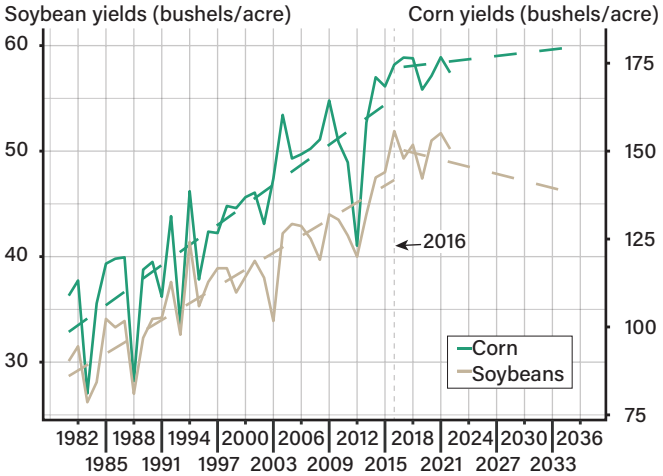
Since 1970, U.S. corn and soybean yields have doubled, but damaging effects of extreme weather events such as droughts and floods have slowed yield gains and interrupted decades of rapidly rising agricultural productivity. Such extreme weather events are expected to become more common, according to the United Nations' Intergovernmental Panel on Climate Change (IPCC). A recent study by USDA's Economic Research Service (ERS) modeled how climate-linked changes in temperatures and precipitation, especially east of the 100th meridian where farms are predominantly rain-fed, might affect future U.S. corn and soybean yields and what that would mean for markets and trade through the middle of the next decade. Using 2016 as a base year, the model estimated an increase in U.S. corn yields but a decrease in soybean yields by the year of 2036. These changes also would affect exports of U.S. corn and soybeans. In the model, corn exports are projected to increase 0.36 percent by 2036, compared with 2016, while soybean exports drop 1.17 percent for a total decrease for the two crops of as much as $256 million by 2036.

U.S. corn yields were estimated to increase 3.1 percent by 2036, representing historically slow yield growth compared with previous decades. In contrast, soybean yields were projected to reverse their multidecade growth trend and decrease 3.0 percent. With the yield changes, the use of land in corn and soybean production also was expected to shift. U.S. corn producers were expected to plant fewer acres of corn, because of increased yields, for an estimated 0.11 percent net increase in projected U.S. corn production by 2036. Soybean producers, however, were projected to increase acreage, offsetting the impact of the expected yield decrease and resulting in a net production increase of about 1 percent by 2036.

Some States were expected to feel the effects of climate change on yields more

profoundly than others. Declines in productivity were concentrated in central States, where corn and soybean yields were projected to decrease by 14.5 percent and 7.1 percent, respectively. Climate-linked yield declines in Kansas, Nebraska, Oklahoma, and North and South Dakota were the most extreme, projected as great as 25.4 percent for corn and 43.4 percent for soybeans. Balancing those expectations, yields were expected to increase in four States in the Corn Belt, the region that produces about 80 percent of U.S. corn and soybeans. On average, yields in Illinois, Missouri, Iowa, and Wisconsin were projected to increase 5.7 percent for corn and 1.2 percent for soybeans by 2036. Outside the Corn Belt, small, mostly offsetting yield losses and gains for both crops were projected.

U.S. soybean yields to decrease, corn yields to increase based on climate projections



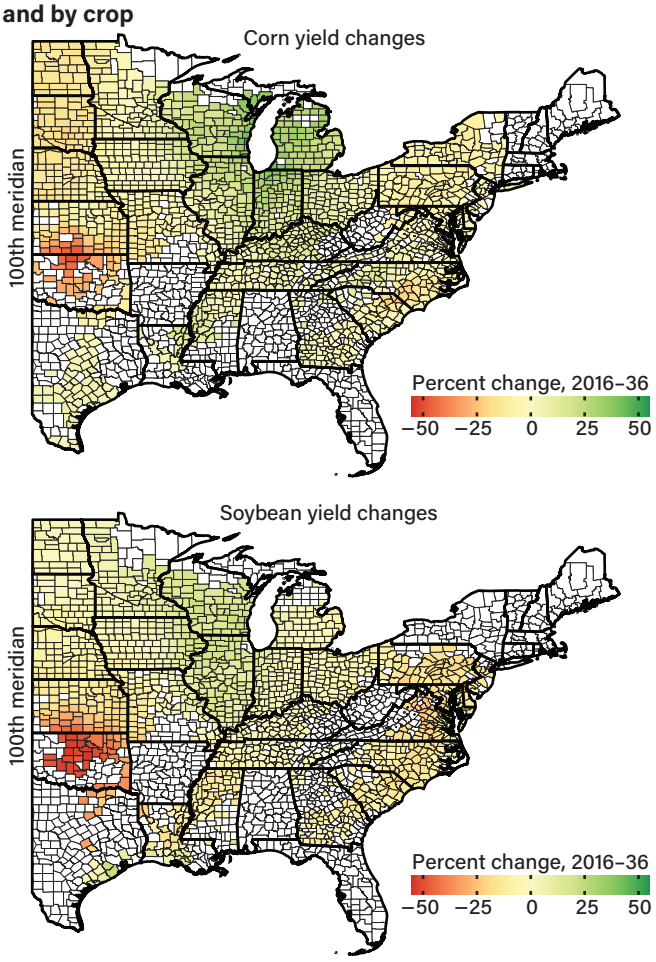
Note: Solid lines represent year-to-year changes, and dashed lines represent past and future trends. Researchers used 2016 as the base year to determine change in 2036.

Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service.

The yield results also have implications for U.S. exports of corn and soybeans. By 2036, exports of corn were projected to increase by the equivalent of $63 million (in 2016 dollars), with additional shipments to China ($18 million), Mexico ($9 million), Japan ($4 million), South Korea ($4 million), and other countries ($28 million). Exports of soybeans, however, were projected to decline $319 million across all trading partners. A $171 million reduction in soybean exports to China, where U.S. market share of soybean trade has retracted in recent years, was the largest projected decrease.

The United States contributed more to the global corn supply than China, India, and Russia combined in 2020. U.S. soybean production was exceeded only by Brazil's harvest that year, making the United States a top producer and exporter of corn and soybeans.

Climate-linked yield changes projected to vary by region and by crop



Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service.

This article is drawn from...

Beckman, J., Ivanic, M., & Nava, N. J. (2023). ***Estimating market implications from corn and soybean yields under climate change in the United States*** (Report No. ERR-324). U.S. Department of Agriculture, Economic Research Service.

You may also be interested in...

Morgan, S., Arita, S., Beckman, J., Ahsan, S., Russell, D., Jarrell, P., & Kenner, B. (2022). ***The economic impacts of retaliatory tariffs on U.S. agriculture*** (Report No. ERR-304). U.S. Department of Agriculture, Economic Research Service.

Williams, B., Dohlman, E., & Miller, M. (2023, February 9). Declining crop prices, rising production and exports highlight U.S. agricultural projections to 2032. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.

Read More From *Amber Waves*

Fiscal Year 2024

Unpriced Corn Inventories Higher Than Other Commodities After 2019 Harvest, Study of Pandemic-Related Situation Shows

Water Delivery Organizations Convey Much of the Water Used for Irrigation in the Western United States

U.S. Exports of Animal Agricultural Commodities Face Many Similar Threats and Opportunities

June **2024**

By **Danielle J. Ufer**

HIGHLIGHTS

- U.S. animal product exports face both headwinds and tailwinds in a number of ways, including livestock and poultry diseases that often lead to trade restrictions.
- Tariff and nontariff trade barriers can form obstacles to the export of U.S. animal commodities.
- Trade agreements can facilitate competition by opening access to markets for U.S. animal product exports, but they also can benefit U.S. competitors.
- Emerging economies, such as those of Southeast Asia, represent new opportunities for increased U.S. animal product exports.

The United States is a leading global exporter of beef, pork, and chicken, as well as several dairy products. While U.S. animal product exports have grown in recent years, those of global competitors also have strengthened. Like the United States, many major players in animal product export markets have strong export portfolios across multiple animal commodities. However, they all must contend with trade barriers, disruptions, tensions, and provisions in trade agreements, which can represent opportunities as well as threats to competitiveness and overall trade performance.

U.S. animal product exports exceeded $37 billion in 2023, representing about one-fifth of the value of total U.S. agricultural exports. The United States holds strong market positions in many of its most common destinations for animal agricultural commodities, including Japan, South Korea, China, and the North American markets of Mexico and Canada. In 2022, U.S. exports accounted for more than two-thirds of Canada's total imports of beef, pork, chicken, and many dairy commodities, and more than 83 percent of those same categories for Mexico. Export competitors for U.S. animal products include the European Union (EU), Brazil, New Zealand, Australia, and Canada.

Livestock Diseases Pose Threats, Opportunities for U.S. Animal Product Trade

Issues related to livestock or poultry disease have presented some of the biggest challenges for U.S. animal product trade in recent years. Diseases that can be passed from animals to humans (known as zoonotic diseases) are a natural cause for trade restrictions given the public health risks. Even animal diseases that are not passed

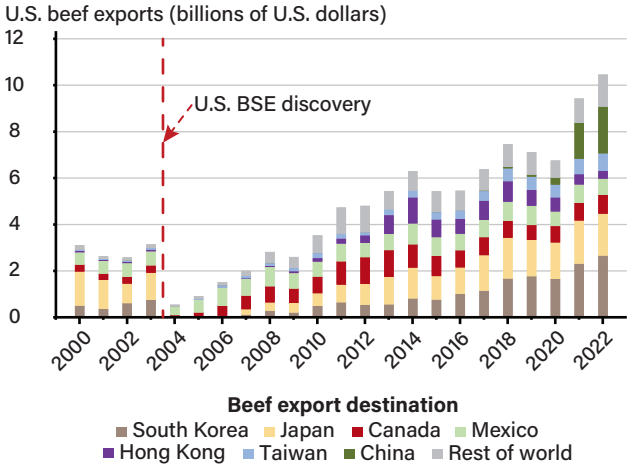
to humans can motivate countries to put trade restrictions in place to protect their agricultural sectors and food supplies.

In the past three decades, bovine spongiform encephalopathy (BSE), commonly known as mad cow disease, was an example of a disease that influenced trade. When the disease was discovered in the United States in 2003, foreign markets closed their borders to U.S. beef. Exports of U.S. beef subsequently dropped from $3.2 billion in 2003 to $551 million in 2004.

Such restrictions can last well beyond the actual threat of the disease. Even after the World Organization for Animal Health declared the United States to be of negligible risk for BSE, U.S. beef trade partners were slow to remove restrictions, and U.S. beef exports recovered gradually. China restored market access only as recently as 2017.

Outbreaks of highly pathogenic avian influenza (HPAI) in the past decade also have resulted in trade restrictions on a variety of animal products, including chicken broiler meat. While importing countries claimed the protection of public health to justify BSE-related restrictions, HPAI-based restrictions were primarily instituted with the stated goal of protecting domestic poultry industries. More recently, countries have limited their HPAI-based import restrictions to products originating in affected geographic regions rather than from an entire country. That trend has helped reduce the effect of disease threats to exports and market access. Still, the impact of any severe outbreak can reduce total exports.

Discovery in 2003 of bovine spongiform encephalopathy (BSE) affected U.S. beef exports until 2017



Note: Beef trade is defined using the USDA, Foreign Agricultural Service's Production, Supply and Distribution beef category. Data are not adjusted for inflation.

Source: USDA, Economic Research Service using data from Trade Data Monitor.

Recently, USDA and other Federal agencies have begun to investigate the presence of HPAI in some U.S. dairy cattle. In April, USDA, Animal and Plant Health Inspection Service (APHIS) announced the start of mandatory testing of dairy cows to take place before they are moved between States. The recent discovery of HPAI in dairy cattle has prompted some trade actions, including limitations on U.S. beef exports to Colombia from States with affected dairy herds and HPAI testing requirements for live U.S. dairy cattle imported into Canada.

On the other hand, disease outbreaks in a trading partner's domestic industry or when an export competitor faces disease-related restrictions open a window for U.S. exports. Recent events surrounding African swine fever (ASF), a disease with no known human health risk but that is often fatal to swine, are one such example. In 2018, China's domestic pork industry was devastated by an ASF outbreak, heavily contributing to a nearly sixfold increase in China's pork imports, from $2 billion to nearly $12 billion in 2 years. U.S. pork exports to China grew at an even faster rate, more than tripling from $129 million in 2018 to $507 million in 2019 and then tripling again in 2020. ASF also affected major pork exporters such as Germany, where the discovery of the disease in wild and domesticated hogs in 2020 cost that country its nearly 15 percent share of China's pork import market. Germany's loss created export opportunity for competitors, including the United States.

Heightened Overseas Standards for Animal Husbandry Also Threaten U.S. Competitiveness

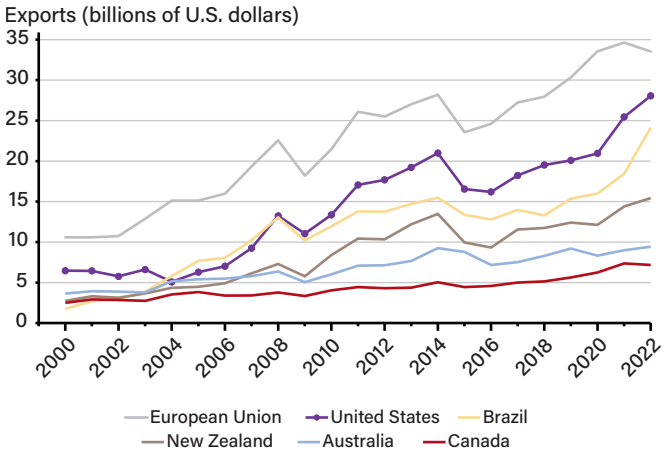
Another challenge for exporters is when importing countries restrict products that come from livestock raised using specific practices. Among the most common such restrictions on U.S. exports are those on products from animals raised with growth-promoting substances such as ractopamine and other beta-adrenergic agonists. U.S. beef and pork producers have used growth-promoting substances extensively in recent decades. Major markets for beef and pork, such as China or the EU, prohibit imports of meat produced using such substances despite statements from the World Health Organization and Food and Agriculture Organization that ractopamine is safe under certain thresholds.

Measures on production standards such as animal welfare requirements or environmental impacts also threaten exports and competitiveness. For example, the EU included animal welfare standards in its 2022 and 2023 trade agreements with New Zealand and Chile, respectively. In 2023, the EU also started prohibiting the sale within the EU of products from cattle raised on land that was recently deforested or linked to forest degradation.

