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Market Impact of Domestic Offset Programs

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Abstract

Three recent reports have estimated the market impacts of domestic offset programs, including afforestation, contained in the American Clean Energy and Security Act (ACES). The magnitude of these estimated impacts motivates this study. We show that with carbon prices as low as $30 per metric ton, a significant number of U.S. crop acres would be used to grow trees and this would cause price increases for some U.S. commodities. Although we present only one carbon price scenario, the modeling approach that we use suggests that the acreage and price impacts we describe here would increase at higher carbon prices.

Keywords: afforestation, agricultural sector, commodity prices, land-use change.

Introduction

The American Clean Energy and Security Act (ACES) creates a cap-and-trade program similar in many respects to the European Union's Emissions Trading Scheme (ETS). An important part of the ACES program is the use of carbon offsets to mitigate many of the costs inherent in such a program. These offsets would be distributed by the U.S. to parties engaged in the mitigation or sequestration of CO_2 or its equivalent (CO_2-e), with one offset being exchanged for every metric ton of CO_2-e that is mitigated or sequestered. The holders of these offsets could then sell them to capped polluters, raising the polluter's emissions cap by one metric ton for every offset they purchase while increasing the revenue potential of the offset practitioners.

ACES creates two separate offset programs: a domestic program managed by the U.S. Department of Agriculture (USDA) and an international program managed by the Environmental Protection Agency (EPA). While each can distribute one billion offset credits annually, the two programs differ significantly. Whereas the specific details regarding the structure and implementation of the international program have been left for the EPA to determine, the domestic program is explicitly defined by the legislation. The legislation specifies which practices qualify and contains a moratorium prohibiting, for at least the first four years of the program, any consideration of indirect land-use change (ILUC) when determining whether the practice actually mitigated or sequestered CO_2-e. The international program contains no such restriction and explicitly requires ILUC to be considered when determining whether the offset practice resulted in a net avoidance of CO_2-e emissions. International offsets can thus be rescinded in part or entirely if the EPA determines that the avoidance practice resulted in additional CO_2-e emissions elsewhere.

One consequence of this difference between the international and domestic offset programs is that it removes uncertainty from the domestic offsets compared to the international offsets, as the latter are more likely to be found not to have produced a net avoidance. This should have the effect of increasing the value of the domestic offset credits over that of the international offset credits. The Energy Information Agency (EIA) projects that the international offsets would be worth only 80% of the value of the domestic offsets in 2020 and 35% of the value in 2030, increasing the likelihood that offset practices would occur inside the U.S. rather than elsewhere (EIA 2009, table ES-1, p. xi). Additionally, the domestic offset program focuses on practices involving agriculture and forestry, creating numerous opportunities for food producers to become offset holders. Based on the different values of the various offset practices, many food producers will find it in their financial interest to take land out of production and devote it entirely to carbon sequestration.

The goal of this paper is to quantify the short-term (2010-2023) economic impacts that the domestic offset program will have on U.S. agriculture and determine how these relate to the projections made in other studies using different methods to determine the same impacts. We pay particular attention to changes in production levels, prices, and export levels of major U.S. food crops. Previous studies, which this study relies upon, have measured the response of U.S. agricultural land use to the implementation of different offset policies and found afforestation to possess the greatest CO_2-e sequestration potential. Any significant afforestation of cropland by food producers could increase cash rents for the cropland remaining in production and increase the respective crop production costs and prices accordingly. In this paper we measure the projected changes in prices resulting from the domestic offset program as well as the responses

by the domestic agricultural sector to these changes. We verify the results using farm- and county-level cash rents data, and compare them to results of a similar study by Baker et al.

The literature review in the next section provides a brief survey of the other studies and reports that look at the domestic offset programs. Following the review, the specific offset program provisions in ACES are analyzed. Then the U.S. Agricultural Model of the Center for Agricultural and Rural Development (CARD) is presented, and the scenario that was used to simulate the economic impact of the ACES domestic offset program on agricultural prices is described. The simulation results are discussed and analyzed, and the final section contains the study conclusions and a discussion of the policy implications with recommendations for further study.

Literature Review

The study of the economic impacts of the domestic offset program has been limited because of the legislation's recent creation. Babcock provides a broad examination of the costs and benefits of ACES to the agricultural sector, although he does not examine the overall impacts of the offset programs. EIA calculates the impacts of ACES on the U.S. economy under various scenarios, including with and without the use of offsets. These scenarios only measure changes to the overall U.S. economy according to gross domestic product (GDP). The Economic Research Service of the USDA calculates the costs and benefits of ACES to the agricultural sector according to gross revenues but does not calculate the impacts on agricultural commodity prices (USDA-ERS 2009, p. 1). Outlaw et al. provide a comprehensive analysis of the overall impacts of ACES on U.S. representative farms. The analysis is dependent on the results of an EPA study, which uses the National Energy Modeling System (NEMS) to simulate the economic

impacts on the agricultural and forestry sectors (EPA 2009, p. v). Baker et al. use FASOM-GHG (the Forest and Agricultural Sector Optimization Model/Greenhouse Gases) to simulate the economic effects of greenhouse gas offsets on the U.S. forestry and agricultural sectors and report a net benefit to the agricultural sector under ACES (Baker et al. 2009, pp. 13-14).

Specific reference should be made to a study by De la Torre Ugarte et al., which analyzes the ACES agricultural offset program and projects small increases in domestic commodity prices and a net gain in domestic cropland. The difference between the results of that study and our results lies in the fact that the former makes several assumptions about the legislation that our study does not make. The first of these is the inclusion of offset practices not found in ACES, such as the growing of dedicated energy crops (De la Torre Ugarte et al. 2009, pp. 2-3). Second, that study also attributes greater value to dedicated energy crop production than to afforestation (figure 3, p. 8) and, as a consequence, projects no afforestation under the offset program (table 4, p. 13). ACES includes no offsets for dedicated energy crop production, and, of the agricultural offset practices found in the Act, afforestation has the greatest sequestration (and thus offset) value in most U.S. regions.

The study of the economic impacts of generic carbon offsets is more extensive, although at present most research investigates a broad variety of offsets rather than those incorporated into ACES. Lewandrowski et al. analyze the economic effects of agricultural and forestry offsets under various price scenarios on the agricultural sector, including changes to land rents and commodity prices. They analyze a generic offset program that bears significant differences to the domestic offset program found in ACES. EPA (2005) provides a very comprehensive and extensive overview of the ability of agricultural and forestry offsets (such as those found in ACES) to mitigate CO_2-e emissions, including data that serves as the basis for the present study.

The EPA study uses FASOM-GHG as its simulation model (EPA 2005, p. ES-1). Its economic analysis is limited to determining how widespread adoption of offset practices would be under various scenarios and how many acres of land would be impacted by these practices. There is no region-specific analysis and, as such, no discussion of how the agricultural sector would be directly affected by adoption of the offset practices. Our current study focuses on the results of the EPA analysis (2005) and those of Baker et al. We attempt to replicate the market price results from Baker et al. using the CARD U.S. Agricultural Model and to evaluate whether the numbers of acres of Corn Belt cropland diverted into afforestation in the EPA analysis is reasonable.

The Title V and Title VII Offset Programs

ACES contains two separate provisions mandating the creation of carbon offset programs: Title V, which creates a domestic offset program overseen by the USDA, and Title VII, which creates an international offset program overseen by the EPA.

Title V

The Title V domestic program provides for offsets to be distributed to entities engaged in carbon mitigation or sequestration in the agricultural, forestry, and manure sectors. Specifically, Section 502(b)(1) allows offset credits to be distributed for programs that represent "verifiable" greenhouse gas emission reductions, avoidance, or increases in sequestration. Section 501(a)(5)(B) includes methane gas in the definition of greenhouse gases. Section 503(b) lists the specific types of practices that are to qualify for offsets under Title V. They are split into categories involving agriculture and grassland, land-use change and forestry, and manure management and disposal.

Section 507(b) requires the exchange of one offset credit for each metric ton of CO_2-e that the USDA determines has been reduced, avoided, or sequestered during a specified time span. Section 504(e)(2) places this time span at 5 years for agricultural practices, 20 years for forestry practices, and 10 years for all others (i.e., manure management). The practitioner may re-enroll in the offset program within 18 months of the time span's completion provided the practice still qualifies under the program. Section 503(c) tasks the secretary of agriculture with updating the list of qualifying offset practices biannually to include additional programs that meet the requirements of Section 502(b)(1). The public may petition the secretary to consider adding particular practices. It must be demonstrated that new practices will result in emission mitigation or avoidance exceeding a pre-existing guideline before they may be added.

Section 504(a)(2)(D) states that, when accounting for carbon leakage resulting from an offset practice, indirect land-use changes are to be excluded until such time as the National Academies of Science prepare a report on the accuracy of ILUC calculations, at which point the EPA administrator and secretary of agriculture shall determine whether ILUC may be used as a factor in calculating the effectiveness of domestic offset practices, among other things. The legislation mandates the release of the report within four years of becoming law.