Trade Agreements Foster Market Opportunities for United States as Well as Its Competitors

The political relations and policies defining trade relationships

U.S. major animal product exports are exceeded only by the European Union



Note: Trade data include USDA, Foreign Agricultural Service's Production, Supply and Distribution categories of beef, pork, chicken, and select dairy commodities of butter, cheese, dry skim milk products (nonfat dry milk), dry whole milk powder, and fluid milk. Data are not adjusted for inflation.
Source: USDA, Economic Research Service using data from Trade Data Monitor, Eurostat, and Stats NZ.

also can present threat and opportunity for U.S. animal product exports. Global markets generally are structured such that tariffs, tariff-rate quotas, and safeguard mechanisms often bind and restrict trade. Trade negotiations and free trade agreements often relax these policies as well as nontariff barriers. Trade agreements have become essential in creating or preserving market access. Moreover, they help establish long-term expectations for trade prospects with specific trading partners or coalitions.

The United States is party to several trade agreements enacted over the past three decades, including many with the world's largest animal agricultural commodity partners. The United States had 20 free trade agreements in place in 2022. U.S. animal product exports to Canada and Mexico have been supported by the North American Free Trade Agreement (NAFTA) and, more recently, the U.S.-Mexico-Canada Agreement (USMCA). Meanwhile, bilateral, or individual, trade agreements with Japan, South Korea, and China each have expanded or maintained market access for U.S. animal commodities. These agreements often grant preferential or reduced tariffs on many U.S. goods and can create opportunities for future negotiation or reduction of nontariff trade barriers. For example, provisions in the U.S. free trade agreement with South Korea (known as KORUS) removed tariffs on more than 90 percent of U.S. pork by 2016. Provisions of the Phase One Agreement between the United States and China granted China's recognition of USDA, Food Safety Inspection Service (FSIS) standards, allowing all FSIS-approved processors to export to China without needing to receive individual-level approval. The Phase One Agreement also included provisions for negotiation and discussion of a protocol to govern the importation of live breeding cattle from the United States.

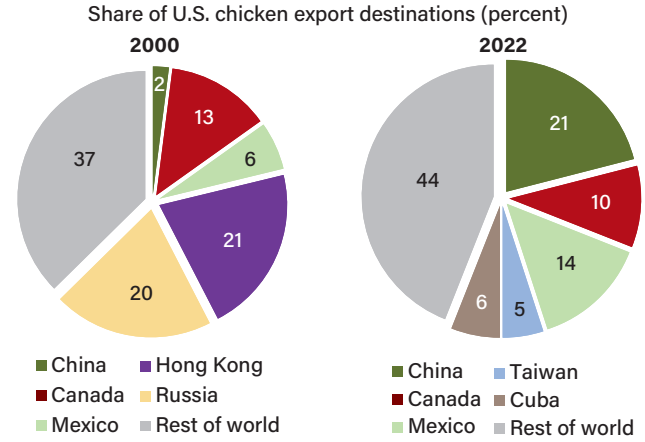
U.S. competitors also engage in trade agreements, complicating the global network of trade advantages for the United States. For example, the South Korea-EU Free Trade Agreement (KOREU), implemented in 2011, offered tariff reduction benefits similar to those in KORUS. The terms of KOREU effectively neutralized much of the United States' preferential access advantage over the EU, the top competitor in South Korea's imported pork market.

Foreign relations and tensions over issues beyond agricultural commodities also can impact market access. Disputes over trade in nonagricultural goods can result in retaliatory actions that affect U.S. agricultural interests. In 2018, China imposed tariffs on U.S. pork and other agricultural products in response to U.S. Section 232 and Section 301 investigations and resulting tariffs on China's manufactured goods and other products. Several other major trade partners levied their own retaliatory tariffs on U.S. agricultural goods in response to similar investigations and trade restrictions. USDA, Economic Research Service (ERS) researchers estimated that from mid-2018 through 2019, U.S. pork export losses from retaliatory tariffs totaled nearly $646 million on an annualized basis.

Tensions over events unrelated to trade also can affect exports. The United States and Russia imposed sanctions and countersanctions on agricultural imports from one another after Russia's 2014 invasion and annexation of Crimea. Because of these actions, the United States lost all access to Russia's poultry market. Russia had been a major destination for U.S. chicken, with exports worth $306 million in 2013, the year before the sanctions.

Opportunities for U.S. exports may arise amid tensions between U.S. trade partners and competitors. Recent political tensions between Australia and China, for example, resulted in restricted

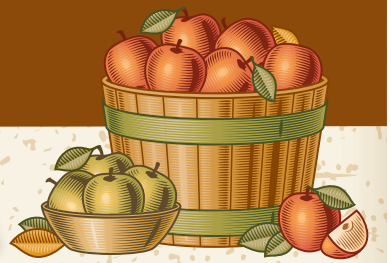
Russia's sanctions on U.S. chicken in 2014 erased a market that had accounted for one-fifth of U.S. exports in 2000



Note: Shares are calculated using export values. Chicken trade is defined using the USDA, Foreign Agricultural Service's Production, Supply and Demand chicken category.
Source: USDA, Economic Research Service using data from Trade Data Monitor.

USDA Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

U.S. APPLES: Slicing Through the Data



The United States is expected to produce almost **10 billion pounds** of apples during the 2023/24 season, up 1.5 percent from 2022/23. As apple production increases, **new varieties** of apples are growing in popularity.

We ate HOW MUCH?!

More than
26 pounds
per person consumed in 2021

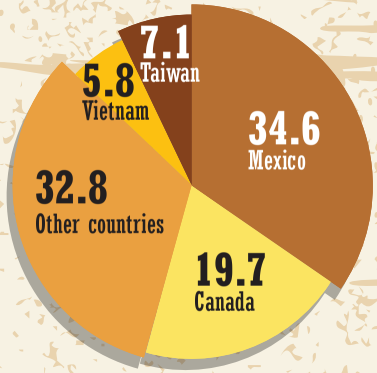
People in the U.S. consumed an average **14.7 pounds** (equivalent to 1.7 gallons) of apple juice, roughly **9 pounds** of fresh apples, and a total of **3.1 pounds** of canned, dried, and frozen apples in 2021.

Top producing States

in million pounds

1	6,700	Washington
2	1,150	Michigan
3	1,100	New York
4	440	Pennsylvania

Top U.S. fresh apple export destinations, by volume

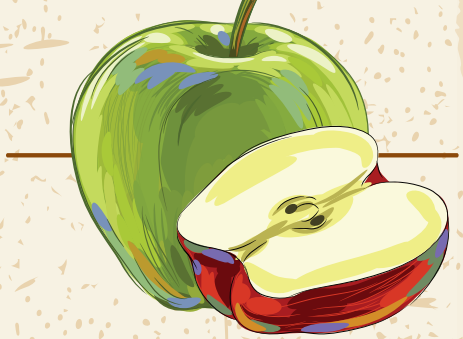


Top 5 varieties

grown in Washington, 2022/23 (millions of 42-lb. bushels)

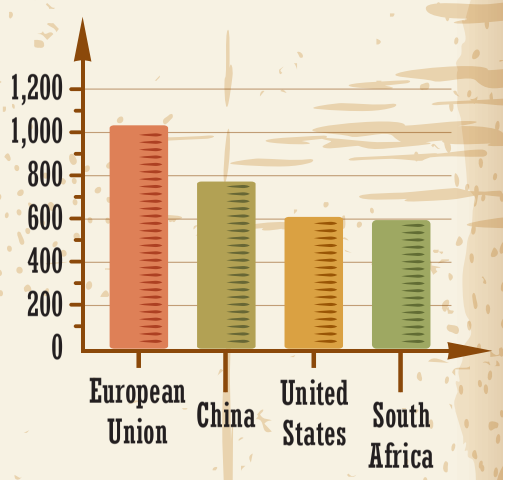
Gala
46.0

The marketing season for apples is August–July, and the **peak picking time** differs by variety and State. October is an especially big month, particularly in Washington. Apples **not sold immediately** after harvest are stored in packinghouses and used throughout **the following year**.



U.S. ranks 3rd among apple exporters

Volume of exports, 2022/23 (thousands of metric tons)



USDA ORGANIC

Organic apples account for:

- **16%** of total U.S. apple sales value.
- **22%** of the total U.S. organic crop sales value.
- **30%** of total U.S. acreage planted to apples.

(2019 data)

This infographic is drawn from Weber, C., Simnitt, S., Wechsler, S., & Wakefield, H. (2023). *Fruit and tree nuts outlook: September 2023* (Report No. FTS-377). U.S. Department of Agriculture, Economic Research Service.

Weber, C. (2023). *Fruit and tree nuts data* [Data product]. U.S. Department of Agriculture, Economic Research Service.

www.ers.usda.gov

Carlson, A., Greene, C., Raszap Skorbiansky, S., Hitaj, C., Ha, K., Cavigelli, M., Ferrier, P., & McBride, W. (2023). *U.S. organic production, markets, consumers, and policy, 2000–21* (Report No. ERR-315). U.S. Department of Agriculture, Economic Research Service.

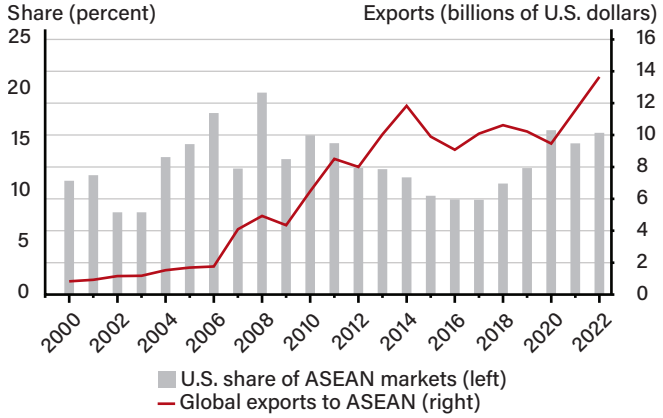
Kantor, L. & Blazejczyk, A. (2023). *Food availability (per capita) data system* [Data product]. U.S. Department of Agriculture, Economic Research Service.

market access for Australia's beef exports, compounding Australian beef export challenges from severe drought. Though it is not clear to what extent Australia and China's political tensions may have directly benefited U.S. beef exports, they did create a potential advantage for the U.S. industry, where processors retained Chinese approval and, consequently, market access.

Emerging Markets Offer Opportunity for U.S. Export Growth

Notable opportunities for U.S. animal product growth exist in emerging markets. A prime example is in Southeast Asia, where imports of animal commodities have grown since 2000. Typical economic drivers such as income growth continue to boost demand for imported as well as domestic animal products. Other factors may create demand for specific products. For example, African swine fever reduced Vietnam's pork supply, leading to an increase in pork imports for that country. Export potential already is evident in some commodities, such as U.S. dry skim milk product exports (nonfat dry milk), for which several Southeast Asian countries are among the top global importers. In 2022, four of the five largest Southeast Asian dry skim milk product export markets bought more than a third of their imports from the United States, with over half of imports to the Philippines originating in the United States. ERS researchers found similar prospects for other animal product exports in emerging markets as their economies continue to develop.

From 2000–22, U.S. share of Southeast Asia's growing animal product imports ranged from 8.1 to 19.8 percent



Note: **ASEAN** = Association of Southeast Asian Nations. Member countries are Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. Major animal product commodities include USDA, Foreign Agricultural Service's Production, Supply and Distribution categories of beef, pork, chicken, and select dairy commodities of butter, cheese, dry skim milk products (nonfat dry milk), dry whole milk powder, and fluid milk.

Source: USDA, Economic Research Service using data from Trade Data Monitor.

This article is drawn from...

Ufer, D. J., Padilla, S., & Link, N. (2023). ***U.S. trade performance and position in global meat, poultry, and dairy exports*** (Report No. ERR-312). U.S. Department of Agriculture, Economic Research Service.

Knight, R., Taylor, H., Hahn, W., Valcu-Lisman, A., Terán, A., Haley, M., & Grossen, G. (2024). ***Livestock, Dairy, and Poultry Outlook: May 2024*** (Report No. LDP-M-359). U.S. Department of Agriculture, Economic Research Service.

You may also be interested in...

Morgan, S., Arita, S., Beckman, J., Ahsan, S., Russell, D., Jarrell, P., & Kenner, B. (2022). ***The economic impacts of retaliatory tariffs on U.S. agriculture*** (Report No. ERR-304). U.S. Department of Agriculture, Economic Research Service.

Padilla, S., Ufer, D. J., Morgan, S., & Link, N. (2023). ***U.S. export competitiveness in select crop markets*** (Report No. ERR-313). U.S. Department of Agriculture, Economic Research Service.

Williams, B., Dohlman, E., & Miller, M. (2024, February 15). U.S. pork exports projected to surpass chicken in the next decade. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.

Davis, C. G., & Cessna, J. (2020). ***Prospects for growth in U.S. dairy exports to Southeast Asia*** (Report No. ERR-278). U.S. Department of Agriculture, Economic Research Service.

Read More From *Amber Waves*

Fiscal Year 2024

Meat Consumption in Mexico, Led by Poultry, Will Continue Rising Over Next Decade, USDA Projections Show

Since Brexit, United Kingdom's Agricultural Trade With European Union Remains Strong; Opportunities for U.S. Exports Emerge

With Expanded Options, Organic Producers of Specialty Crops Increase Use of Federal Risk Management Products

October **2023**

By **Gregory Astill** and **Sharon Raszap Skorbiansky**

HIGHLIGHTS

- As of 2021, more than 17,000 U.S. organic farms sold $11.2 billion of certified organically produced products.
- Organic producers face different production and market risks than their conventional counterparts, but until 2001, Federal risk management tools were not targeted to differentiate that risk.
- Organic price elections for specialty crops coverage became widely available between 2014 and 2022, allowing producers to ensure their crop losses would be paid off at a contracted or published price. By 2022, nearly all organic crops were insurable under a Federal crop insurance program with organic-specific prices, and organic producers increasingly signed up.
- Organic specialty crop producers used buy-up options (a level of coverage exceeding the minimum) at similar rates as conventional specialty crop producers once the organic-specific prices were offered. Depending on the program, as many as 4 out of every 5 dollars are covered under buy-up options offered under Federal crop insurance.

While all crops are prone to risk, organic specialty crops—a broad term that includes fruits, tree nuts, vegetables, beans (pulses), and horticulture nursery crops—face specific challenges. Organic certified crops are grown in accordance with the standards set by USDA's National Organic Program. To meet organic standards, producers must follow restrictions that can increase production costs. For instance, to maintain USDA organic certification, growers must prevent the commingling of their organic crops with nonorganic products and adopt specialized practices for pest, disease, and weed management. Organic growers also face different marketing characteristics that affect risk management. Organic crops may have fewer market participants than conventionally grown crops, limited availability of marketing data, and an increased risk of financial loss due to contamination from prohibited substances. Additionally, organic crops generally command higher prices than conventional crops. This price premium gives farmers an opportunity to recover production costs but also introduces further price risk.

USDA operates a variety of risk management programs that benefit U.S. producers by offering protection from perils inherent to farming. These tools, including crop insurance and disaster assistance programs, serve to maintain stable farm income, prevent bankruptcies, and in

turn, avoid disruptions to the food supply chain. Historically, few risk management products have been available to producers of organic specialty crops.

In 2021, more than 17,000 organic farms sold $11.2 billion of agricultural products. Specialty crops accounted for more than 40 percent of the total value of certified organic agricultural products sold. As domestic production of organic crops has grown, USDA has expanded the menu of risk management options available to their producers. The response from producers indicates strong demand for, and interest in, these tools.

Risk Management Program Options for Organic Specialty Crop Producers

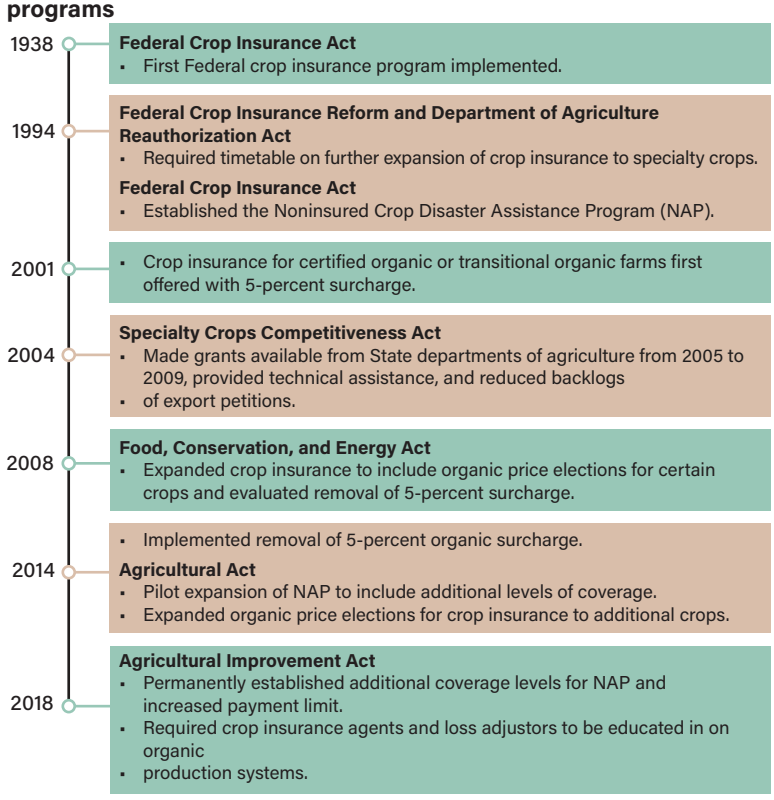
The USDA, Risk Management Agency (RMA) oversees the Federal Crop Insurance Program (FCIP), helping producers mitigate yield and revenue losses from natural causes. FCIP policies cover a percentage of the expected yield or of the revenue for the crop (referred to as the coverage level), with the remainder constituting the deductible covered by the producer. For yield policies, the minimum coverage option, called "catastrophic," covers losses of more than 50 percent of the expected yield, valued at 55 percent of the insured price.

RMA establishes premium rates specific to commodities and counties and calculates them to be actuarially sound, which means total premiums paid are expected, on average, to equal or exceed total claims paid. FCIP products are most often available for crops in counties that are major producers of the crop and have sufficient data to determine premium rates. For crops in counties where there is insufficient data to determine premium rates for FCIP policies, the USDA, Farm Service Agency (FSA) provides a yield-only risk management program, the Noninsured Crop Disaster Assistance Program (NAP). Like FCIP's catastrophic coverage, NAP's basic plan covers losses that exceed 50 percent of expected production, paying 55 percent of the crop's average market price. Historically, FCIP has covered specialty crops in the primary production areas for those specific crops, such as almonds, grapes, and oranges in California or dry beans and dry peas in North Dakota. For specialty crop producers in counties where FCIP is not available, NAP has become an important risk management program.

When FCIP began providing policies for certified organic crops and for crops transitioning from conventional to organic in 2001, policies did not reflect the higher prices that organic producers typically receive for their crops. Moreover, they included a 5-percent surcharge for premium rates. The last three Farm Bills contained provisions aimed at adoption of organic-specific prices for crop insurance products. The Food, Conservation, and Energy Act of 2008 required the Risk Management Agency to evaluate the 5-percent surcharge, and the surcharge was removed for all crops starting in 2014. That bill also required the development of separate organic "price elections" to reflect higher prices for several commodities. Price elections are the per-unit value of the insured commodity for the purpose of determining the premium and the indemnity in the event of loss. Organic-specific price elections now available allow growers to insure their organic crop by using either their contract price or the published RMA organic price, which more closely reflects the crop's value. The Agriculture Act of 2014 required RMA to expand the list of crops for which separate organic pricing would be available. As a result, crop insurance priced for organics became widely available in 2015, and by 2021, most specialty crop policies had separate prices for organics. However, 13 crops, such as chili peppers and mango trees, did not. In those instances, there was at least one of three contributing factors:

- There was no known organic production in insured areas,
- Available data did not meet RMA's data requirement, or
- The commodity's organic market price was not higher than the conventional crop price.

Timeline of key risk management legislation and changes to programs



Source: USDA, Economic Research Service.

Read More From *Amber Waves*

Fiscal Year 2024

Rising Consumer Demand Reshapes Landscape for U.S. Organic Farmers

USDA Created Organic Assistance Programs From 2021 to 2023 in Response to Disruptions, Decreased Organic Transitioning Acreage

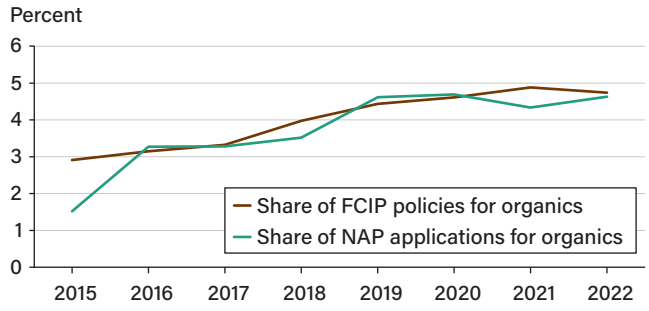
Two crops without separate organic price elections—processing apricots and processing freestone peaches—qualify for the Contract Price Addendum, which allows producers to receive a higher price if they can provide contract information. The 2014 Farm Act clarified that FSA, through NAP, may set separate market prices for organic producers of a specific commodity. The 2018 Agriculture Improvement Act required RMA to continue educating loss adjusters and insurance agents to ensure they know the conservation activities and agronomic practices used in organic systems.

Organic Specialty Crop Insurance Policies Grew With Price Election Expansion

From 2015 to 2022, organic specialty crop insurance policies rose from about 3 percent of total specialty crop policies to about 5 percent. During those years, the number of organic specialty crop policies grew from about 1,700 to more than 2,500. While NAP applications for all specialty crops decreased from 2017 to 2022 (from 95,000 to 54,000), the proportion of those for organic crops rose from about 2 percent in 2015 to about 5 percent in 2022. Although these two measures (share of crop insurance policies and share of NAP applications) are not directly equivalent, they indicate that organic producers increased their use of Federal risk management programs once organic price elections expanded.

Organic specialty crop acreage covered under FCIP has expanded over the past decade, with most growth in coverage occurring among organic specialty field crops such as dry beans or dry peas. Coverage for organic dry peas, for example, rose from about 8,000 acres to more than 30,000 acres and for dry beans from about 12,000 acres to roughly 23,000 acres.

From 2015 to 2022, organic specialty crop producers increasingly used Federal risk management programs



Note: **FCIP** = Federal Crop Insurance Program. **NAP** = Noninsured Crop Disaster Assistance Program.

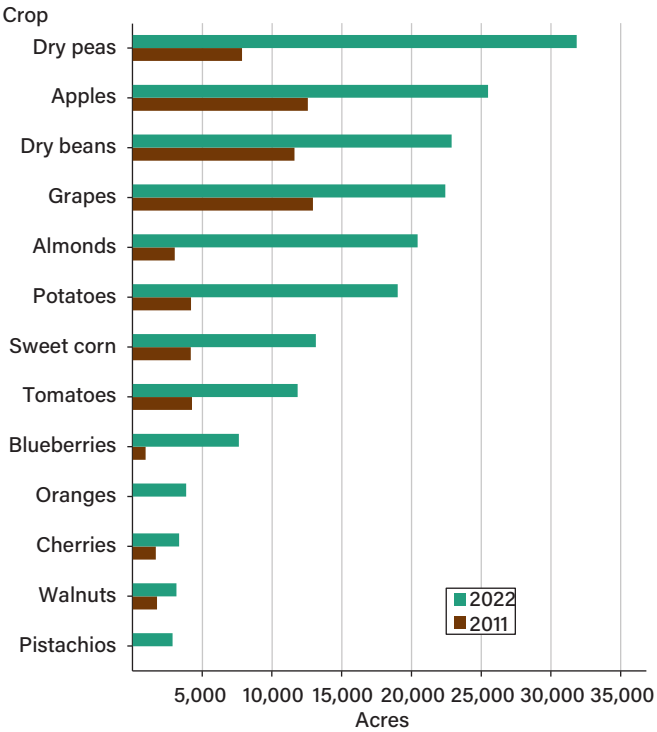
Source: USDA, Economic Research Service using information from USDA, Risk Management Agency and USDA, Farm Service Agency.

As organic price elections became available, producers of several specialty crops began enrolling organic acreage in FCIP. In 2011, there were no policies with organic price elections covering oranges or pistachios. By 2022, organic acreage coverage had expanded to about 4,000 acres for oranges and about 3,000 acres for pistachios.

The two specialty crops with the highest organic acreage in 2011, apples and grapes, also had the most organic acreage covered by FCIP that year. In the late 1990s, roughly 2 percent of apple and grape acres were grown organically, and by 2019, almost 30 percent of apple production used an organic farming system. By value, apple and grape crops ranked in the top four organic exports. The popularity of these two fruits and their producers' early adoption of organic systems provided the necessary data required by RMA to create separate organic price elections. From 2011 to 2022, organic FCIP acreage for apples and grapes expanded from about 13,000 to more than 25,000 and 22,000 acres respectively.

In 2011, FCIP covered about 3,000 to 4,000 acres for organic tomatoes, sweet corn, potatoes, and almonds. By 2022, organic acreage under FCIP had tripled for tomatoes and sweet corn to about 12,000 and 13,000 acres respectively, quadrupled for potatoes to about 19,000, and grew by more than six times for almonds to more than 20,000 acres. These trends demonstrate existing demand when organic price elections were made available.

From 2011 to 2022, organic acreage covered by Federal crop insurance expanded for many specialty crops



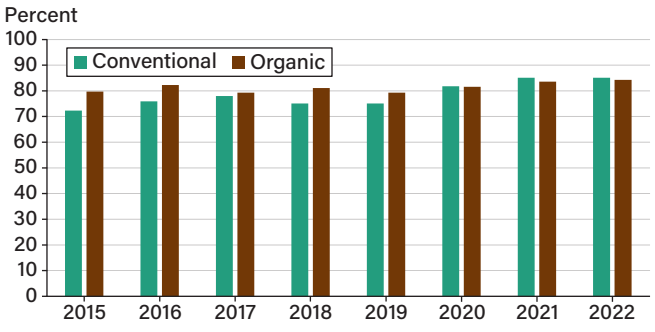
Note: Included are selected specialty crops covered by Federal crop insurance in 2022.

Source: USDA, Economic Research Service using information from the USDA, Risk Management Agency, Summary of Business Report for State, county, crop, coverage type, practice, and unit.

Popular FCIP and NAP Buy-Up Options Catch On at Conventional Crop Rates

Both FCIP and NAP include organic price elections and additional levels of coverage known as "buy-up" coverage. For FCIP, the highest level of coverage available varies by crop, location, and plan, although policies typically range from 50 to 85 percent of expected yield or revenue. The 2014 Farm Act introduced buy-up options for NAP from 2015 to 2018, and they were made permanent in the 2018 Farm Act. For all counties and crop types, NAP buy-up increases coverage for levels up to 65 percent of expected yield and at 100 percent of the price.

Specialty crop producers using buy-up coverage make up the majority of the value of crops insured through FCIP



Note: **FCIP** = Federal Crop Insurance Program.

Source: USDA, Economic Research Service using the USDA, Risk Management Agency, Summary of Business Report.

Although the additional protection offered under buy-up options comes at a higher cost, a large share of producers of high-value specialty crops are choosing them. Organic producers have insured a similar portion of FCIP liabilities using buy-up options compared with conventional specialty crop producers. From 2015 to 2022, about 4 out of every 5 dollars of the value of FCIP organic specialty crop insurance were spent on buy-up coverage.

Similar trends occurred for the share of NAP applications that included buy-up coverage. On average from 2015 to 2022, organic producers chose buy-up coverage on about two out of every five applications for NAP. The share of organic NAP specialty crop applications with buy-up exceeded the share of similar conventional NAP specialty crop applications in 6 of the 8 years.

In 2022, USDA announced the creation of the Transitional and Organic Grower Assistance Program (TOGA), which subsidizes FCIP premiums for transitional and already certified organic producers. Transitional organic producers are those in the process of becoming organic (meaning they have stopped use of prohibited fertilizers and pesticides), but who may not yet market or sell their products as organic. TOGA made $25 million available for new FCIP premium subsidies during the 2023 reinsurance year (July 2023 to June 2024) under the following three options:

- a 10-percentage-point premium subsidy for crop acreage in transition to organic production,
- a $5 per insured acre premium assistance for organic grain and feed crops; and
- a 10-percentage-point premium subsidy for producers purchasing whole-farm insurance policies with transitioning or certified organic acreage.

This article is drawn from...

Raszap Skorbiansky, S., Astill, G., Rosch, S., Higgins, E., Ifft, J., & Rickard, B. J. (2022). ***Specialty crop participation in federal risk management programs*** (Report No. EIB-241). U.S. Department of Agriculture, Economic Research Service.

You may also be interested in...

Raszap Skorbiansky, S., & Astill, G. (2022, November 7). Use of federal risk management programs varies widely by specialty crop. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.