Title VII

Section 732 mandates the creation of a second offset program that, according to Section 743(a), may be issued to practitioners of CO_2-e mitigation or sequestration practices in countries other than the United States. This international offset program is to be overseen by the EPA administrator. Unlike the domestic offset program, this one does not expressly mandate which programs will qualify for offsets but instead gives the EPA administrator full discretion in

making the determination in Section 733(a)(1). The EPA administrator is also tasked with developing methodologies for determining the effectiveness of an offset in mitigating or sequestering CO_2-e (Section 734(a)(1)) and whether the offset has caused carbon leakage (Section 734(a)(4)). Of particular note is that the moratorium on using ILUC as a factor in calculating leakage found in Section 504(a)(2)(D) is not included here, allowing it to be used immediately at the EPA administrator's discretion.

Model Description

Our study utilizes the CARD U.S. Agricultural Model, which is part of a broad modeling system of world agriculture comprised of U.S. and international multi-market, partial-equilibrium, and non-spatial models. The CARD U.S. Agricultural Model is a modified version of the FAPRI model utilized by FAPRI at Iowa State University. A full description of the model is provided in FAPRI (2004). The U.S. Agricultural Model includes behavioral equations that determine crop planted acreage, domestic feed, food and industrial uses, trade, and ending stocks in marketing years. The model solves for the set of prices that brings annual supply and demand into balance in all commodity markets. The reduced version used in this study only measures the U.S. market and trade impacts. The U.S. model is divided into nine regions with area equations for each crop grown within each region. The crop area planted in each region is determined by the expected net returns of the crop as well as the expected net returns of competing crops in the region and domestic policies such as decoupled payments. Harvested area is typically lower than the planted area and is determined for each state and region. For each modeled crop, the harvested area at the regional level is calculated by adding up the harvested area of the states in the respective region. Crop production in the United States is the sum of crop production in all

modeled regions and is determined by the sum of the area harvested times the yield. Total use is the sum of feed use, seed use, food use and other industrial uses, exports, and stocks.

For crops with by-products, behavioral equations for the by-products are also included, for example, high fructose corn syrup, ethanol, and corn oil from corn, and soybean meal, soybean oil, and biodiesel from soybeans. For each commodity, a market-clearing price is calculated by equating quantity supplied to quantity demanded. The U.S. Agricultural Model includes reduced-form equations, which mimic the trade responses from the world market for grains and oilseeds.

The model is calibrated on the most recent marketing year data for crops and calendar-year data for biofuels. These data sets provide historical data that are used to calibrate the model, and the model provides 15-year projections for supply and utilization of commodities and prices. The model assumes that existing domestic and trade policy variables will remain unchanged in the projection period. Supply and utilization data include production, consumption, net trade, and stocks. Most of the data for the agricultural commodities is obtained from the USDA National Agricultural Statistics Service (USDA/NASS) Online Database. Macroeconomic variables such as real GDP, GDP deflator, and population, which drive the projections, are exogenous to the model.

The Scenario

Baseline

Using the U.S. Agricultural Model, first a baseline is established based on the most recent historical data, which is from 2008, as well as domestic and trade policies. The calendar years in crops correspond to marketing years, with the market year typically being September through

August. The baseline includes 15-year projections, i.e., 2009-2023, by crop for production, consumption, trade, and stocks. Table 1 presents the baseline acres by crop.

Scenario

As briefly described earlier, EPA (2005) uses the FASOM-GHG model to calculate the total sequestration values of a variety of national offset practices under different carbon price scenarios. The practices analyzed include agricultural soil sequestration, afforestation, forest management, and minor practices. The total sequestration potential—in million metric tons of CO_2-e—for each offset practice is calculated per region. In the case of afforestation, the measurements also include the total acres converted to forest by land-use type (cropland and pasture). The total land-use changes resulting from the adoption of offset practices are measured on a national scale rather than by region. Such regional data is necessary when projecting the consequences of large amounts of cropland leaving production because without it factors such as which crops will be impacted and to what extent cannot be determined.

In determining how many acres would be afforested under an offset policy on a regional basis, it is first necessary to know how many acres will be afforested nationwide. We obtained that data from EPA's $30/metric ton carbon price scenario (EPA 2005) and, in constructing our own scenario, assumed the price would be reached by 2023. This is in accordance with the projected carbon prices under ACES or similar cap-and-trade programs in the current literature. We assumed the domestic offset price equals the price of emission allowances (i.e., the price on carbon), in accordance with EIA. The first two projections come from the EPA's analysis of ACES, performed immediately before its passage (EPA 2009, p. 12). While two separate models (the Applied Dynamic Analysis of the Global Economy and the Intertemporal General

Equilibrium models) were used for each projection, the results for each are nearly identical. The third projection comes from the U.S. Congressional Budget Office's analysis of ACES (CBO 2009, table 3, p. 13). The CBO report issues estimates only for 2010-2020. The fourth projection comes from the EIA's analysis of ACES (EIA 2009, table 1, p. 14), which contains estimates for 2010-2030. Results from the Basic Scenario were used. The fifth projection comes from consultant firm CRA International (Montgomery et al. 2009, table 1-1, p. 7), which used three models to produce its estimates: the Multi-Sector, Multi-Region Trade (MS-MRT) model, the Multi-Regional National (MRN) model, and the North American Electricity and Environment Model (NEEM).

The final projection comes from a study by Paltsev et al. on the impacts of a cap-and-trade program similar but not identical to ACES. The study makes projections for a scenario assuming a cap at 287 billion metric tons of CO_2-e per annum, which is similar to the cap amount under ACES (Paltsev et al. 2007, table 4, p. 17). The Emissions Prediction and Policy Analysis (EPPA) model was used to determine the estimates.

To calculate the carbon prices used in our study, the mean projected carbon price for each year was determined from the aforementioned studies. In 2023 this was $31.39/metric ton. This figure was rounded down to $30/metric ton for the sake of simplicity. EPA projects the afforestation of roughly 100 million acres of land throughout the United States under the $30/metric ton carbon price scenario, 50 million of which will occur on cropland (EPA 2005, figure 4-2, pp. 4-6). While regional land-use-change data is not calculated, the study does provide the sequestration potential from afforestation practices for the following regions: Corn Belt, Lake States, Pacific States, Rocky Mountains, South Central, and Southeast (see table 2).

Some modifications to the regional definitions were necessary because of differences in the FASOM-GHG regions used by EPA and the CARD regions that we use. The most important of these was the splitting of the FASOM-GHG South Central region into two new regions: Delta States and Southern Plains. We were able to properly allocate the South Central's sequestration potential to the two new regions by comparing the sequestration rates for each. While the rate for the Delta States is found in Lewandrowski et al., the Southern Plains rate is not available. We were able to calculate it using data from Birdsey and arrived at 2.66 metric tons/acre/year. We calculated the sequestration rate for the Southern Plains that was missing from Lewandrowski using data on regional estimates of forest carbon for fully stocked timberland after cropland reversion to forest (Birdsey 1996, table 3, p. 312). The total carbon sequestered was then converted into metric tons (mt) of CO_2-e/acre/year. We used the 100-year time period because it is the same as that used by the EPA to calculate regional carbon sequestration potential from afforestation (EPA 2005, table 4.A.3, pp. 4-26). The following equation was used:

$$(((205 \text{ thousand lbs C/acre} - 45 \text{ thousand lbs C/acre}) \div 100 \text{ years}) \times 0.453 \text{ kg/lb})$$
$$\times 3.67 \text{ mt } CO_2\text{/mt C}$$

The difference between total carbon in Year 0 and Year 100 is calculated (205 thousand lbs C/acre – 45 thousand lbs C/acre) so that the carbon that is already in the soil at the time of afforestation is not accounted for. This number is then annualized over the time period (100 years) to arrive at an annual sequestration rate in terms of 1,000 lbs/acre. This number is then converted to kilograms (multiplied by 0.453) before being converted from carbon to CO_2-e (multiplied by 3.67). The result is 2.66 metric tons CO_2-e/acre/year.

Based on an analysis of rainfall patterns within the United States and the presence of only 16 million acres of land in the Delta States (dividing the South Central sequestration potential by

the Delta States sequestration rate calls for the conversion of 18 million acres), we calculated that the sequestration potential for the Southern Plains is 28.6 million metric tons (mmt) CO_2-e, with the remaining 200.0 mmt CO_2-e being found in the Delta States (see table 2). While Lewandrowski et al. do not consider afforestation to be viable in the Southern Plains (which encapsulates the states of Texas and Oklahoma) because of its arid climate, figure 1 shows that part of the region receives enough rainfall to support forest growth.

Both Lewandrowski et al. and EPA (2005) show sequestration rates and potentials for regions that we chose not to include in this analysis. While Lewandrowski et al. provided sequestration rates for Appalachia (see table 3), EPA does not include a sequestration potential for that region. This is likely because the majority of the area is already forested and contains little cropland, limiting the amount of afforestation that can occur there. The Northern Plains region was omitted because its arid climate is not conducive to afforestation. In turn we also omitted the Rocky Mountain region, which is found in the EPA analysis, for similar reasons. Table 2 shows the regions remaining in which both the climate and the landscape are conducive to large-scale afforestation.