RESOURCE AND RURAL ECONOMICS

Agricultural Land Near Solar and Wind Projects Usually Remained in Agriculture After Development

September **2024**

By **Karen Maguire, Sophia Tanner,** and **Justin B. Winikoff**

From 2012 to 2020, more than 90 percent of large-scale, commercial wind turbines and 70 percent of solar farms in rural areas were installed on agricultural land (either cropland or pasture-rangeland). The amount of rural land directly affected by wind turbines and solar farms, however, is small compared with the amount of farmland in the United States: 424,000 acres in 2020 compared with 897 million total acres used for farmland, less than 0.05 percent. As development has expanded, some communities have raised concerns about the local effects of solar and wind projects. USDA, Economic Research Service researchers recently studied how solar and wind development affects land cover near wind turbines and solar farms. Researchers examined the land cover in the three years prior to and following installation and found that cropland or pasture-rangeland usually stayed in the same land cover even after the addition of solar or wind development.

HIGHLIGHTS

- Between 2012 and 2020, 43 percent of solar farms and 56 percent of wind turbines in rural areas were installed on land that was in cropland prior to development.
- The distribution of solar and wind farms varies regionally. In the Midwest, 70 percent of solar farms and 94 percent of wind turbines were sited on cropland. In the West, most solar farms (60 percent) and wind turbines (69 percent) were located on pasture-rangeland.
- Between 2012 and 2017, agricultural land cover changed on 22 percent of solar farm sites but only 4 percent of wind turbine sites after installation. Fifteen percent of the solar sites shifted out of agriculture after installation; for wind, it was less than 1 percent.

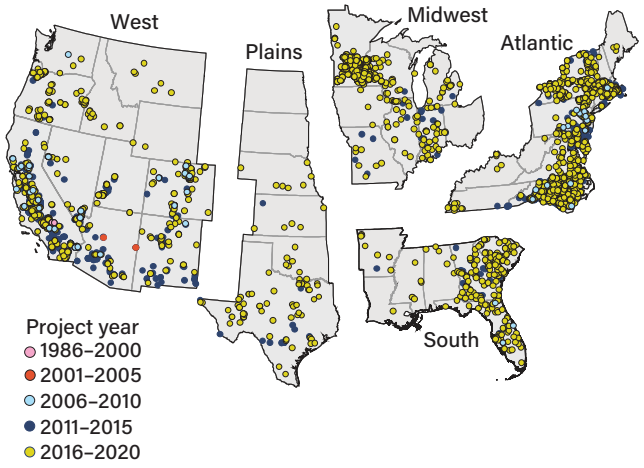
Wind development has been expanding since the late 1990s and accounts for a larger share of renewable energy capacity than solar. In 2020, wind accounted for 8.4 percent of total U.S. electricity generation, and solar accounted for 2.3 percent. Solar is a younger industry than wind—most solar farms were installed after 2016—and is growing at a faster rate, with solar expected to make up nearly three-quarters of the growth in renewable generation by 2025. Solar farms tend to be smaller than wind farms, but the direct land cover impact of a solar farm (the area beneath solar panels and other infrastructure) typically extends throughout a larger portion of the individual solar farm. Wind farms typically take up much larger areas, but more than 95 percent of the land in a wind farm does not contain related structures such as turbine pads or roads. Further, solar farms require about 10 times more land area per megawatt of capacity than wind farms. Differences in the location of solar and wind developments, as well as

variations in the type and extent of land directly affected, are likely to result in differing impacts of solar and wind energy on agricultural land cover.

Solar Energy Development

From 2016 to 2020, large-scale, commercial solar capacity in rural areas more than doubled, increasing to 45 gigawatts, or 3.7 percent of U.S. electric power capacity, and the number of solar projects increased from 2,316 to 3,364. About 70 percent of the solar projects—93 percent of solar capacity—installed from 2009 to 2020 were in rural areas. Solar projects were concentrated in the Atlantic and West regions of the United States, especially in North Carolina, Massachusetts, and California, which have State-level policies promoting renewable energy development.

Utility-scale solar projects in rural United States concentrated in West and Atlantic regions, 2020



Note: Total number of solar projects = 3,364. USDA's Agricultural Resource Management Survey Production Expenditure Regions do not include Alaska and Hawaii. One dot represents the location of a solar project, and the color corresponds with the year in which the project started. Because of scale, some points may overlap with others. Utility scale means large-scale commercial solar energy development.

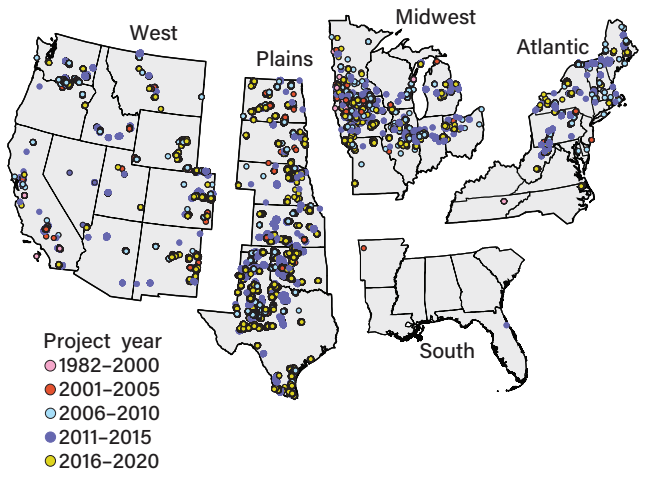
Source: USDA, Economic Research Service using data from the U.S. Energy Information Administration Form 860 (2020); USDA, National Agricultural Statistics Service Agricultural Resource Management Survey Production Expenditure Regions; and U.S. Department of Commerce, Bureau of the Census 2019 urban-rural boundaries.

Solar panels also are frequently installed in small-scale systems typically built on existing structures such as rooftops and do not directly affect land cover or lead to concerns about land use competition. In 2021, 96 percent of the solar photovoltaic systems in the United States were small-scale systems, although more than 70 percent of solar capacity was from large-scale, commercial solar projects. Agricultural producers also use small-scale solar systems, such as rooftop solar and solar-powered electric fences. Two percent of U.S. farms in 2012 had small-scale solar panels for on-farm use.

Wind Energy Development

The United States saw significant growth in wind power beginning in the mid-2000s. Capacity increased from 11 megawatts in 2006 to 119 megawatts in 2020, and the number of turbines in rural areas in 2020 was more than six times the number in 2006 (64,985 turbines compared with 10,651). Large-scale, commercial wind energy development in the contiguous United States is concentrated in areas with consistent, high wind speeds. Wind turbines are most prominent in the Plains, followed by the Midwest and West. Although State-level energy policies influence the regional distribution of wind energy development, the most important factor is the area's wind potential. Some States, such as those in the South and southern Atlantic regions, do not have the year-round wind speeds required for large-scale development.

Utility-scale wind energy development in rural United States concentrated in Plains, Midwest, and West regions, 2020



Note: Total number of wind turbines = 64,985. USDA's Agricultural Resource Management Survey Production Expenditure Regions do not include Alaska and Hawaii. One dot represents the location of a wind turbine, and the color corresponds with the year in which the project started. Because of scale, some points may overlap with others. Utility scale means large-scale commercial wind energy development.

Source: USDA, Economic Research Service using data from the U.S. Wind Turbine Database (January 14, 2022); USDA, National Agricultural Statistics Service Agricultural Resource Management Survey Production Expenditure Regions; and U.S. Department of Commerce, Bureau of the Census 2019 urban-rural boundaries.

The direct land cover impact of a wind farm is limited to the relatively small area on which service roads, turbine pads, and other infrastructure are built. Farmers and ranchers typically can continue agricultural production near wind turbines, so landowners can earn income from energy leases as well as agricultural production. At the same time, wind developments can be associated with noise disturbance, altered views, and effects on wildlife.

Read More From *Amber Waves*

Fiscal Year 2024

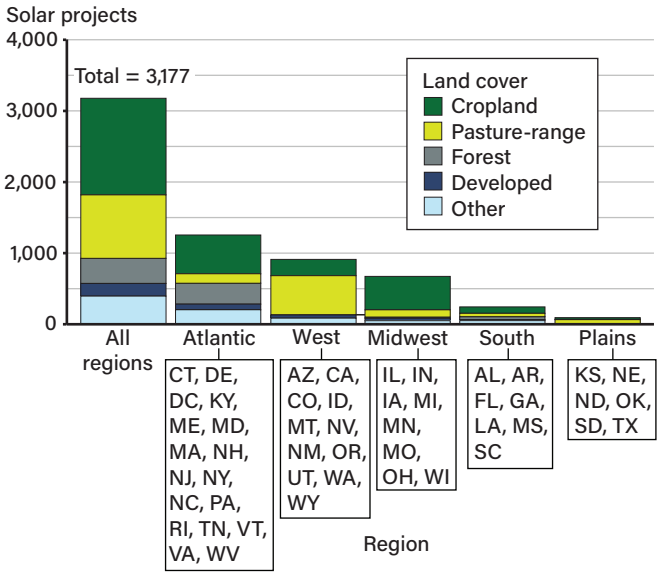
As Drought Threats Continue, Government's Financial Climate Risk From Livestock Forage Disaster Program Expected to Increase

Study Links Federally Declared Weather Disasters to Reductions in U.S. Pork Processing

Land Cover Prior to Solar Development

Of the 3,177 utility-scale solar projects installed in rural areas from 2012 to 2020, the largest share (43 percent) was on cropland. The Midwest had the highest share of solar installations on cropland (70 percent), followed by the Atlantic (43 percent) and South (37 percent). Twenty-eight percent of solar projects were installed on pasture-rangeland. In the West and Plains, installations occurred mostly on pasture-rangeland (60 and 65 percent, respectively). The Atlantic region had the highest share of solar sites on land in forest (23 percent), and the Atlantic and South tied for the highest share (6 percent) of solar installations on nonagricultural, developed land. Sites in the South were the most diverse, with 37 percent categorized as cropland, 19 percent as pasture-range, 17 percent as forest, and 21 percent as other.

Midwest had biggest share of utility-scale solar projects on cropland; largest share on pasture-rangeland was in West, 2012–20



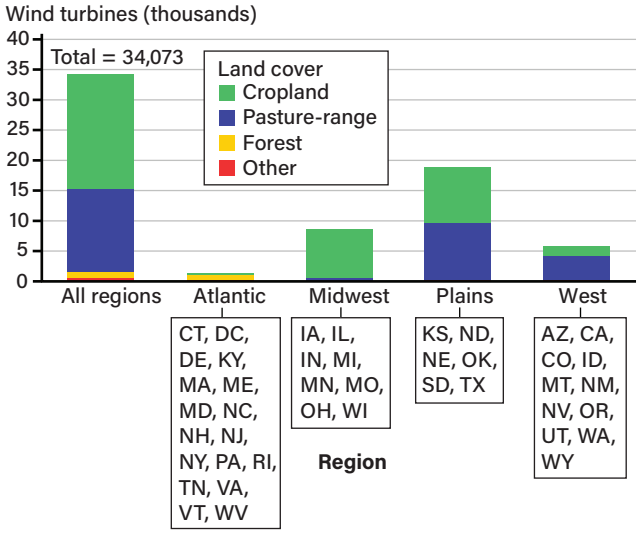
Note: Land cover category is determined based on the land cover in the 3 years prior to installation within a 150-meter buffer for each site. Other includes the USDA, National Agricultural Statistics Service Cropland Data Layer land cover classes of barren, wetlands, open water, woody wetlands, herbaceous wetlands, and sites that shifted between land cover categories within the 3-year period before installation. USDA's Agricultural Resource Management Survey Production Expenditure Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service using data from the U.S. Energy Information Administration Form 860 (2020); USDA, National Agricultural Statistics Service (NASS) Cropland Data Layer 2009–20; NASS Agricultural Resource Management Survey Production Expenditure Regions; and U.S. Department of Commerce, Bureau of the Census 2019 urban-rural boundaries.

Land Cover Prior to Wind Energy Development

Most of the 34,073 turbines installed on rural land from 2012 to 2020 were on either cropland (56 percent) or pasture-rangeland (40 percent). In the Midwest, 94 percent of wind turbine sites were classified as cropland. In the Plains, sites were almost equally split between cropland (49 percent) and pasture-rangeland (50 percent). The Atlantic was the only region with a large share of turbines on nonagricultural land, with 75 percent on forest land. However, the Atlantic region had only 3 percent of the Nation's wind turbines, and fewer than 1,000 turbines were on land categorized as forest.

Plains and West regions had biggest shares of utility-scale wind turbines on pasture-rangeland, 2012–20



Note: Land cover category is determined based on the land cover in the 3 years prior to installation within a 150-meter buffer for each site. Other includes the USDA, National Agricultural Statistics Service Cropland Data Layer land cover classes of barren, wetlands, open water, woody wetlands, herbaceous wetlands, and sites that shifted between land cover categories within the 3-year period before installation. USDA's Agricultural Resource Management Survey Production Expenditure Regions do not include Alaska and Hawaii. The chart does not include 10 wind turbines that were on developed land, including one turbine in the South, because they represent a small share of the total. However, they are included in the total for all regions.

Source: USDA, Economic Research Service using data from the U.S. Wind Turbine Database (January 14, 2022); USDA, National Agricultural Statistics Service (NASS) Cropland Data Layer 2009–20; NASS Agricultural Resource Management Survey Production Expenditure Regions; and U.S. Department of Commerce, Bureau of the Census 2019 urban-rural boundaries.

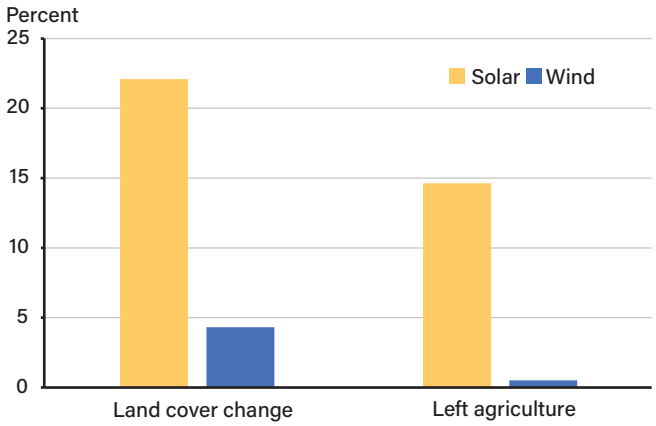
Agricultural Land Cover Change

Most agricultural lands surrounding solar farms and wind turbines remained in agriculture during the period studied, although land cover change was more common after solar farm development than after wind turbine development. On solar farms, land cover changed on 22 percent of sites that were in agriculture before development and on 4 percent of wind turbine sites. Fifteen percent of solar sites that had been in agriculture before installation were not being used for agriculture afterward. For wind turbines, the share that left agriculture was less than 1 percent.