We now have the regions in which mass afforestation is possible, the sequestration potential and rates from afforestation for those regions, and the number of acres nationwide that would be afforested under a $30/metric ton carbon price scenario. While the number of acres that would be afforested under that scenario is not available in the previously mentioned sources on a regional basis, this can now be calculated by dividing the sequestration potential for each region (table 2) by the corresponding sequestration rate (table 3). The resulting 96.55 million acres of land is the amount that would be afforested under a $30/metric ton carbon price scenario for each region, regardless of current use. To properly account for the amount of cropland that is

afforested, it is necessary to prorate the result according to the 50 million acres of cropland that EPA shows as being afforested (EPA 2005). Here the total number of acres projected to be afforested (96.55 million) is nearly twice that of the number of cropland acres EPA projects (50 million). Therefore, dividing the regional numbers by 1.931 results in the figures found in table 4.

In the scenario, the planted area in each of the six regions was reduced annually throughout the projection period (2010-2023) based on the cropland conversions for 2023. The reduction of acres in each region was distributed across crops based on each crop's share of total area in the baseline. For example, in 2010, the share of corn area in the Corn Belt is 46% so 0.82 million acres (0.46 × 1.786 million acres) were removed from corn acres in this region. Additionally, the reductions are distributed across the states within each region based on the individual state's share in the specific crop area. It is important to note that once the model solves for an equilibrium, the total acres reduced are not equal to the initial reduction in acres presented in table 4 (about 40 million acres versus the initial 50 million acres). This occurs because of two reasons. First, the initial reduction in area results in an increase in crop prices but then the area increases in response to the higher price changes resulting in a lower net decline in total area. Second, reductions are made in the planted acres, but crop production is based on harvested acres, which are lower than planted acres.

Results

The adoption of a policy of rewarding carbon mitigation practices with offset credits would result in the conversion of significant amounts of U.S. cropland to forest between implementation and 2023. This would in turn drive up crop prices as production decreases.

When compared to the baseline, the harvested area for all of the modeled commodities—with the exception of barley and canola—is lower following implementation of the offset program. All commodities experience corresponding increases in price relative to the baseline over the same time period. In the case of barley and canola, a significant portion of area planted is located in the Northern Plains, where no reductions were implemented. Thus, barley and canola area planted increase in response to the increase in crop prices. With the exceptions of oats, barley, and canola, U.S. exports of all of the modeled crops decrease relative to the baseline through 2023 as production decreases and prices increase. All results below reflect the change from the baseline in 2023 unless otherwise noted.

In the U.S. wheat market, the harvested area decreases by 11.4% (5.7 million acres). Wheat production decreases by 12.9% (314 million bushels), and the price of wheat rises by 14.6% ($0.89/bushel). U.S. wheat exports fall by 24.5% (294.5 million bushels).

In the U.S. corn market, the harvested area decreases by 6% (4.6 million acres) by 2023 as farmland in the Corn Belt (Illinois, Indiana, Iowa, Missouri, and Ohio) is converted to forest. Consequently, corn production falls by 5.5% (829.5 million bushels) relative to the baseline by 2023. This results in a 28% increase in corn prices ($1.05/bushel). This diminished supply also has a negative effect on U.S. corn exports, resulting in a decrease of 17% (513 million bushels). Higher corn prices have a significant impact on the price of distillers grains, which increases by 26% ($40.7/ton).

Dramatic changes are also seen in the U.S. soybean market, with the harvested area decreasing by 25.3% (19.6 million acres). This causes soybean production to fall by 25% (913 million bushels) and prices to increase by 20.5% ($2.03/bushel). U.S. soybean exports drop by 63% (650 million bushels) relative to the baseline.

The U.S. rice market is most affected by the offset program. The planted area for rice drops by a substantial 39.4% (1.16 million acres) relative to the baseline. Rice production in turn falls by 38% (89 million cwt) and the price increases by 28.4% ($3.91/cwt). Rice exports decrease by 80% (82.1 million cwt) in 2023 and imports increase by 6.8% (1.7 million cwt) over the same time period.

As the disparity in impacts per crop type suggests, different geographic regions are affected differently by the offset program. The amount of carbon that can be sequestered by one acre of forest depends on the type of trees comprising the forest, which in turn depends on the region in which the forest is grown. Converting cropland to forest in the South Central region results in a substantially higher sequestration rate than doing the same in the Far West region, for example (see table 3). Of the 39.89 million acres projected to come out of crop production by 2023, 22.55 million acres come from the Corn Belt (Illinois, Indiana, Iowa, Missouri, and Ohio). This represents a 25.7% decrease from the baseline in that region. In terms of the greatest percentage of cropland being converted to forest, the Delta States (Arkansas, Louisiana, and Mississippi) experience a 92.7% decrease relative to the baseline (14.84 million acres), leaving a mere 1.22 million acres of cropland by 2023. Together, these two regions are home to 94% of the converted cropland. The amount of available cropland increases slightly in the Central Plains (Colorado, Kansas, and Nebraska), the Northern Plains (Montana, North Dakota, South Dakota, and Wyoming), and the Northeast as land comes into production in response to higher commodity prices, although these amounts (a combined 3.36 million acres) do little to offset the decrease experienced by other states.

More detailed results are provided in Appendix A.

Comparison with Analysis by Baker et al.

Baker et al. project significant increases in the prices of cotton, corn, soybeans, and wheat as a result of ACES offset program adoption, as well as less substantial increases in the prices of sorghum and rice under a $30 per metric ton scenario (Baker et al. 2009, table 1, p. 12). Our results are similar to those produced by Baker et al. (see table 5) especially for cotton and wheat. Baker et al. show only narrow adoption of offset practices in the Southeast region (figure 3, p. 9), which explains why their projected price increases for sorghum and rice are significantly lower than our results. Baker et al. attribute the price increases to afforestation and higher fuel and energy costs. Our study does not account for changes in fuel and energy costs resulting from ACES and we therefore attribute all of the increases shown in our results to afforestation. It is notable that the price increases are similar in both studies despite each using a different model to calculate them (FASOM-GHG in Baker et al., the CARD U.S. Agricultural Model in this study).

Ground-Truthing the Acreage Diversion Results

The results we've presented all depend on assumptions and models of land allocation that are embedded in large-scale models run by the EPA and others. One result that troubled us was a relatively large reliance on Corn Belt cropland for this offset program. At first glance it seemed unlikely that landowners in this region would be willing to divert acres from feed and biofuel production. What follows is a comparison of land-use returns under an offset program with the current return on this land. We take the perspective of a landowner who must choose between renting out land for corn or soybean production against the offset values previously described. The comparison is limited to the Corn Belt, in part because the work depends on the distribution

of cash rents across farms within a county, data that we are comfortable with only for the Corn Belt.

We obtained survey data for cash rents on 3,000 Iowa farms for 2009 from Dr. William Edwards at Iowa State University and used this to determine the coefficient of variation of cash rents in Iowa. We also obtained 2009 cash rental data by county from the USDA National Agricultural Statistics Service and used this to calculate the mean cash rent value across Corn Belt counties. We then used the coefficient of variation from the Iowa data and the mean cash rent from the Corn Belt data to generate a log normal distribution of cash rents for the Corn Belt, (see figure 2). Ideally we would have used a Corn Belt survey of cash rents to generate this distribution but these data were not available to us.

The distribution shown in figure 2 suggests that at an offset value of $117 per acre, 25.3% of cropland in the Corn Belt would have an annual value in an afforestation program greater than its current value as estimated by cash rents in 2009. This is very close to the results upon which the earlier part of this paper is based, which indicate that 25.7% of cropland in the Corn Belt is afforested when the offset value reaches $103, particularly when the higher sequestration rates in the eastern reaches of the Corn Belt are accounted for. In much of Ohio the sequestration rate is 4.44 metric tons CO_2-e/acre/year as opposed to the prevalent Corn Belt sequestration rate of 3.43 metric tons CO_2-e/acre/year that was used in this study.

Conclusions

In this study we calculate the impact of the domestic offset program mandated by ACES on agricultural commodities using the CARD U.S. Agricultural Model. We do this by using projected changes in total land use from the EPA (2005) to determine which crops would be

affected by afforestation, measuring the changes from the CARD 2009 baseline in commodity production, exports, and prices for the eight crop commodities covered by the model and their by-products. We also measure the changes from baseline made to total cropland area per state. These results are then verified via the ground-truthing method and compared to results of Baker et al. produced using the FASOM-GHG model. We found the results in our study to be largely similar to those of Baker et al., confirming that study's findings that ACES, and its domestic offset program in particular, would cause significant increases in the domestic prices of several different agricultural commodities.

The domestic offset program encourages landholders to take cropland out of production and convert it to forest by offering strong financial incentives to do so. In our modeling results, by 2023 a total of 39.89 million acres are converted from cropland in response to the offset program, a decrease of 11.6% from the baseline. Producers of all commodities except barley and canola take land out of their respective crop production, decreasing total supply for each commodity. Prices for all commodities experience upward movement in response, and exports of all except barley fall to meet the shortfall in supply.

This study contains several limitations. We used baseline shares to determine the amount of afforestation within each region, a process that fails to account for variations in land productivity and potential CO_2-e sequestration. Ideally state-specific or even county-specific rates and potentials would have been used to generate more accurate land-use-change predictions. Within those disaggregated results, the conversion rates would depend on agroclimatic conditions and the relative regional return of crops. This would permit the reduction of acres by state and crop by conversion rather than by baseline shares, producing more accurate results. Finally, the analysis does not take into account certain issues that might affect the

conversion decision of farmers. First, the conversion costs of cropland to forest are ignored. These costs can range from $250 to $2,000 (Gorte 2009, pp. 3-4). Furthermore, when the landowner makes the decision to plant a forest, the investment in tree planting can be considered to be irreversible. So there is an option value involved in postponing the decision to plant trees on cropland. On the other side, an income can be locked in by using forward carbon contracts, which lock in the revenue of a landowner and make that revenue independent of crop yield fluctuations. So a wide variety of aspects need to be considered in future research.

Because of the limited scope of this study, several issues are in need of further research. This study projects significant decreases in U.S. exports of soybeans and rice by 2023 from current levels (63.3% and 80.1% respectively). The United States is the world's largest producer and exporter of soybeans and the third-largest exporter of rice (USDA-FAS 2009), and these changes should place significant upward pressure on the global price of both commodities. This study only measures the effects on domestic commodity prices. International prices will not have access to such an escape valve and should increase significantly more than their domestic U.S. counterparts as a result. Research on the increase in international commodities will be an important part of determining how significant of an impact the U.S. afforestation forecast in this study will have on the rest of the world. Additionally, any substantial increase in global prices of these food staples could encourage international farmers to convert forest to cropland, releasing captured emissions in the process. Data on such emissions would be useful, particularly if domestic offsets are allowed to be discounted according to ILUC in the future. Moreover, this study does not cover any impact that the calculated increases in corn and soybean prices would have on meat prices resulting from their widespread use as livestock feed. The significant projected decreases in crop production should have a detrimental impact on the overall

agricultural sector and rural communities as demand for agricultural products (seeds, machinery, labor, etc.) decreases in turn.

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Tables and Figures

Table 1. Baseline planted area of major U.S. crops (million acres)

Marketing year	08/09	14/15	19/20	20/21	23/24
Barley	4.23	4.24	3.90	3.82	3.61
Canola	1.01	1.21	1.30	1.33	1.42
Corn	85.98	90.73	90.29	89.82	88.08
Cotton	9.30	8.27	8.52	8.52	8.69
Oats	3.22	3.32	3.13	3.10	3.03
Peanuts	1.53	1.41	1.41	1.41	1.41
Rice	3.00	2.93	2.95	3.00	2.95
Sorghum	8.28	7.54	7.61	7.58	7.51
Soybeans	75.72	74.98	76.31	76.80	78.39
Sunflower	2.52	2.44	2.43	2.45	2.54
Wheat	63.15	59.54	59.19	59.06	58.30
Total	257.94	256.61	257.04	256.89	255.93

Table 2. Sequestration potential from afforestation by FASOM-GHG and CARD model regions

FASOM-GHG		CARD	
Region	MMT CO_2-e	Region	MMT CO_2-e
Corn Belt	162.5	Corn Belt	162.5
Lake States	14.9	Delta States	200.0
Pacific States	4.7	Far West	4.7
Rocky Mountains	11.8	Lake States	14.9
South Central	228.6	Southeast	12.4
Southeast	12.4	Southern Plains	10.75

Source: EPA 2005, table 4. A.3, p. 4-26.

Table 3. Carbon sequestration rates by region and practice (metric tons CO_2-e/acre/year)

Region	Cropland to forest	Pasture to forest	CAC to grassland	Conventional till to conservation till
Appalachia	5.75	3.43	1.40	0.49
Corn Belt	3.43	3.10	1.79	0.62
Delta States	6.30	3.76	1.85	0.65
Lake States	4.87	4.54	1.55	0.55
Mountain States	0.00	0.00	0.91	0.31
Northeast	4.42	4.09	1.41	0.49
Northern Plains	0.00	0.00	1.38	0.49
Pacific States	2.93	2.93	1.14	0.40
Southeast	5.75	3.43	1.20	0.41
Southern Plains	2.66	2.65	1.44	0.51

Source: Lewandrowski et al. 2004, table 4.2, p. 26. Includes data for Southern Plains that were found in Birdsey but not included in the original Lewandrowski et al. study. See p. 12 for details.

Table 4. Cropland converted to forest (million acres)

	Corn Belt	Delta States	Far West	Lake States	Southeast	South Plains
Year	50%	32%	2%	3%	3%	10%
2010	2	1	0	0	0	0
2011	4	2	0	0	0	1
2012	5	3	0	0	0	1
2013	7	5	0	0	0	1
2014	9	6	0	1	1	2
2015	11	7	0	1	1	2
2016	13	8	1	1	1	3
2017	14	9	1	1	1	3
2018	16	10	1	1	1	3
2019	18	11	1	1	1	4
2020	20	13	1	1	1	4
2021	21	14	1	1	1	4
2022	23	15	1	1	1	5
2023	25	16	1	2	2	5

Table 5. Comparison of projected price increases between Baker et al. and our study

Commodity	Baker results ($30/metric ton)	Our results ($30/metric ton)
Cotton	+9.77%	+10.10%
Corn	+40.76%	+27.60%
Rice	+1.25%	+28.40%
Sorghum	+5.50%	+23.40%
Soybeans	+9.40%	+20.50%
Wheat	+14.23%	+14.60%

Source: Baker et al. 2009, table 1, p. 12.