The fact that a high share (about 85 percent) of crop and pasture-rangeland in proximity to solar farms remained in agricultural production may be somewhat unexpected because the land

cover under and between solar panels is removed during the construction of a typical solar farm. This suggests there was some crop production and the potential for livestock grazing on land near solar farms. For wind turbines, the persistence of agricultural land cover after development suggests that wind turbine development was compatible with agricultural production.

Agricultural land with solar development saw most land cover change after installation, 2012–17



Note: Land cover category is determined based on the land cover in the 3 years prior to and after installation within a 150-meter buffer for each site. Agricultural land includes cropland and pasture-range. Non-agricultural land categories include forest, developed, and other. The other category includes the USDA, National Agricultural Statistics Service Cropland Data Layer land cover classes of barren, wetlands, open water, woody wetlands, herbaceous wetlands, as well as sites that shifted between land cover categories within the 3-year period prior to or after installation.

Source: USDA, Economic Research Service using data from the U.S. Energy Information Administration Form 860 (2020); U.S. Wind Turbine Database (January 14, 2022); USDA, National Agricultural Statistics Service Cropland Data Layer 2009–20; and U.S. Department of Commerce, Bureau of the Census 2019 urban-rural boundaries.

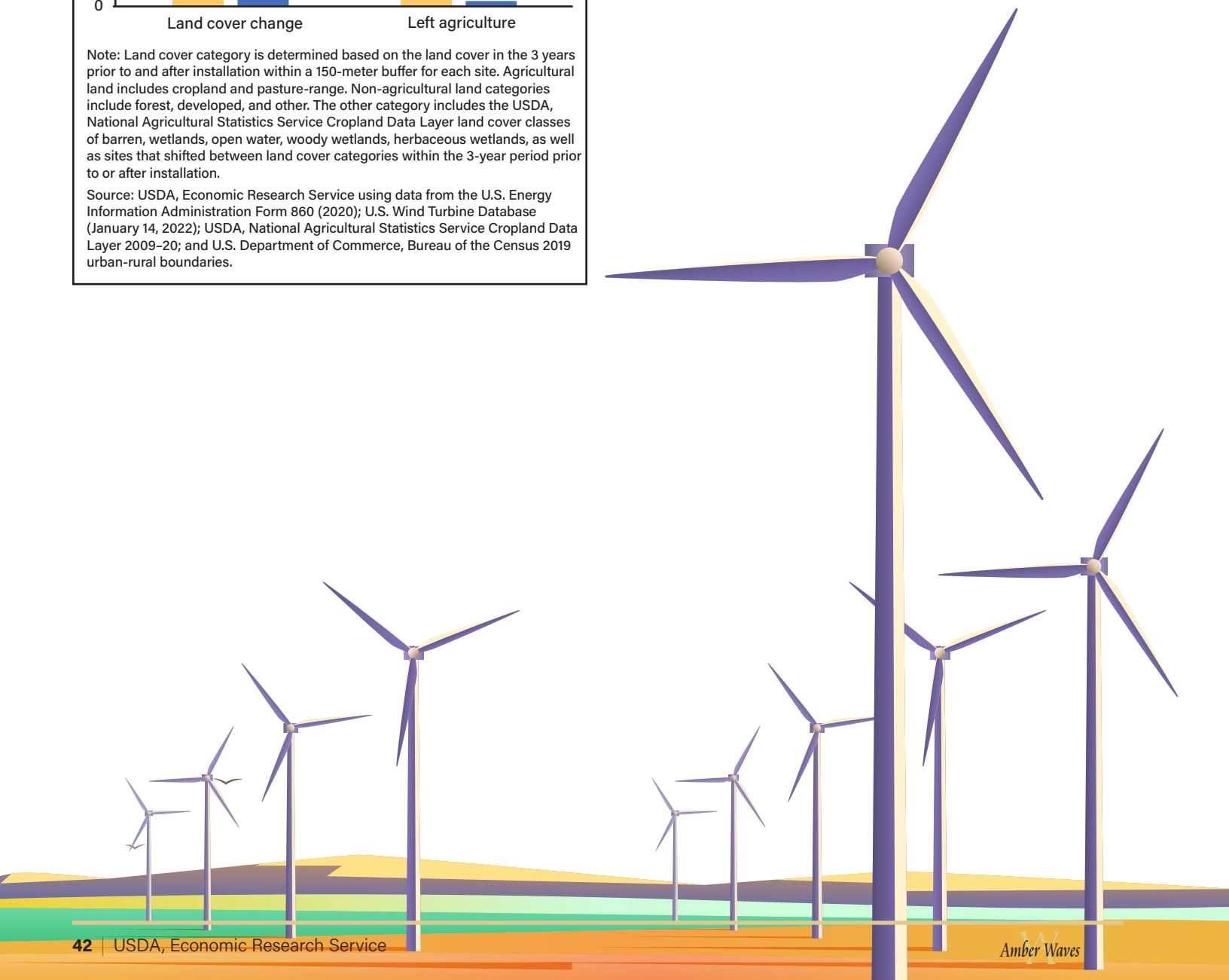
This article is drawn from. . .

Maguire, K., Tanner, S., Winikoff, J. B., & Williams, R. (2024) ***Utility-scale solar and wind development in rural areas: Land cover change (2009–20)*** (Report No. ERR-330). U.S. Department of Agriculture, Economic Research Service.

You may also be interested in . . .

Winikoff, J. B., & Maguire, K. (2024, July 9). Energy payments to farmers vary according to farm size, energy markets, location. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.

Maguire, K. (2024, April 22). Common ground for agriculture and solar energy: Federal funding supports research and development in agrivoltaics. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.



Farm Households Face Larger Tax Liabilities When Provisions of the Tax Cuts and Jobs Act of 2017 Expire

March **2024**

By **Tia M. McDonald** and **Ron Durst**

HIGHLIGHTS

- The sunsetting of Federal individual income tax provisions from the Tax Cuts and Jobs Act that will have the biggest effect on total tax liabilities of farm households are the reduced marginal tax rates and related changes, the qualified business income deduction, and the expanded Child Tax Credit.
- Moderate-sales farm households would experience the largest percentage increase in tax liability as a result of the expiration of reduced marginal tax rates and related changes and the qualified business income deduction.
- Expiration of the increased estate tax exemption (which will decrease the amount exempted from $13.95 million to $6.98 million) is estimated to increase the percent of farm operator estates taxed from 0.3 to 1.0.

The 2017 Tax Cuts and Jobs Act (TCJA) made significant changes to Federal individual income and estate tax policies. Federal income and estate tax policy modifications can affect not only the financial well-being of farm households but also the number and size of farms, so these changes are of considerable importance to family farms. Several of the TCJA changes to Federal individual income and estate tax policies were temporary and are scheduled to expire by the end of 2025.

The expiration of the TCJA provisions would result in:

- Higher marginal income tax rates. The TCJA reduced the top income tax rate to 37 percent from 39.6 percent and changed the income tax brackets to make more income subject to lower rates. It also increased the standard deduction for married joint and single filers and eliminated the personal exemption.
- A decrease in the Child Tax Credit amount and eligibility. The TCJA expanded the per-child tax credit to $2,000 from $1,000 and increased the income threshold for eligibility for the tax credit.
- An increase in the scope of the alternative minimum tax (AMT). For higher income earners, the TCJA significantly reduced the impact of the AMT by increasing its exemption amount and increasing the threshold where the exemption begins to phase out.
- The elimination of the qualified business income deduction (QBID), created through TCJA for farms and other businesses

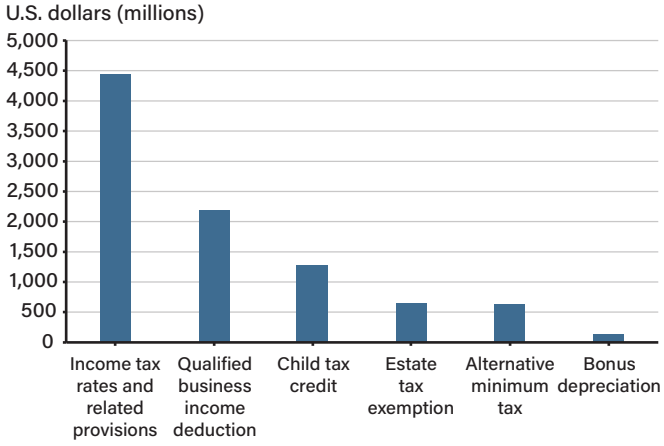
that are not organized as C-corporations, which are taxed separately from their owners. The QBID provision was intended to provide parity with C-corporations, which received tax rate cuts through the TCJA.

- The elimination of bonus depreciation, which allows businesses to deduct a percentage of their capital expenses in the first year. TCJA increased that deductible amount to 100 percent from 50 percent. The bonus depreciation allowance is set to be fully phased out by 2026.

- A decrease in the estate tax exemption. TCJA increased the estate tax exemption to $11.18 million in 2018. At the end of 2025, the exemption amount will revert to the pre-TCJA level (adjusted for inflation) of $6.98 million.

In a recently released report, researchers with the USDA, Economic Research Service (ERS) estimated the impact these expiring tax provisions would have on farms by using two economic models coupled with demographic and financial data for farms and farm households collected as part of USDA's Agricultural Resource Management Survey (ARMS). As shown in the chart on the right, the expiration in income tax rates and related provisions would increase total tax liabilities the most. Changes after the provisions expire include tax bracket revisions resulting in more income being taxed at higher rates, reductions in the standard deduction, reinstatement of the personal exemption, and removal of a limit on the deduction for State and local taxes. The expiring provision with the second biggest total impact would be the elimination of the QBID. This deduction allows sole proprietorships and other noncorporate business owners to deduct 20 percent of their business income from their taxable income. Eliminating this deduction has the potential to increase tax liabilities for farmers who typically earn positive farm income. Expiring expansions to the Child Tax Credit would increase total tax liabilities by more than $1 billion the year following expiration. The expiring provisions related to the AMT, bonus depreciation, and the estate tax exemption generally affect higher income and wealthier households and are more limited in their total impact.

Potential change in family farm households' tax liability after Tax Cuts and Jobs Act provisions expire



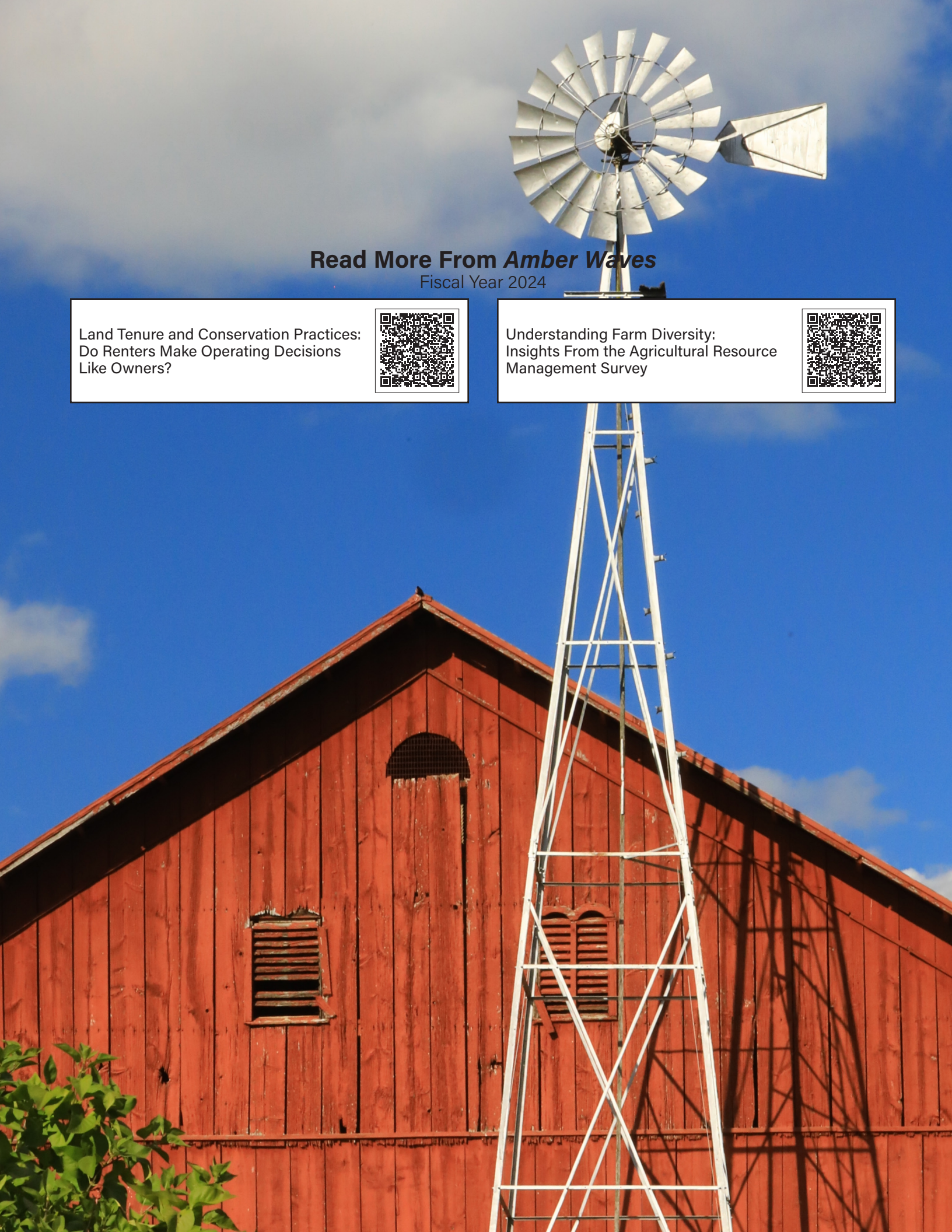
Note: All data adjusted to 2021 values. Baseline excludes American Rescue Plan Act's child tax credit expansions, which expired in 2022.

Source: USDA, Economic Research Service and National Agricultural Statistics Service, 2018–2021 Agricultural Resource Management Survey.

Expiring TCJA Child Tax Credit (CTC) expansions would reduce tax credits to family farm households

	Percent of farm households receiving Child Tax Credits		Average Child Tax Credit for eligible farm households (dollars)	
Farm type	**Baseline, TCJA active**	**Expired TCJA CTC expansion**	**Baseline, TCJA active**	**Expired TCJA CTC expansion**
Small				
Retirement	14.6	12.5	3,341	1,422
Off-farm occupation	42.4	29.5	4,107	1,342
Low sales	34.4	30.2	3,099	1,331
Moderate sales	43.3	30.4	4,325	1,588
Midsize	39.5	19.6	4,249	1,029
Large scale				
Large	27.3	12.9	4,348	981
Very large	17.7	10.2	4,017	1,159
All farm households	35.9	26.8	3,770	1,331

Note: **TCJA** = Tax Cuts and Jobs Act. **CTC** = child tax credit. All data adjusted to 2021 values. Baseline excludes American Rescue Plan Act's child tax credit expansions, which expired in 2022. **Small** family farms have gross cash farm income (GCFI) less than $350,000. **Retirement** farms have GCFI less than $350,000 and principal operators who report they are retired. **Off-farm occupation** farms have GCFI less than $350,000 and principal operators who report a primary occupation other than farming. **Low-sales** farms have GCFI less than $150,000. **Moderate-sales** farms have GCFI from $150,000 to $349,999. **Midsize** family farms have GCFI from $350,000 to $999,999. **Large** family farms have GCFI from $1 million to $4,999,999. **Very large** family farms have GCFI of $5 million or more.
Source: USDA, Economic Research Service and National Agricultural Statistics Service, 2018–2021 Agricultural Resource Management Survey.