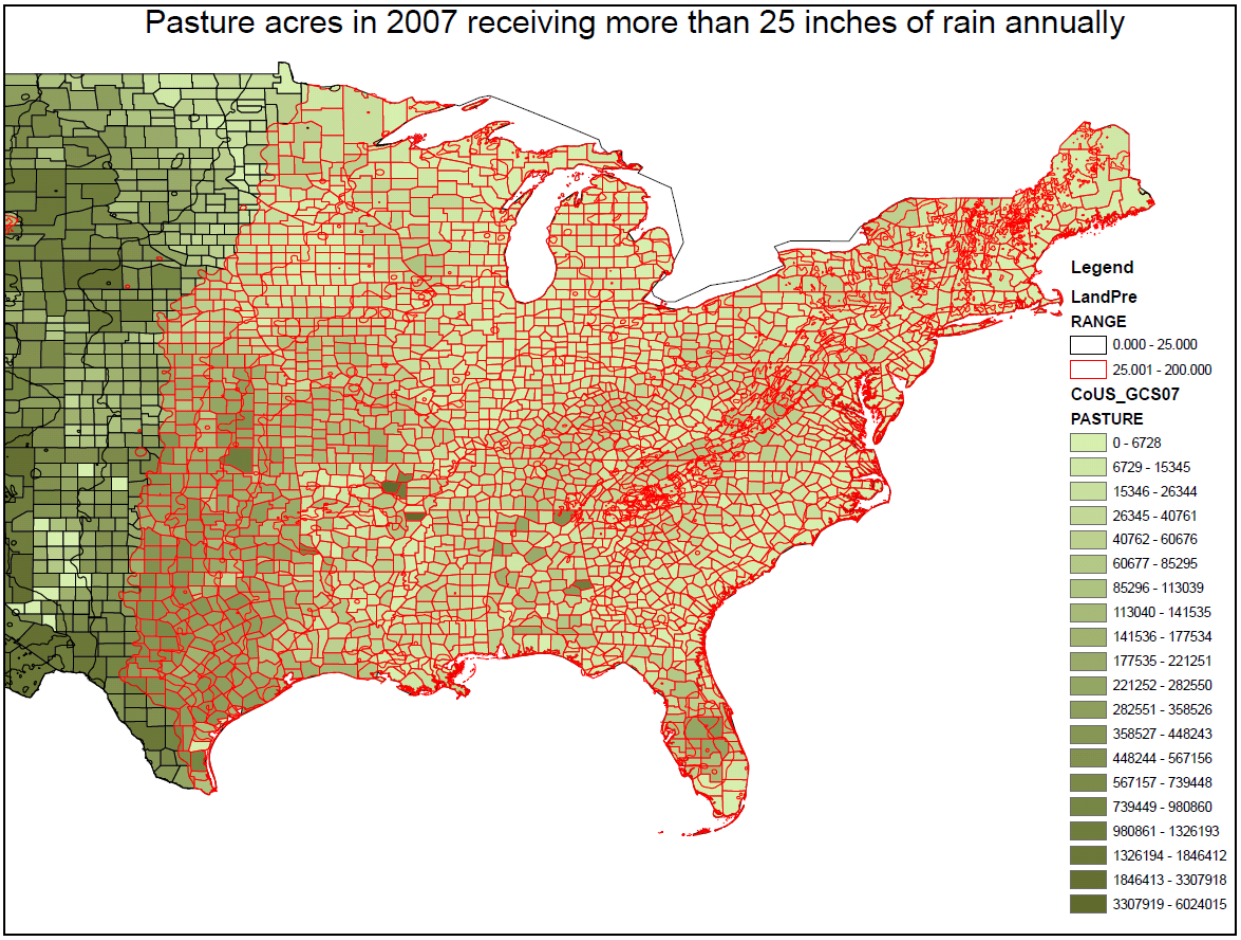

Figure 1. Acres receiving enough rainfall to support afforestation

Source: Dumortier

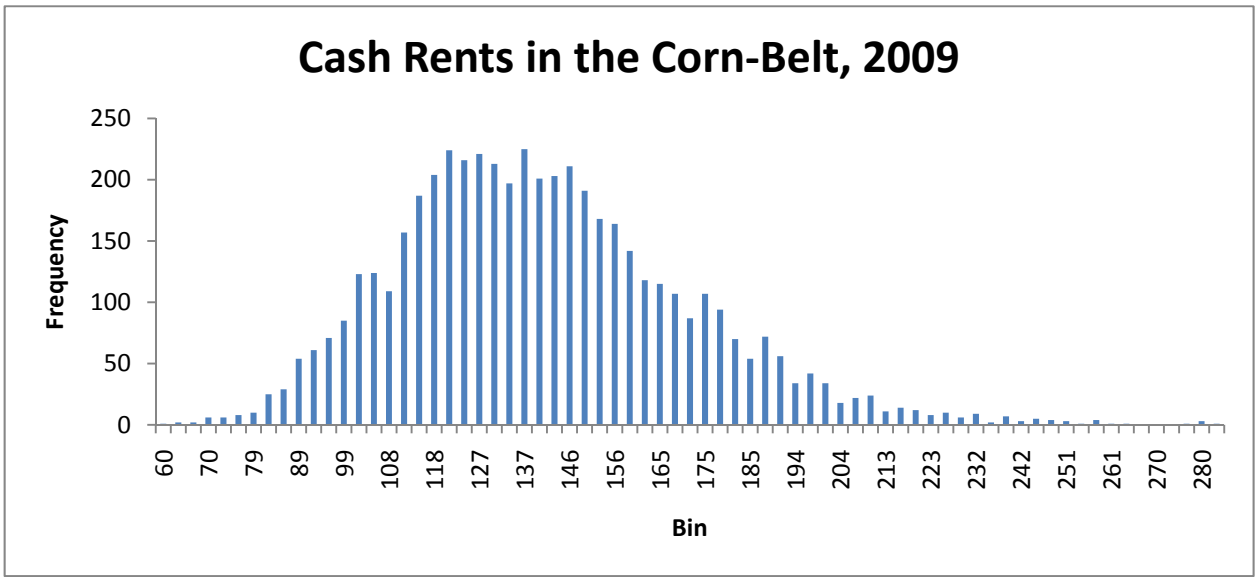

Figure 2. Histogram of cropland cash rent values in the Corn Belt

Appendix A: Detailed Study Results

Total Crops Planted: Change From Baseline

Marketing year	2015	2020	2023
US total	-4.2%	-9.2%	-11.6%
Corn Belt	-9.2%	-20.2%	-25.7%
Illinois	-9.6%	-21.1%	-26.8%
Indiana	-9.8%	-21.4%	-27.2%
Iowa	-8.8%	-19.3%	-24.6%
Missouri	-8.5%	-18.5%	-23.6%
Ohio	-9.9%	-21.7%	-27.6%
Central Plains	0.5%	1.1%	1.4%
Colorado	0.0%	-0.1%	-0.1%
Kansas	-0.3%	-0.6%	-0.7%
Nebraska	1.6%	3.7%	4.9%
Delta States	-32.0%	-70.1%	-89.3%
Arkansas	-34.5%	-75.5%	-96.3%
Louisiana	-29.2%	-64.0%	-81.5%
Mississippi	-30.3%	-66.3%	-84.5%
Far West	-1.5%	-3.2%	-4.1%
Lake States	-0.7%	-1.4%	-1.7%
Michigan	-0.9%	-1.7%	-2.1%
Minnesota	-0.9%	-1.9%	-2.4%
Wisconsin	-0.1%	0.1%	0.4%

Total Crops Planted: Change From Baseline

Marketing year	2015	2020	2023
Northeast	0.9%	2.1%	2.7%
Northern Plains	1.7%	4.1%	5.3%
Montana	0.5%	1.2%	1.4%
North Dakota	1.6%	3.8%	5.0%
South Dakota	2.6%	6.3%	8.4%
Wyoming	1.6%	4.1%	5.5%
Southeast	-1.3%	-2.9%	-3.7%
Alabama	-1.5%	-3.3%	-4.2%
Florida	-0.2%	-1.1%	-1.5%
Georgia	-1.5%	-3.2%	-3.9%
Kentucky	-1.2%	-2.7%	-3.5%
North Carolina	-1.3%	-2.7%	-3.3%
South Carolina	-0.8%	-1.7%	-2.0%
Tennesee	-1.5%	-3.4%	-4.3%
Virginia	-1.5%	-3.4%	-4.4%
Southern Plains	-4.0%	-8.8%	-11.2%
New Mexico	-3.0%	-6.9%	-8.8%
Oklahoma	-5.4%	-12.2%	-15.9%
Texas	-3.5%	-7.5%	-9.5%

US Planted and Idled Area: Change from Baseline

Marketing year	15/16	19/20	23/24
Planted area			
Corn	-2.6%	-4.4%	-4.9%
Soybeans	-11.0%	-19.8%	-25.2%
Wheat	-5.0%	-9.4%	-12.2%
Upland cotton	-8.3%	-13.5%	-16.3%
Sorghum	-4.3%	-7.9%	-10.1%
Barley	1.5%	2.9%	3.9%
Oats	-5.4%	-9.9%	-12.5%
Rice	-17.2%	-31.3%	-39.4%
Sunflower seed	-1.5%	-2.6%	-3.3%
Peanuts	-2.5%	-4.0%	-5.0%
Canola	0.5%	1.0%	1.2%
Sugar beets	-1.6%	-2.7%	-3.2%
Sugarcane harvested	-0.5%	-1.7%	-2.5%
13-crop planted	-5.9%	-10.7%	-13.6%
Hay area harvested	-3.3%	-6.2%	-8.0%
13 crops + hay	-5.4%	-9.8%	-12.5%
Conservation reserve	0.0%	0.0%	0.0%
13 crops + hay + CRP	-4.9%	-9.0%	-11.4%
Double crop area	0.3%	0.6%	0.8%
Total corrected for double crop	-5.0%	-9.2%	-11.6%

US Biodiesel Sector

October-September year	15/16	19/20	23/24
Biodiesel supply and use			
Production	-3.5%	-6.1%	-8.5%
From soybean oil	-5.6%	-9.6%	-13.4%
From canola oil	-1.2%	-1.1%	-0.7%
From other feedstocks	-0.8%	-1.5%	-2.2%
From corn oil	2.2%	5.3%	15.7%
From Lard	-1.7%	-3.1%	-5.2%
From Poultry	-1.6%	-3.0%	-5.1%
From Edible tallow	-1.6%	-3.0%	-5.1%
From Inedible tallow	-1.9%	-3.5%	-5.7%
From Yellow grease	-1.5%	-3.0%	-5.1%
From Other	-0.7%	-1.6%	-3.3%
Net exports	-21.0%	-33.1%	-44.8%
Fuel prices			
Biodiesel rack	2.3%	3.9%	5.5%
#2 diesel, refiner sales	0.0%	0.0%	0.0%
#2 diesel, retail	0.1%	0.1%	0.2%
Tax credit, pre-consumer	0.0%	0.0%	0.0%
Tax credit, other feedstocks	0.0%	0.0%	0.0%
Costs and returns			
Biodiesel value	2.3%	3.9%	5.5%
Glycerin value	0.0%	0.0%	0.0%
Soyoil cost	3.2%	5.3%	7.3%
Other operating costs	0.0%	0.0%	0.0%
Net operating return	-6.5%	-6.8%	-6.7%

US Feed Consumption: Change from Baseline

Marketing year	15/16	19/20	23/24
Corn (mil. bu.)	-3.2%	-4.8%	-8.0%
Sorghum (mil. bu.)	-0.4%	0.4%	4.9%
Barley (mil. bu.)	2.9%	5.2%	8.7%
Oats (mil. bu.)	-0.4%	-1.0%	-0.8%
Wheat (mil. bu.)	4.5%	8.0%	12.9%
Soybean meal (1000 tons)	-0.3%	-0.5%	-0.7%
Sunflower meal (1000 tons)	0.1%	0.2%	0.3%
Cottonseed meal (1000 tons)	-3.6%	-5.6%	-7.5%
Rapeseed meal (1000 tons)	0.4%	0.7%	0.5%
Dist./brewers grains (1000 t)	0.5%	1.0%	9.1%
Corn gluten feed (1000 t)	-0.2%	-0.9%	-0.8%
Corn gluten meal (1000 t)	-1.3%	-3.5%	-4.3%
Corn	-3.2%	-4.8%	-8.0%
Sorghum	-0.4%	0.4%	4.9%
Barley	2.9%	5.2%	8.7%
Oats	-0.4%	-1.0%	-0.8%
Wheat	4.5%	8.0%	12.9%
Grain sub-total	-2.8%	-4.2%	-7.1%
Soybean meal	-0.3%	-0.5%	-0.7%
Sunflower meal	0.1%	0.2%	0.3%
Cottonseed meal	-3.6%	-5.6%	-7.5%
Rapeseed meal	0.4%	0.7%	0.5%
Meal sub-total	-0.3%	-0.5%	-0.8%
Distillers/brewers grains	0.5%	1.0%	9.1%
Corn gluten feed	-0.2%	-0.9%	-0.8%
Corn gluten meal	-1.3%	-3.5%	-4.3%
Corn co-products sub-total	0.3%	0.5%	6.8%
Total feed	-1.8%	-2.8%	-3.9%

US Wheat: Change from Baseline

June-May year	15/16	19/20	23/24
Area			
Planted area	-5.0%	-8.5%	-12.2%
Harvested area	-4.6%	-7.9%	-11.4%
Yield	-0.6%	-1.1%	-1.7%
Supply	-4.9%	-8.5%	-12.5%
Beginning stocks	-4.9%	-9.3%	-14.1%
Production	-5.2%	-8.9%	-12.9%
Imports	1.6%	2.7%	3.5%
Domestic use	-0.1%	-0.2%	-0.3%
Feed and residual	4.5%	8.0%	12.9%
Seed	-5.9%	-9.4%	-13.3%
Food and other	-0.4%	-0.7%	-1.0%
Exports	-9.8%	-16.7%	-24.5%
Total use	-4.6%	-8.0%	-11.7%
Prices, program provisions			
Farm price	5.7%	9.7%	14.6%
Returns and payments			
Gross market revenue/a.	5.1%	8.6%	12.7%
Variable expenses/a.	0.0%	0.0%	0.0%
Market net return/a.	9.9%	16.2%	24.5%

US Corn: Change from Baseline

September-August year	15/16	19/20	23/24
Area			
Planted area	-2.6%	-4.0%	-4.9%
Harvested area	-2.9%	-4.6%	-5.7%
Yield	0.0%	0.1%	0.2%
Supply	-3.4%	-5.6%	-7.4%
Beginning stocks	-8.2%	-15.8%	-24.4%
Production	-2.9%	-4.5%	-5.5%
Imports	0.0%	0.0%	0.0%
Domestic use	-1.5%	-2.4%	-1.8%
Feed and residual	-3.2%	-4.8%	-8.0%
Fuel alcohol	-0.1%	-0.2%	5.6%
HFCS	0.1%	0.2%	0.3%
Seed	-2.9%	-4.4%	-3.8%
Food and other	-0.9%	-1.3%	-1.9%
Exports	-8.4%	-12.3%	-16.8%
Total use	-2.7%	-4.3%	-4.9%
Ending stocks	-10.1%	-17.8%	-29.4%
Under loan	-30.3%	-45.3%	-59.6%
Other stocks	-7.7%	-14.3%	-25.0%
Prices, program provisions			
Farm price	10.0%	17.1%	27.6%
Returns and payments			
Gross market revenue/a.	10.0%	17.2%	27.8%
Variable expenses/a.	0.0%	0.0%	0.0%
Market net return/a.	18.7%	32.7%	56.1%

US Corn Processing: Change from Baseline

September-August year	15/16	19/20	23/24
Corn food, industrial use			
Fuel alcohol	-0.1%	-0.2%	5.6%
HFCS	0.1%	0.2%	0.3%
Glucose and dextrose	-0.7%	-1.2%	-1.7%
Starch	-0.9%	-1.4%	-1.9%
Beverage alcohol	-0.9%	-1.3%	-1.8%
Cereals and other	-0.9%	-1.4%	-1.9%
Total	-0.2%	-0.3%	4.0%
Corn dry milling			
Corn dry milled for ethanol	0.2%	0.4%	6.9%
(Share of total ethanol)	0.2%	0.6%	1.2%
(Share fractionating)	2.0%	4.9%	8.2%
Costs and returns			
Ethanol value	4.0%	7.2%	13.4%
Distillers grains value	9.7%	16.6%	25.2%
Corn cost	10.0%	17.1%	27.6%
Net operating return	-5.4%	-9.4%	-2.1%
Corn wet milling			
Corn wet milled for ethanol	-1.9%	-5.6%	-7.1%
(Share of total ethanol)	-1.9%	-5.4%	-12.1%
Other corn wet milling	-0.4%	-0.6%	-0.8%
Total corn wet milling	-0.9%	-2.1%	-2.6%
Costs and returns			
Ethanol value	4.0%	7.2%	13.4%
Gluten feed value	10.4%	17.9%	27.7%
Gluten meal value	5.7%	9.9%	14.8%
Corn oil value	3.4%	5.7%	7.5%
Corn cost	10.0%	17.1%	27.6%
Net operating return	-5.5%	-9.8%	-7.4%

US Ethanol: Change from Baseline

September-August year	15/16	19/20	23/24
Petroleum fuel prices			
Petroleum, W. Texas interm.	0.0%	0.0%	0.0%
Petroleum, refiners acquisition	0.0%	0.0%	0.0%
Unl. gasoline, FOB Omaha	0.0%	0.3%	-0.3%
Unleaded gasoline, retail	0.3%	0.6%	-1.1%
Ethanol supply and use			
Production	-0.4%	-3.7%	-12.8%
From corn	0.0%	-0.1%	5.7%
From other feedstocks	-3.3%	-4.5%	-5.4%
Cellulosic	-8.0%	-23.2%	-43.2%
Imports (ethyl alcohol)	0.2%	0.1%	0.2%
Domestic disappearance	-0.3%	-2.9%	-8.6%
Conventional	0.0%	0.0%	11.2%
Cellulosic	-8.0%	-23.2%	-43.2%
Other advanced ethanol	-0.2%	-0.1%	-0.1%
Exports (ethyl alcohol)	-4.9%	-5.8%	-72.8%
Ending stocks	-0.8%	-3.5%	-11.1%
Ethanol prices			
Conventional rack, Omaha	4.0%	7.2%	13.4%
AMS spot plant price, Iowa	4.0%	7.2%	13.4%
Cellulosic rack	0.1%	0.1%	1.4%
Other advanced rack	4.0%	7.2%	13.4%
Effective retail	0.3%	0.8%	0.0%
Ethanol/gasoline retail	0.0%	0.3%	1.1%

US Corn Products: Change from Baseline

Marketing year	15/16	19/20	23/24
High-fructose corn syrup			
Production	0.1%	0.2%	0.3%
Domestic use	0.1%	0.3%	0.4%
Net exports	-0.6%	-0.7%	-0.9%
Domestic use per capita	0.1%	0.3%	0.4%
Price, 42% Midwest	2.8%	4.9%	7.7%
HFCS price/refined sugar price	-0.6%	-1.2%	-1.8%
Distillers, brewers grains			
Production (dry equivalent)	0.1%	0.2%	6.4%
From Corn with Oil Extraction	2.2%	5.3%	15.7%
Domestic use	0.5%	1.0%	9.1%
Net exports	-1.8%	-2.9%	-3.6%
Price, Lawrenceburg, IN	9.8%	16.8%	25.5%
Corn gluten feed			
Production	-0.9%	-2.1%	-2.6%
Domestic use	-0.2%	-0.9%	-0.8%
Net exports	-5.2%	-9.3%	-13.8%
Price, 21%, IL points	10.4%	17.9%	27.7%
Corn gluten meal			
Production	-0.9%	-2.1%	-2.6%
Domestic use	-1.3%	-3.5%	-4.3%
Net exports	-0.6%	-1.0%	-1.3%
Price, 60%, IL points	5.7%	9.9%	14.8%
Corn oil			
Production	-0.5%	-1.1%	0.3%
Domestic use	-0.5%	-1.0%	0.7%
Net exports	-0.6%	-1.0%	-1.3%
Ending stocks	-2.9%	-5.2%	-6.1%
Chicago price	3.4%	5.7%	7.5%

US Ethanol Supply and Use (Calendar Year)

Calendar year	2015	2020	2023
Supply and use			
Production	-0.3%	-4.3%	-12.5%
Net imports (ethyl alcohol)	0.8%	0.6%	9.0%
Disappearance	-0.2%	-3.5%	-9.3%
Ending stocks	-0.6%	-3.7%	-10.7%
Production capacity, Jan. 1	0.5%	-1.2%	-7.6%
Fuel prices			
Petroleum, W. Texas interm.	0.0%	0.0%	0.0%
Petroleum, refiners acquisition	0.0%	0.0%	0.0%
Unl. gasoline, FOB Omaha	0.0%	0.4%	0.6%
Unleaded gasoline, retail	0.3%	0.6%	-0.1%
Ethanol rack, FOB Omaha	3.4%	7.4%	9.6%

US Corn Wet Milling for HFCS

September-August year	15/16	19/20	23/24
Corn milled for HFCS	0.1%	0.2%	0.3%
HFCS yield per bu. of corn	0.0%	0.0%	0.0%
Costs and returns			
HFCS value	2.8%	4.9%	7.7%
Gluten feed value	10.4%	17.9%	27.7%
Gluten meal value	5.7%	9.9%	14.8%
Corn oil value	3.4%	5.7%	7.5%
Corn cost	10.0%	17.1%	27.6%
Fuel and electricity cost	0.0%	0.0%	0.0%
Returns - selected costs	-0.4%	-0.4%	-0.4%