Read More From *Amber Waves*

Fiscal Year 2024

Land Tenure and Conservation Practices: Do Renters Make Operating Decisions Like Owners?

Understanding Farm Diversity: Insights From the Agricultural Resource Management Survey

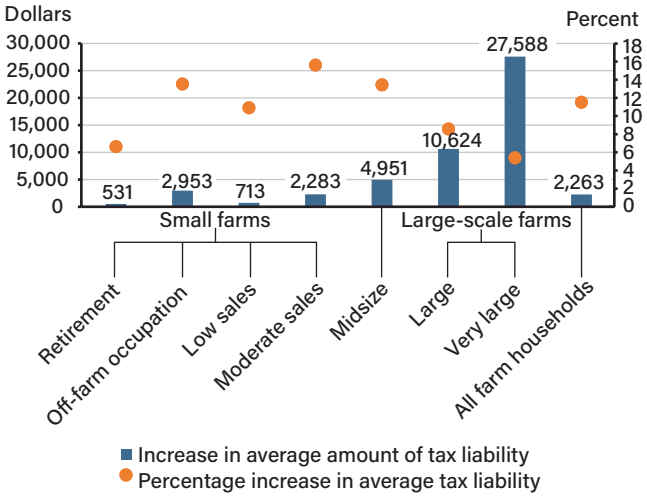
To estimate the effect of each expiring income tax provision, researchers put family farm household adjusted gross income and tax liability data into ERS's Federal Income Tax model. For the Federal estate tax estimations, researchers used ERS's Estate Tax model, an actuarial model using farm financial information from ARMS (2018-21). The estate tax model also uses mortality data from the Social Security Administration (2019), publicly available estate tax data from the Internal Revenue Service (2020), and interest rate data from Farm Credit System lenders (2021). With this model, researchers can compare Federal estate tax liabilities for farm households in 2026 for the exemption levels increased through TCJA with the exemption level that would apply if the law's provisions were to expire.

Researchers used ERS's farm typology—categorizing family farms by size and primary occupation of the principal operator—to explore additional insights into the effects of those expiring tax provisions. Retirement farms have gross cash farm income (GCFI) of less than $350,000, and the principal operators report they are retired from farming. Off-farm occupation farms have GCFI of less than $350,000, and the principal operators' primary occupation is not farming. For all other farm types, the primary occupation of the principal operator is farming. The GCFI thresholds for low-sales, moderate-sales, midsize, and large farms are $150,000, $350,000, $1 million, and $5 million, respectively. Very large farms are those with more than $5 million GCFI.

The Impact of Expiring Income Tax Provisions Would Vary by Farm Typology

The combined effect of expiring marginal income tax rates and other income tax changes would increase average tax liabilities

Tax liability increases after Tax Cuts and Jobs Act provisions expire for tax rates, deductions, and personal exemptions



Note: All data adjusted to 2021 values. **Small** family farms have gross cash farm income (GCFI) less than $350,000. **Retirement** farms have GCFI less than $350,000 and principal operators who report they are retired. **Off-farm occupation** farms have GCFI less than $350,000 and principal operators who report a primary occupation other than farming. **Low-sales** farms have GCFI less than $150,000. **Moderate-sales** farms have GCFI from $150,000 to $349,999. **Midsize** family farms have GCFI from $350,000 to $999,999. **Large** family farms have GCFI from $1 million to $4,999,999. **Very large** family farms have GCFI of $5 million or more.

End to qualified business income deduction would affect largest family farms the most

Farm type	Percent of farm households that received qualified business income deduction	For farm households affected by expiration of qualified business income deduction	
		Change in average tax liability (dollars)	Change in tax liability (percent)
Small			
Retirement	43.4	851	8.4
Off-farm occupation	40.6	1,010	4.0
Low sales	39.1	711	9.0
Moderate sales	73.3	3,068	20.0
Midsize	76.0	5,678	14.0
Large scale			
Large	77.8	11,868	8.5
Very large	79.7	87,219	14.1
All farm households	45.3	2,464	9.0

Note: **TCJA** = Tax Cuts and Jobs Act. **CTC** = child tax credit. All data adjusted to 2021 values. Baseline excludes American Rescue Plan Act's child tax credit expansions, which expired in 2022. **Small** family farms have gross cash farm income (GCFI) less than $350,000. **Retirement** farms have GCFI less than $350,000 and principal operators who report they are retired. **Off-farm occupation** farms have GCFI less than $350,000 and principal operators who report a primary occupation other than farming. **Low-sales** farms have GCFI less than $150,000. **Moderate-sales** farms have GCFI from $150,000 to $349,999. **Midsize** family farms have GCFI from $350,000 to $999,999. **Large** family farms have GCFI from $1 million to $4,999,999. **Very large** family farms have GCFI of $5 million or more.
Source: USDA, Economic Research Service and National Agricultural Statistics Service, 2018–2021 Agricultural Resource Management Survey.

for a farm household by $2,263, or 11.5 percent, compared with current law. Retirement farm households would experience the lowest increase in both dollar amounts and percentage terms. Moderate-sales farm households would experience the highest percentage increase in tax liabilities of 15.6 percent. Very large farms would experience the largest dollar increase in tax liabilities of $27,588, a 5.4-percent increase.

The TCJA temporarily increased the Child Tax Credit from $1,000 per child to $2,000 per child. It also increased the income phaseout threshold for married filers from $110,000 to $400,000 and for single filers from $75,000 to $200,000. Reinstating the more restrictive income thresholds would decrease the share of farm households that receive the Child Tax Credit from 36 to 27 percent. These lower income thresholds would have the largest effect on midsize and large farm households and would approximately halve the share of these households that receive the Child Tax Credit. For households that would continue to receive the Child Tax Credit, the expiring TCJA provision would reduce the amount they receive. Across farm households affected by the expiration, the average Child Tax Credit received would decrease from $3,770 to $1,331, with each farm type and size showing a similar outcome.

Elimination of the qualified business income deduction will affect business owners who typically earn positive net income from their business. Estimates suggest that 45.3 percent of all farm households earned positive farm income and received an average decrease in their tax liability of $2,464 because of the deduction. The total increase in tax liability resulting from the expiration of QBID increases with farm size. Without the QBID, tax liabilities would increase for low-sales farm households by an average of $711 and would increase for very large farm households by an average of $87,219. The percentage increase in tax liability ranges from a 4 percent increase in tax liability for off-farm occupation farm households to a 20 percent increase in tax liability for moderate-sales farm households.

Expiring Estate Tax Provisions Will Increase Percentage of Farm Operator Estates That Owe Tax

The Federal estate tax has applied to the transfer of property at death since 1916, but it has never directly affected a large percentage of farmers or other taxpayers. Since the TCJA, the percent that owe Federal estate tax has dropped to about 0.1 percent of all estates.

One of the primary determinants of the scope of the estate tax is the exemption amount. Only those estates with assets exceeding the estate tax exemption amount must file a Federal estate tax return, and only those returns that have a taxable estate above the exemption amount after deductions for expenses, debts, and bequests to a surviving spouse or charity are subject to tax.

In 2018, the TCJA increased the estate tax exemption amount to $11.18 million. Adjusting for inflation, that amount is expected to grow to $13.95 million by the time it expires at the end of 2025. When that happens, the exclusion amount will revert to the pre-TCJA level adjusted for inflation of $6.98 million.

Return to lower estate tax exemption would affect family farms across the board

	Exemption = $13.95 million			Exemption = $6.98 million		
Farm type	**Percent of estates paying estate tax**	**Average net worth of estates taxed (dollars)**	**Average tax rate (percent)**	**Percent of estates paying estate tax**	**Average net worth of estates taxed (dollars)**	**Average tax rate (percent)**
Small						
Retirement	0.1	35,800,000	11.3	0.5	20,900,000	10.7
Off-farm occupation	0.3	23,800,000	9.7	1.4	15,600,000	11.4
Low sales	0.1	42,500,000	11.2	0.5	19,500,000	13.5
Moderate sales	0.6	36,000,000	20.6	1.5	24,800,000	18.5
Midsize	1.4	29,600,000	14.6	3.3	22,900,000	15.8
Large scale						
Large	2.8	34,500,000	17.8	7.3	21,200,000	19.8
Very large	6.9	53,000,000	28.1	8.5	45,900,000	31.7
All farm households	0.3	32,500,000	14.6	1.0	19,600,000	14.7

Note: **TCJA** = Tax Cuts and Jobs Act. **CTC** = child tax credit. All data adjusted to 2021 values. Baseline excludes American Rescue Plan Act's child tax credit expansions, which expired in 2022. **Small** family farms have gross cash farm income (GCFI) less than $350,000. **Retirement** farms have GCFI less than $350,000 and principal operators who report they are retired. **Off-farm occupation** farms have GCFI less than $350,000 and principal operators who report a primary occupation other than farming. **Low-sales** farms have GCFI less than $150,000. **Moderate-sales** farms have GCFI from $150,000 to $349,999. **Midsize** family farms have GCFI from $350,000 to $999,999. **Large** family farms have GCFI from $1 million to $4,999,999. **Very large** family farms have GCFI of $5 million or more.
Source: USDA, Economic Research Service and National Agricultural Statistics Service, 2018–2021 Agricultural Resource Management Survey.

Since 2011, married couples have been able to take advantage of their combined exemption amounts more fully by electing to allow any unused portion of the deceased spouse's exemption amount to be transferred to the estate of the surviving spouse. This portability provision will be of increased importance if the exemption amount reverts to the pre-TCJA level. A spouse who has died or dies between 2018 and 2025, when exemptions are higher, potentially will have more unused exemption to pass to their surviving spouse. That could be beneficial to the estates that result from the death of the surviving spouse, if that occurs after 2025, when exemptions are lower.

An actuarial estate tax model and ARMS data were used to estimate the number of farm estates that would be created in 2026 as well as the share of those estates that would be required to file a return and would owe Federal estate tax. Under the increased exemption amount, about 0.3 percent of all farm estates are estimated to owe tax, with the share increasing with farm size, ranging from 0.1 for low-sales farms to 6.9 percent for very large farms. Total Federal estate taxes for all taxable farm estates are estimated at $572 million in 2026.

Upon expiration of the higher exemption amount provided in the TCJA, the share of farm estates that would owe tax would increase to 1.0 percent. While the share of retirement, off-farm occupation, low-sales, and moderate-sales farms expected to owe tax would remain under 2 percent, the share of the large and very large farms subject to tax would increase to 7.3 and 8.5 percent respectively. Total Federal estate taxes for all taxable farm estates are expected to more than double to $1.2 billion after the exemption amounts revert to pre-TCJA levels.

This article was drawn from . . .

McDonald, T.M., & Durst, R. (2024). ***An analysis of the effect of sunsetting tax provisions for family farm households*** (Report No. ERR-328). U.S. Department of Agriculture, Economic Research Service.

You might be interested in . . .

McDonald, T. (2023, April 14). ***Federal tax issues***. U.S. Department of Agriculture, Economic Research Service.

McDonald, T.M., & Durst, R. (2021, April 2). Less than 1 percent of farm estates owed federal estate taxes in 2020. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.

Williamson, J., & Bawa, S.G. (2018). ***Estimated effects of the Tax Cuts and Jobs Act on farms and farm households*** (Report No. ERR-252). U.S. Department of Agriculture, Economic Research Service.

U.S. Agriculture Production Grew Steadily From 1948 to 2021 as Productivity Increased

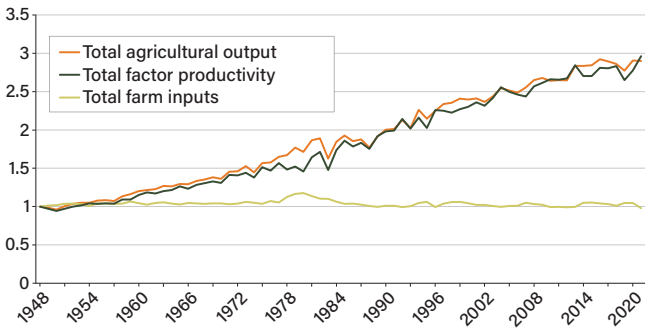
September **2024**

By **Eric Njuki, Sun Ling Wang, Richard Nehring,** and **Roberto Mosheim**

From 1948 to 2021, U.S. agricultural productivity increased at an annual rate of 1.49 percent. To arrive at this rate, USDA, Economic Research Service (ERS) calculates total factor productivity as a measure of the difference in the rate of growth of total output relative to the rate of growth of total inputs. Total output includes crops, livestock, and livestock products. Inputs comprise the factors of production—land, labor, capital, and intermediate inputs (such as fertilizer, pesticides, energy, and purchased custom services). Growth in total factor productivity accounts for the part of output growth that cannot be explained by total input growth.

According to U.S. agricultural productivity statistics maintained by ERS, total output increased at a rate of 1.46 percent per year in the past seven decades, while the growth rate of total inputs declined 0.03 percent per year. The result is that farmers were able to produce more with less. From 1948 to 2021, the amount of land and labor used for farming declined at annual rates of 0.45 percent and 1.93 percent, respectively. Meanwhile, the use of durable capital equipment increased at an annual rate of 0.95 percent, and intermediate inputs increased at a rate of 1.01 percent per year. With a larger cost share in the use of labor and land combined on average, the total input use declined slightly over that period.

U.S. agricultural output, inputs, and total factor productivity, 1948–2021



Source: USDA, Economic Research Service Agricultural Productivity in the U.S. data product.

The primary driver behind agricultural productivity growth has been technological progress from innovations associated with new knowledge, processes, and systems that convert inputs into outputs in farming. Improved seed varieties, genetic enhancements in livestock, advanced equipment and machinery, and more effective fertilizers and pesticides are all examples of technological progress. Also playing a role are structural changes that create scale advantage and substitution of labor with capital, and managerial efficiency that enables producers to combine various inputs to produce the most total output.