US Sorghum Supply and Utilization

September-August year	15/16	19/20	23/24
Area			
Planted area	-4.3%	-7.2%	-10.1%
Harvested area	-4.9%	-8.2%	-11.7%
Yield	-0.9%	-1.7%	-2.8%
Supply	-6.4%	-11.0%	-15.9%
Beginning stocks	-10.0%	-17.9%	-25.6%
Production	-5.8%	-9.8%	-14.2%
Domestic use	-1.7%	-2.2%	-1.5%
Feed and residual	-0.4%	0.4%	4.9%
Food, seed, industrial	-3.8%	-5.6%	-7.2%
Exports	-11.4%	-17.7%	-24.2%
Total use	-5.4%	-9.5%	-13.6%
Ending stocks	-12.0%	-19.8%	-28.3%
Under loan	-43.7%	-63.2%	-78.4%
Other stocks	-11.9%	-19.6%	-28.1%
Prices, program provisions			
Farm price	9.0%	15.1%	23.4%
Sorghum/corn price ratio	-0.9%	-1.7%	-3.3%
Returns and payments			
Gross market revenue/a.	8.0%	13.1%	19.9%
Variable expenses/a.	0.0%	0.0%	0.0%
Market net return/a.	27.4%	43.6%	71.4%

US Barley Supply and Utilization

June-May year	15/16	19/20	23/24
Area			
Planted area	1.5%	2.6%	3.9%
Harvested area	1.5%	2.5%	3.8%
Yield	-0.4%	-0.6%	-0.9%
Supply	-0.1%	-0.2%	-0.5%
Beginning stocks	-2.2%	-4.1%	-6.3%
Production	1.1%	1.9%	2.9%
Imports	-4.1%	-6.3%	-9.5%
Domestic use	0.3%	0.5%	0.8%
Feed and residual	2.9%	5.2%	8.7%
Food, seed, industrial	-0.9%	-1.5%	-2.1%
Exports	5.8%	9.1%	14.9%
Total use	0.8%	1.3%	2.1%
Ending stocks	-2.7%	-4.7%	-7.7%
Under loan	-42.9%	-60.9%	-75.9%
Other stocks	-2.5%	-4.5%	-7.3%
Prices, program provisions			
All barley farm price	8.6%	14.7%	23.5%
Feed barley price	9.4%	16.1%	26.0%
Returns and payments			
Gross market revenue/a.	8.2%	14.0%	22.4%
Variable expenses/a.	0.0%	0.0%	0.0%
Market net return/a.	15.5%	27.3%	46.3%

US Oats Supply and Utilization

June-May year	15/16	19/20	23/24
Area			
Planted area	-5.4%	-9.0%	-12.5%
Harvested area	-6.0%	-10.2%	-14.5%
Yield	0.0%	0.1%	0.3%
Supply	-1.7%	-3.0%	-4.3%
Beginning stocks	-3.8%	-7.3%	-10.8%
Production	-6.0%	-10.1%	-14.2%
Imports	3.2%	5.3%	7.7%
Domestic use	-0.6%	-1.1%	-1.2%
Feed and residual	-0.4%	-1.0%	-0.8%
Food, seed, industrial	-0.9%	-1.3%	-1.7%
Exports	0.0%	0.0%	0.0%
Total use	-0.6%	-1.1%	-1.2%
Ending stocks	-4.7%	-8.2%	-12.1%
Under loan	0.0%	0.0%	0.0%
Other stocks	-4.7%	-8.2%	-12.2%
Prices, program provisions			
Farm price	7.5%	13.3%	21.2%
Returns and payments			
Gross market revenue/a.	7.6%	13.5%	21.6%
Variable expenses/a.	0.0%	0.0%	0.0%
Market net return/a.	18.3%	33.1%	55.5%
ACRE payment/a.	-79.4%	-61.9%	-73.5%

US Soybean Supply and Utilization

September-August year	15/16	19/20	23/24
Area			
Planted area	-11.0%	-18.1%	-25.2%
Harvested area	-11.0%	-18.1%	-25.3%
Yield	0.1%	0.2%	0.2%
Supply	-9.5%	-15.7%	-22.1%
Beginning stocks	9.2%	14.9%	22.7%
Production	-10.9%	-18.0%	-25.1%
Imports	0.0%	0.0%	0.0%
Domestic use	-4.7%	-7.5%	-9.9%
Crush	-3.7%	-5.9%	-8.0%
Seed and residual	-16.4%	-25.5%	-33.2%
Exports	-24.1%	-42.9%	-63.3%
Total use	-11.0%	-18.0%	-25.0%
Ending stocks	10.8%	16.9%	21.3%
Under loan	-33.4%	-48.7%	-60.6%
Other stocks	14.0%	22.1%	28.8%
Prices, program provisions			
Farm price	8.3%	14.1%	20.5%
Illinois processor price	7.6%	12.8%	18.7%
Returns and payments			
Gross market revenue/a.	8.4%	14.3%	20.8%
Market net return/a.	12.4%	21.0%	30.6%
Other indicators			
Soybean/corn price ratio	-1.5%	-2.6%	-5.5%
48% soymeal price/ton	7.5%	12.9%	19.5%
Soyoil price/cwt	3.2%	5.3%	7.3%
Crushing margin/bu.	-7.8%	-11.7%	-15.5%

US Soybean Oil: Change from Baseline

October-September year	15/16	19/20	23/24
Supply	-3.9%	-6.3%	-8.6%
Beginning stocks	-7.0%	-13.4%	-22.2%
Production	-3.7%	-5.9%	-8.0%
Imports	0.0%	0.0%	0.0%
Domestic use	-2.2%	-3.6%	-5.0%
Biodiesel	-5.6%	-9.6%	-13.4%
Food and other	-1.0%	-1.6%	-2.3%
Exports	-12.6%	-15.9%	-18.6%
Total use	-3.6%	-5.8%	-7.9%
Ending stocks	-8.5%	-15.4%	-24.1%
Decatur price	3.2%	5.3%	7.3%

US Soybean Meal: Change from Baseline

October-September year	15/16	19/20	23/24
Supply	-3.7%	-5.9%	-8.0%
Beginning stocks	-2.6%	-4.7%	-6.7%
Production	-3.7%	-5.9%	-8.0%
Imports	0.0%	0.0%	0.0%
Domestic use	-0.3%	-0.5%	-0.7%
Exports	-11.6%	-17.9%	-24.1%
Total use	-3.7%	-5.9%	-8.0%
Ending stocks	-3.1%	-5.2%	-7.2%
Decatur price, 48% protein	7.5%	12.9%	19.5%

US Upland Cotton: Change from Baseline

August-July year	15/16	19/20	23/24
Area			
Planted area	-8.3%	-12.5%	-16.3%
Harvested area	-8.8%	-13.4%	-17.5%
Yield	-0.6%	-0.8%	-0.9%
Supply	-7.8%	-12.3%	-16.2%
Beginning stocks	-3.6%	-7.1%	-10.0%
Production	-9.3%	-14.1%	-18.2%
Imports	0.0%	0.0%	0.0%
Domestic use			
Mill use	-2.6%	-4.8%	-6.9%
Exports	-11.0%	-16.3%	-20.5%
Total use	-9.0%	-13.8%	-17.8%
Ending stocks	-4.5%	-7.8%	-11.5%
Other stocks	-4.5%	-7.8%	-11.5%
Prices, program provisions			
Farm price	4.3%	7.1%	10.1%
N. Europe A index price			
Far East A index price	1.9%	2.8%	3.6%
Adjusted world price	2.5%	3.5%	4.5%
Returns and payments			
Gross market revenue/a.	4.3%	7.2%	10.5%
Market net return/a.	23.2%	35.1%	50.1%
CCP payment/base a.	-59.5%	-100.0%	-100.0%

US Cottonseed Supply and Utilization

Marketing year	15/16	19/20	23/24
Supply	-9.3%	-14.1%	-18.4%
Beginning stocks	-10.6%	-17.4%	-22.6%
Production	-9.2%	-14.0%	-18.2%
Imports	0.0%	0.0%	0.0%
Domestic use	-9.1%	-13.9%	-18.1%
Crush	-3.3%	-5.2%	-6.9%
Other	-16.5%	-24.2%	-30.3%
Exports	-8.0%	-12.4%	-16.3%
Total use	-9.0%	-13.8%	-18.0%
Ending stocks	-12.5%	-18.8%	-24.0%
Prices			
Farm price/ton	7.1%	11.8%	16.9%
Meal price/ton	9.8%	16.9%	25.8%
Oil price/cwt	3.1%	5.1%	7.1%
Crushing margin/ton	1.4%	2.6%	3.8%

US Hay Supply and Utilization

May-April year	15/16	19/20	23/24
Area harvested	-3.3%	-5.6%	-8.0%
Yield	-0.1%	-0.2%	-0.2%
Supply	-4.2%	-7.3%	-10.6%
Production	-3.4%	-5.7%	-8.1%
Beginning stocks	-9.1%	-16.9%	-25.3%
Disappearance	-3.1%	-5.4%	-7.8%
Ending stocks	-11.0%	-18.9%	-27.5%
Prices			
All hay (crop year)	10.9%	19.2%	29.5%
Alfalfa (calendar year)	11.3%	20.3%	31.4%