As the chart shows, U.S. total factor productivity growth fluctuates from year to year, reflecting transitory events such as unfavorable weather or energy shocks. Nonetheless, productivity tends to return to its long-term trend growth after short-term reductions.

Improved agricultural productivity means the U.S. agricultural sector can compete more effectively with global competitors without reducing farm profits. At the same time, land and labor can shift to uses in other sectors of the economy. Finally, improved agricultural productivity may benefit consumers in the form of lower prices.

The article is drawn from . . .

Wang, S. L., Nehring, R., Mosheim, R., & Njuki, E. (2024). ***Measurement of output, inputs, and total factor productivity in U.S. agricultural productivity accounts*** (Report No. TB-1966). U.S. Department of Agriculture, Economic Research Service.

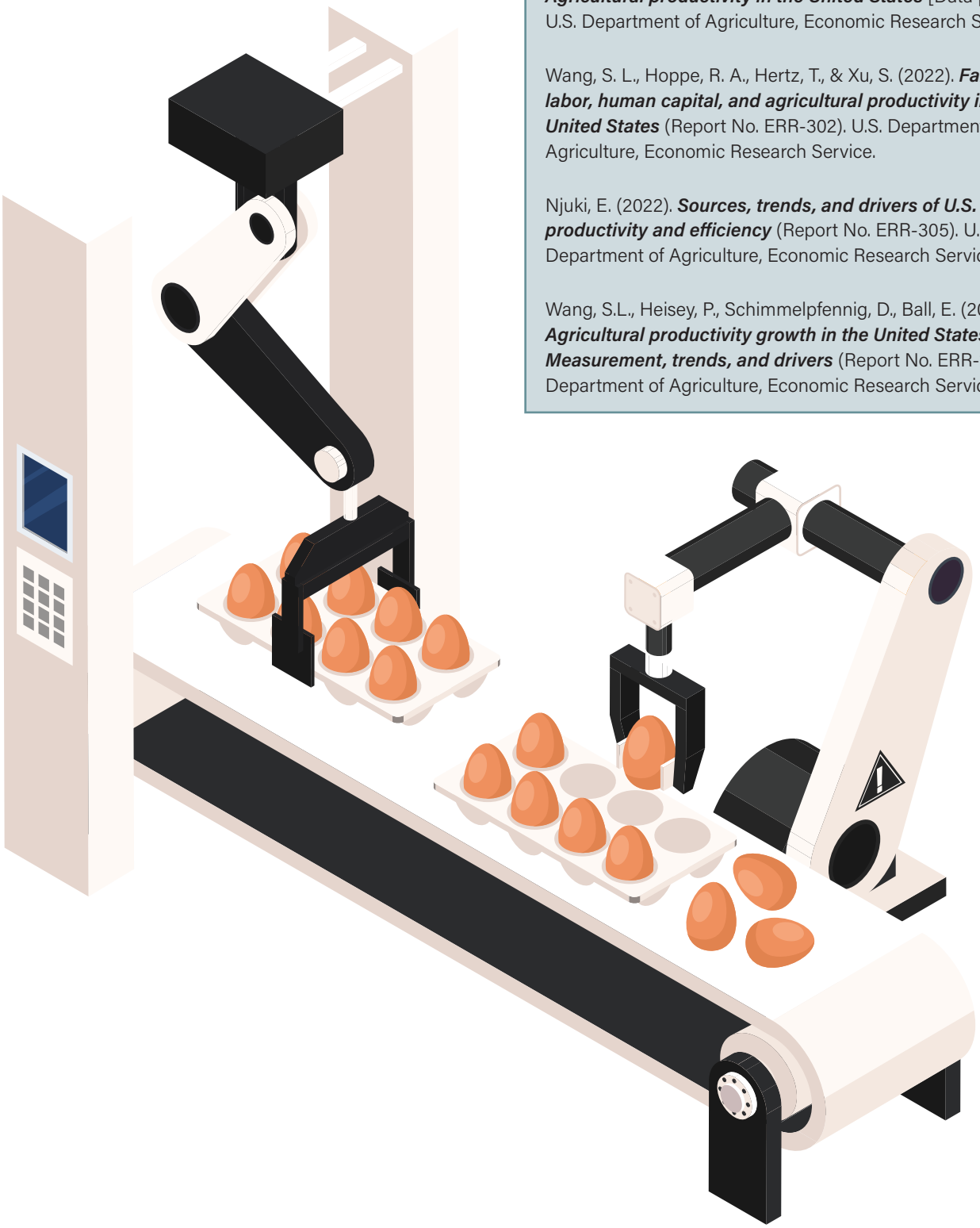
You may also be interested in . . .

Wang, S. L., Njuki, E., Nehring, R., & Mosheim, R. (2024). ***Agricultural productivity in the United States*** [Data product]. U.S. Department of Agriculture, Economic Research Service.

Wang, S. L., Hoppe, R. A., Hertz, T., & Xu, S. (2022). ***Farm labor, human capital, and agricultural productivity in the United States*** (Report No. ERR-302). U.S. Department of Agriculture, Economic Research Service.

Njuki, E. (2022). ***Sources, trends, and drivers of U.S. dairy productivity and efficiency*** (Report No. ERR-305). U.S. Department of Agriculture, Economic Research Service.

Wang, S.L., Heisey, P., Schimmelpfennig, D., Ball, E. (2015). ***Agricultural productivity growth in the United States: Measurement, trends, and drivers*** (Report No. ERR-189). U.S. Department of Agriculture, Economic Research Service



Read More From *Amber Waves*

Fiscal Year 2024

Global Changes in Agricultural Production, Productivity, and Resource Use Over Six Decades

World Agricultural Output and Productivity Growth Have Slowed

ERS Introduces Two New Measures Characterizing Rugged Terrain in the United States

January **2024**

By **John Cromartie** and **Elizabeth A. Dobis**

HIGHLIGHTS

- USDA, Economic Research Service researchers developed two nationwide classifications of census tracts: the Area Ruggedness Scale (ARS) and the Road Ruggedness Scale (RRS). These are thought to be the first detailed ruggedness measures with full coverage for the United States and the first to provide a roads-only version to help study the impact of rugged terrain on travel by car.
- In 2010, the rural portion of residents living in level census tracts was 16.1 percent, while the rural portion living in highly rugged tracts was nearly double that amount at 29.7 percent. However, even in highly rugged census tracts, the majority of residents lived in urbanized areas.
- Nearly 60 percent of residents in highly rugged rural locations lived in low-income census tracts compared with about 42 percent of rural residents in level census tracts.

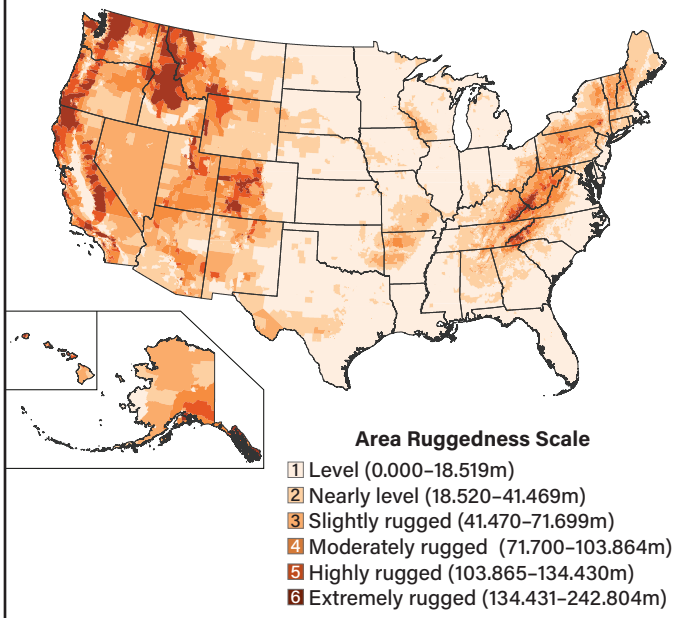
For all its beauty, rugged terrain can have complex and contradictory effects on communities. Whether made up of mountains, canyons, or other landscape features, rugged terrain (defined here as any location with significant variation in elevation) is appreciated by long-term residents and may spur economic growth through tourism and migration. It may also be a barrier to settlement and travel, limiting the amount of land available for development and making it more time-consuming for residents living in or traveling through rugged terrain to access needed goods and services. However, the intersection of rugged terrain and economic activity remains understudied, in part because of the lack of a geographically detailed measure of ruggedness.

To understand rugged terrain as both a benefit and a hindrance, researchers with USDA, Economic Research Service developed two nationwide classifications of U.S. census tracts: the six-level Area Ruggedness Scale (ARS) and the five-level Road Ruggedness Scale (RRS). These scales were created using two versions of a Terrain Ruggedness Index (TRI), a measure of variation in elevation among geographic areas. Using grid cells that average 0.15 square mile in size, the TRIs measure the difference in elevation between each grid cell and its neighboring grid cells. These measures provide a continuum of topographic variation at a very localized scale, ranging from flat to extremely rugged. The researchers calculated the Area TRI using all grid cells nationwide. The Road TRI was created using only the grid cells that contain roads.

Because it is difficult to use grid cell data in many research and program applications, the researchers created data for

census tracts using the mean TRI. Each land-based census tract from the 2010 decennial census was classified into a category within the two ruggedness scales based on the average change in elevation for all terrain (for the Area Ruggedness Scale) and the average change in elevation beneath roads (for the Road Ruggedness Scale). Although the ARS and RRS categories have similar names describing the relative relationship among census tracts, the mean Road TRI values are lower than those for the Area TRI. For example, a census tract with a mean Area and Road TRI value of 70 meters would be considered a highly rugged census tract for the road scale but a slightly rugged tract for the area scale. In other words, the values are comparable within the scales but not between them (see sidebar, "How the Area Ruggedness Scale and the Road Ruggedness Scale Were Created"). In the map of the Area Ruggedness Scale, the light orange color represents the most level land (category 1), and dark orange represents the highest level of ruggedness (category 6). The Appalachian Mountains, the Rocky Mountains, the Pacific Mountain System, and the Sierra Nevada are clearly visible in the ARS. The Southern Coastal areas, Great Plains, and Corn Belt are relatively level. Intermediate terrain, such as the Badlands in North and South Dakota and the Sandhills in Nebraska, also can be identified.

Map of the Area Ruggedness Scale (ARS)

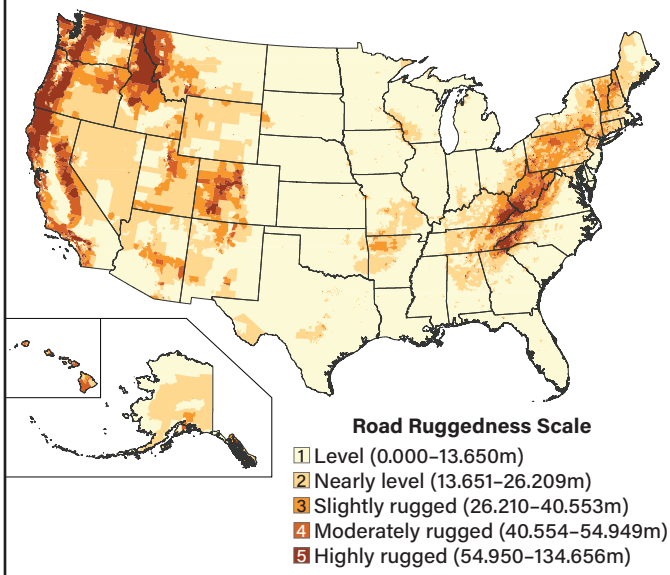


Note: **m** = meters. The **Area Ruggedness Scale (ARS)** is an ordinal scale of topographic variation among U.S. census tracts. The ARS is calculated using the average Area Terrain Ruggedness Index (Area TRI) of grid cells within 2010 census tracts.

Source: USDA, Economic Research Service calculations using U.S. Department of the Interior, U.S. Geological Survey and U.S. Department of Defense, National Geospatial-Intelligence Agency, 7.5 arc-second resolution, Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010); ESRI, ArcGIS StreetMap Premium 2021 Q3 data; and U.S. Department of Commerce, Bureau of the Census, 2010 Census of Population and Housing, TIGER (Topographically Integrated Geographic Encoding and Referencing)/Line boundary files.

The Road Ruggedness Scale has five categories ranging from "level" to "highly rugged" that indicate the changes in elevation beneath roads. The geographic distribution of rugged categories is similar to those of the ARS but with some notable exceptions. Census tracts in the highest category are more numerous in West Virginia, Kentucky, and North Carolina. This reflects the unique landscape of southern Appalachia, where dissected plateaus and the ridge and valley terrain restrict road travel. A similar increase in RRS census tracts in the highest category is seen in the Cascade Mountains in Washington and Oregon. They are lower in average elevation compared with the Rocky Mountains of Colorado, but the RRS shows that traveling by road on level terrain through the Cascades may be more limited.

Map of the Road Ruggedness Scale (RRS)



Note: **m** = meters. The **Road Ruggedness Scale** (RRS) is an ordinal scale of topographic variation along roads in the United States. The RRS is calculated using the average Road Terrain Ruggedness Index (Road TRI) of grid cells within 2010 census tracts.

Source: USDA, Economic Research Service calculations using U.S. Department of the Interior, U.S. Geological Survey and U.S. Department of Defense, National Geospatial-Intelligence Agency, 7.5 arc-second resolution, Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010); ESRI, ArcGIS StreetMap Premium 2021 Q3 data; and U.S. Department of Commerce, Bureau of the Census, 2010 Census of Population and Housing, TIGER (Topographically Integrated Geographic Encoding and Referencing)/Line boundary files.

The Area and Road Ruggedness Scales have discrete categories to help compare levels of topographic variation throughout the United States. However, topographic variation exists on a continuum, with no clear line dividing rugged from nonrugged terrain. For research or program applications in which such a distinction is needed, the choice of which scale to use or categories to include as "rugged" should be made based on the goals of the project. For example, just under 38 percent of land area in the United States is designated as slightly to extremely rugged using the ARS, but these census tracts contained just over 9 percent of the population in 2010. Using the RRS, only slightly less than 15 percent of land is designated as slightly to

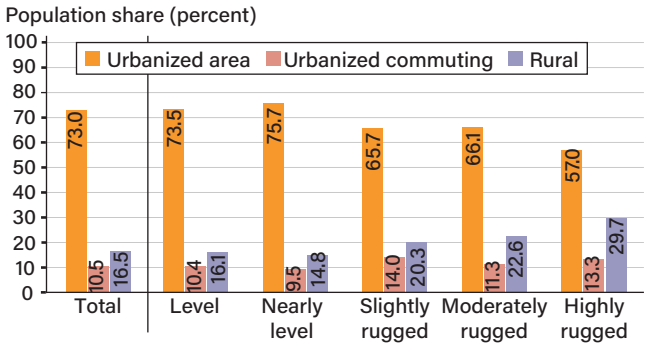
highly rugged, but the population share is higher at nearly 12 percent (see table).

The same pattern exists for the highest ruggedness categories, with the RRS having less than half the land area designated as highly or extremely rugged (3.4 percent compared with 7.9 percent for the ARS) but slightly more people (1.4 percent for the RRS compared with 1.1 percent). These differences between the two scales—less land, more people, and higher population density for the RRS—make sense given that the RRS is built around the Nation's road network. By limiting the measurement of topographic variation to land that contains roads, the RRS can capture travel limitations associated with rugged terrain. Alternatively, the ARS provides a measure of overall topographic variation for a census tract and may be better suited to capturing the scenic attractiveness of rugged terrain.

In locations that are both highly rugged and rural, there may be unique challenges to infrastructure development and accessing to services. This makes it important to document the relationship between ruggedness and rurality, particularly in the context of using road networks. To analyze the relationship between ruggedness and rurality, the researchers classified census tracts into one of three rurality groups according to the Rural-Urban Commuting Area Codes: urbanized area, urban commuting, or rural. Urbanized areas, defined by the Census Bureau as urban cores of at least 50,000 residents, are comparable to central counties of metropolitan areas. The urban commuting group consists of census tracts that are not part of an urbanized area but are economically tied to an urban area through commuting. All other areas are rural. Most U.S. residents lived in urbanized area census tracts in 2010 (73.0 percent). Urban commuting tracts included 10.5 percent of the population, and the remaining 16.5 percent lived in rural census tracts.

As would be expected, the share of the U.S. population living in rural areas increased with the level of road ruggedness, from 14.8 percent in nearly level census tracts to 29.7 percent in highly rugged census tracts in 2010. The increase in the share of rural residents was particularly notable between moderately and highly rugged census tracts, jumping from 22.6 to 29.7 percent. The reverse was true for residents living in urbanized area census tracts. The share of urbanized-area residents in highly rugged census tracts was 57.0 percent, much less than the 75.7 percent in nearly level tracts. However, even in highly

Population shares across rurality groups by Road Ruggedness Scale, 2010



Note: The Road Ruggedness Scale (RRS) is an ordinal scale of topographic variation along roads within census tracts in the United States, ranging from level to highly rugged. For this chart, census tracts were then divided into groups based on Rural-Urban Commuting Area (RUCA) codes: urbanized area (RUCA 1), urban commuting (RUCA 2 and 3), and rural (RUCA 4-10).

Source: USDA, Economic Research Service (ERS) calculations using U.S. Department of the Interior, U.S. Geological Survey and the U.S. Department of Defense, National Geospatial-Intelligence Agency, 7.5-arc second resolution, Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010); ESRI, ArcGIS StreetMap Premium 2021 Q3 data; U.S. Department of Commerce, Bureau of the Census, 2010 Census of Population and Housing, Summary File 1 and TIGER (Topographically Integrated Geographic Encoding and Referencing)/Line boundary files; and ERS, 2010 Rural-Urban Commuting Area Codes.

Comparison of land area and population shares for different ruggedness scale definitions

	Land share (percent)		Population share (percent)	
Ruggedness categories	**ARS**	**RRS**	**ARS**	**RRS**
1–level	40.3	58.1	70.8	65.6
2–nearly level	21.9	27.4	19.9	22.9
3–slightly rugged	20.8	7.7	6.1	7.6
4–moderately rugged	9.1	3.5	2.0	2.5
5–highly rugged	4.5	3.4	0.7	1.4
6–extremely rugged	3.4	—	0.4	—

Note: ARS = Area Ruggedness Scale. RRS = Road Ruggedness Scale. RRS categories range from 1–level to 5–highly rugged and do not include "extremely rugged" found for the ARS. Due to rounding, column totals may not add to 100 percent.
Source: USDA, Economic Research Service calculations using U.S. Department of the Interior, U.S. Geological Survey and U.S. Department of Defense, National Geospatial-Intelligence Agency, 7.5 arc-second resolution, Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010); ESRI, ArcGIS StreetMap Premium 2021 Q3 data; U.S. Department of Commerce, Bureau of the Census, 2010 Census of Population and Housing, Summary File 1 and TIGER (Topographically Integrated Geographic Encoding and Referencing)/Line boundary files; and USDA, Economic Research Service, 2010 Rural-Urban Commuting Area Codes.

Read More From *Amber Waves*

Fiscal Year 2024

Net Migration Spurs Renewed Growth in Rural Areas of the United States

Who is Served by USDA Rural Broadband Projects?

rugged census tracts, more than 50 percent of the population still lived in urbanized areas, indicating that ruggedness does not equate to rurality.

Though ruggedness and rurality are distinct, when they occur simultaneously, unique challenges affecting the well-being of individuals or communities may arise. For example, residents of urban commuting and rural census tracts are likely to travel longer distances than residents of urbanized areas to get the goods and services they need. Adding related transportation challenges that often come with rugged terrain, these residents may find it more difficult to access necessary goods and services. To broadly measure the economic well-being of individuals by rurality and ruggedness, the researchers analyzed the share of the population in each ruggedness level who were also living in low-income census tracts.

Two patterns emerged. First, as road ruggedness increased from level to highly rugged, the share of the population living in low-income census tracts increased for rural locations and

How the Area Ruggedness Scale and the Road Ruggedness Scale Were Created

There were three steps to creating the Area Ruggedness Scale (ARS) and Road Ruggedness Scale (RRS).

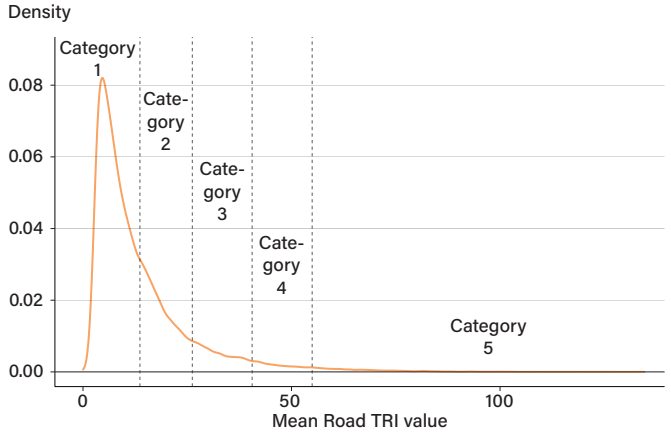
First, Terrain Ruggedness Index (TRI) values were calculated for small, regularly spaced grid cells representing the terrain in the United States. TRI values were calculated by adding the change in elevation between a grid cell and its adjacent neighboring cells. Two sets of TRI values were calculated, one including all territory (the Area TRI) and one including just those grid cells containing roads (the Road TRI). Lower TRI values indicate less change in elevation; higher values indicate areas with higher elevation differences.

Second, the researchers derived aggregate TRI measures for census tracts by taking the average value of all grid cells whose centers were within the boundary of the census tract.

Finally, the researchers classified average census tract Area and Road TRI values into categories using a method known as "head/tail breaks." This method emphasizes values that occur at low rates of frequency but tend to have a high impact and contain much more information than high-frequency values (for an example of a "heavy-tailed" distribution, see the chart in this box). In the case of topographic variation in the United States, there are many more census tracts considered relatively flat on average (high frequency) than those that are more rugged (low frequency), but the rugged census tracts cover a much larger range of values. Therefore, even though there are relatively few rugged census tracts in the tail of the distribution, the head/tail breaks method divides them into more categories to capture their disproportionate impact. The resulting scales, the ARS and RRS, place more emphasis on differentiating among high TRI values (more rugged terrain) than among low TRI values (flatter terrain), helping distinguish different levels of ruggedness. Because the head/tail breaks method closely reflects the distribution of values, the ARS and RRS each have a different number of categories and different cutoff values between categories. Thus, the categories are comparable within each scale but not between the two scales.

Both the discrete ARS and RRS categories and continuous Area TRI and Road TRI values are available from the ERS Area and Road Ruggedness Scales data product. See appendix A of the ERS report Characterizing Rugged Terrain in the United States for more details on the data and methods used to create the TRI values as well as the two ruggedness scales.

Example of a chart showing data with "heavy-tail" distribution



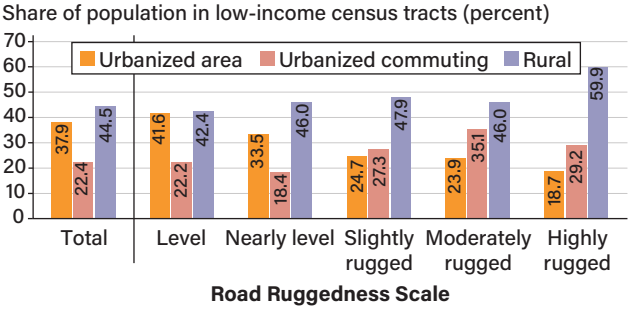
Note: In this chart showing distribution of census tract Road Terrain Ruggedness Index values, the values for categories 4 and 5 show relatively few census tracts associated with them (the tail of the distribution). However, these low-frequency tracts still tend to have high impact and contain much more information than the high-frequency tracts. To capture the disproportionate impact of the low-frequency tracts, researchers use the iterative head/tail breaks method of partitioning the data to divide them into more classification units.

Source: USDA, Economic Research Service calculations using U.S. Department of the Interior, U.S. Geological Survey and U.S. Department of Defense, National Geospatial-Intelligence Agency, 7.5 arc-second resolution, Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010); ESRI, ArcGIS StreetMap Premium 2021 Q3 data; and U.S. Department of Commerce, Bureau of the Census, 2010 Census of Population and Housing, TIGER (Topographically Integrated Geographic Encoding and Referencing)/Line boundary files.

decreased for urbanized area locations. Nearly 60 percent of residents in highly rugged, rural locations lived in low-income census tracts, compared with 42 to 48 percent of rural residents in less rugged census tracts. Conversely, less than 19 percent of residents in highly rugged, urbanized area locations lived in low-income census tracts, compared with nearly 42 percent of urbanized area residents in level census tracts. In urban commuting locations, the share of the population living in low-income census tracts generally increased with ruggedness, but the trend varied more. Second, at every ruggedness level, a greater share of the population living in rural census tracts was also living in a low-income census tract than for urbanized area census tracts.

To the best of ERS's knowledge, the rugged terrain measures and classifications are the first detailed ruggedness measures with full coverage for the United States and the first to provide a roads-only version to help study the impact of rugged terrain on car travel. These measures have the potential to contribute to research on the links between geography and the health and well-being of individuals, especially those living in rural areas. This research may also aid assessments of urban-rural classifications, especially in cases such as the ERS's Frontier and Remote Area Codes, which incorporate travel time by car as a measure of accessibility. Finally, the uses of these new measures will likely extend to research and program applications focused on the benefits of rugged terrain, that is, in gaining a better understanding of the role of scenic amenities as a driver of population and job growth.

Share of population living in low-income census tracts by Road Ruggedness Scale and rurality group, 2010



Note: The Road Ruggedness Scale is an ordinal scale of changes in elevation along roads in the United States, ranging from category 1 (level) to category 5 (highly rugged). Low-income census tracts are defined using criteria from the U.S. Department of Treasury's New Markets Tax Credit program. Census tracts are divided into rurality groups based on Rural-Urban Commuting Area (RUCA) codes: urbanized area (RUCA 1), urban commuting (RUCA 2 and 3), and rural (RUCA 4–10). Only census tracts considered "urban" by the 2010 Food Access Research Atlas (FARA) are included when calculating urbanized area population shares, while only rural census tracts in FARA are used for urban commuting and rural population shares.

Source: USDA, Economic Research Service calculations using U.S. Department of the Interior, U.S. Geological Survey and U.S. Department of Defense, National Geospatial-Intelligence Agency, 7.5 arc-second resolution, Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010); ESRI, ArcGIS StreetMap Premium 2021 Q3 data; U.S. Department of Commerce, Bureau of the Census, 2010 Census of Population and Housing, Summary File 1 and TIGER (Topographically Integrated Geographic Encoding and Referencing)/Line boundary files; USDA, Economic Research Service, 2010 Rural-Urban Commuting Area Codes; and USDA, Economic Research Service, 2010 Food Access Research Atlas data.

This article is drawn from...

Dobis, E. A., Cromartie, J., Williams, R., & Reed, K. (2023). ***Characterizing rugged terrain in the United States*** (Report No. ERR-322). U.S. Department of Agriculture, Economic Research Service.

Dobis, E. A., & Cromartie, J. (2023). ***Area and road ruggedness scales*** [Data product]. U.S. Department of Agriculture, Economic Research Service.

You might also be interested in ...

U.S. Department of Agriculture, Economic Research Service. (2023, September 28). ***Data training webinar: Area and road ruggedness scales*** [Webinar].

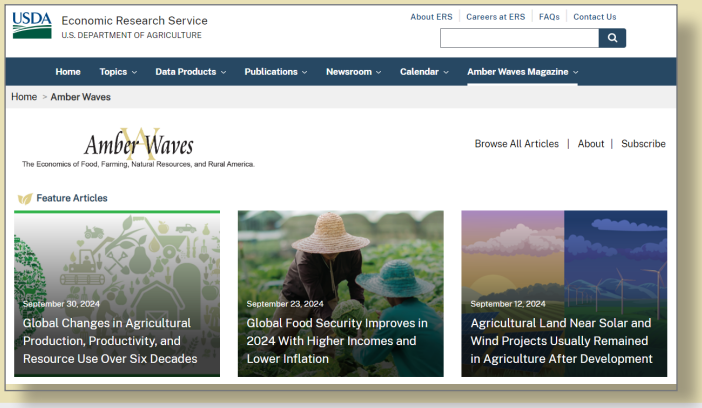
McGranahan, D. (1999). ***Natural amenities drive rural population change*** (Report No. AER-781). U.S. Department of Agriculture, Economic Research Service.

McGranahan, D. (2005, April 1). Behind the data. ***Amber Waves***, U.S. Department of Agriculture, Economic Research Service.

Cromartie, J. (2023). ***Rural-urban commuting area codes*** [Data product]. U.S. Department of Agriculture, Economic Research Service.

Cromartie, J. (2024). ***Frontier and remote area codes*** [Data product]. U.S. Department of Agriculture, Economic Research Service.

Read ERS's award-winning ***Amber Waves*** magazine and Charts of Note online, or have them delivered right to your email inbox!



Amber Waves

The Economics of Food, Farming, Natural Resources, and Rural America

CHARTS of NOTE

Get the newest Charts of Note on the web

Sign up at ers.usda.gov/updates to receive ERS email notifications for *Amber Waves*, Charts of Note, and our latest reports or data of interest.

ers.usda.gov