US Rice Supply and Utilization

August-July year	15/16	19/20	23/24
Area			
Planted area	-17.2%	-28.4%	-39.4%
Harvested area	-17.1%	-28.4%	-39.4%
Yield	0.8%	1.4%	2.1%
Supply	-15.0%	-25.0%	-34.6%
Beginning stocks	-17.2%	-29.5%	-40.6%
Production	-16.5%	-27.4%	-38.1%
Imports	3.1%	5.0%	6.8%
Domestic use	-1.2%	-1.8%	-2.4%
Exports	-32.5%	-56.7%	-80.1%
Total use	-14.3%	-23.9%	-33.3%
Ending stocks	-20.5%	-32.4%	-43.5%
Prices, program provisions			
Farm price	12.2%	20.0%	28.4%
Adjusted world price	3.7%	6.1%	9.0%
Returns and payments			
Gross market revenue/a.	13.0%	21.6%	31.1%
Variable expenses/a.	0.0%	0.0%	0.0%
Market net return/a.	26.6%	44.5%	64.4%

US Long Grain Rice Supply and Utilization

August-July year	15/16	19/20	23/24
Area			
Planted area	-20.8%	-34.5%	-48.3%
Arkansas	-26.8%	-44.5%	-62.5%
California	0.0%	0.0%	0.0%
Louisiana	-27.7%	-46.0%	-64.6%
Mississippi	-28.0%	-46.5%	-65.1%
Missouri	0.4%	0.0%	-1.3%
Texas	26.4%	45.7%	64.9%
Harvested area	-20.7%	-34.4%	-48.2%
Yield	0.2%	0.4%	0.7%
Supply	-18.7%	-31.3%	-43.7%
Beginning stocks	-21.1%	-37.4%	-52.7%
Production	-20.6%	-34.2%	-47.8%
Imports	4.0%	6.5%	8.9%
Domestic use	-1.3%	-2.1%	-2.7%
Exports	-38.1%	-64.4%	-92.0%
Ending stocks	-25.2%	-41.4%	-56.7%
Prices			
Farm price	13.0%	21.5%	30.5%
Milled rice, Gulf	11.3%	18.7%	26.6%

US Medium and Short Grain Rice Supply and Utilization

August-July year	15/16	19/20	23/24
Area			
Planted area	-4.6%	-6.8%	-9.3%
Arkansas	-29.8%	-47.7%	-64.9%
California	1.3%	2.4%	3.3%
Louisiana	-32.0%	-49.8%	-67.3%
Harvested area	-4.6%	-6.8%	-9.2%
Yield	0.6%	0.9%	1.1%
Supply	-4.5%	-6.9%	-9.4%
Beginning stocks	-10.9%	-16.5%	-21.4%
Production	-4.0%	-5.9%	-8.2%
Imports	0.8%	1.1%	1.3%
Domestic use	-0.7%	-1.1%	-1.6%
Exports	-8.5%	-15.5%	-21.0%
Ending stocks	-12.7%	-17.7%	-22.6%
Prices			
Farm price	7.6%	14.0%	20.9%
Milled rice, California	6.9%	12.5%	18.7%

US Peanut Supply and Utilization

August-July year	15/16	19/20	23/24
Area			
Planted area	-2.5%	-3.7%	-5.0%
Harvested area	-1.8%	-2.6%	-3.4%
Yield			
Actual	0.0%	0.0%	0.1%
Supply	-2.0%	-3.0%	-3.9%
Beginning stocks	-2.5%	-4.2%	-5.7%
Production	-1.8%	-2.5%	-3.3%
Imports	0.0%	0.0%	0.0%
Domestic use	-1.5%	-2.3%	-3.0%
Food	-1.0%	-1.6%	-2.1%
Crush	-1.9%	-2.6%	-3.3%
Seed, feed and residual	-3.6%	-5.6%	-7.5%
Exports	-1.8%	-2.7%	-3.6%
Total use	-1.6%	-2.3%	-3.1%
Ending stocks	-3.0%	-4.6%	-6.1%
Prices, program provisions			
Farm price	6.3%	10.4%	14.9%
Returns and payments			
Gross market revenue/a.	6.4%	10.5%	14.9%
Variable expenses/a.	0.0%	0.0%	0.0%
Market net return/a.	25.3%	41.1%	58.8%

US Sunflowerseed Supply and Utilization

Marketing year	15/16	19/20	23/24
Area			
Planted area	-1.5%	-2.4%	-3.3%
Harvested area	-1.4%	-2.4%	-3.2%
Yield	0.0%	0.1%	0.1%
Supply	-1.6%	-2.6%	-3.5%
Beginning stocks	-3.3%	-5.9%	-8.4%
Production	-1.4%	-2.3%	-3.1%
Imports	0.0%	0.0%	0.0%
Domestic use	-0.7%	-1.1%	-1.6%
Crush	0.1%	0.2%	0.3%
Food and residual	-1.7%	-2.9%	-4.1%
Exports	-6.0%	-14.8%	-14.9%
Total use	-1.2%	-2.1%	-2.8%
Ending stocks	-4.0%	-6.6%	-9.2%
Prices, program provisions			
Farm price	3.5%	6.2%	8.6%
Returns and payments			
Gross market revenue/a.	3.6%	6.2%	8.7%
Variable expenses/a.	0.0%	0.0%	0.0%
Market net return/a.	5.7%	10.1%	13.7%

US Canola Supply and Utilization

Marketing year	15/16	19/20	23/24
Area			
Planted area	0.5%	0.9%	1.2%
Harvested area	0.5%	0.9%	1.3%
Yield	0.0%	0.0%	0.0%
Supply	0.2%	0.4%	0.6%
Beginning stocks	-1.3%	-2.3%	-3.3%
Production	0.5%	0.9%	1.3%
Imports	0.1%	0.3%	0.5%
Domestic use	0.4%	0.8%	1.1%
Crush	0.5%	0.9%	1.3%
Seed and residual	-2.4%	-3.8%	-5.1%
Exports	0.2%	0.3%	0.5%
Total use	0.4%	0.7%	1.0%
Ending stocks	-1.5%	-2.5%	-3.6%
Prices, program provisions			
Farm price	3.9%	6.8%	9.7%
Returns and payments			
Gross market revenue/a.	3.9%	6.8%	9.8%
Variable expenses/a.	0.0%	0.0%	0.0%
Market net return/a.	10.2%	17.7%	24.3%

Regional Farm Prices

	15/16	19/20	23/24
Corn			
US	10.0%	17.1%	27.6%
Corn Belt	10.4%	17.8%	28.6%
Central Plains	9.7%	16.6%	26.8%
Delta States	10.3%	17.5%	28.1%
Far West	8.7%	14.9%	23.9%
Lake States	9.8%	16.7%	27.0%
Northeast	9.4%	16.3%	26.6%
Northern Plains	9.8%	16.8%	27.3%
Southeast	10.0%	17.2%	27.8%
Southern Plains	8.2%	13.8%	22.0%
Wheat			
US	5.7%	9.7%	14.6%
Corn Belt	6.4%	10.9%	16.5%
Central Plains	5.8%	9.8%	14.8%
Delta States	6.2%	10.5%	15.7%
Far West	5.3%	8.8%	13.2%
Lake States	5.5%	9.3%	14.0%
Northeast	5.7%	9.7%	14.5%
Northern Plains	5.1%	8.6%	12.9%
Southeast	5.7%	9.8%	14.9%
Southern Plains	5.9%	9.9%	14.8%
Soybeans			
US	8.3%	14.1%	20.5%
Corn Belt	8.4%	14.3%	20.9%
Central Plains	7.8%	13.0%	18.8%
Delta States	8.2%	13.8%	20.2%
Lake States	8.2%	13.8%	20.1%
Northeast	8.0%	13.4%	19.4%
Northern Plains	8.4%	14.3%	20.8%
Southeast	8.1%	13.6%	19.9%
Southern Plains	8.4%	14.0%	20.3%

Regional Farm Prices

	15/16	19/20	23/24
Sorghum			
US	9.0%	15.1%	23.4%
Corn Belt	9.8%	16.4%	25.3%
Central Plains	8.7%	14.6%	22.6%
Delta States	12.2%	20.9%	32.4%
Northern Plains	7.7%	12.7%	19.4%
Southeast	8.8%	14.8%	22.9%
Southern Plains	8.0%	13.2%	20.2%
Cotton			
US	4.3%	7.1%	10.1%
Corn Belt	6.8%	11.5%	16.9%
Central Plains	3.5%	5.5%	7.5%
Delta States	5.5%	9.0%	12.7%
Far West	3.6%	5.8%	8.2%
Southeast	4.4%	7.2%	10.1%
Southern Plains	4.2%	6.9%	9.8%
Rice			
US	12.2%	20.0%	28.4%
California	7.4%	13.5%	20.0%
Missouri	10.4%	16.4%	22.5%
Texas	12.9%	21.5%	30.8%