Measuring Supply-Use of Distillers Grains in the United States

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Introduction

As grain-based ethanol production has expanded in the United States in recent years, so too has the production of distillers grains, a co-product of dry mill ethanol production processes. Distillers grains in its various forms is used in livestock feed rations as a competitive substitute for feedgrains and sometimes soybean meal. This article examines the projected supply and use of distillers grains in the United States during next decade, i.e., from the 2010-11 through 2019-20 feedgrain marketing years, as well as the potential effect of the availability of distillers grains on U.S. corn use. It also provides a preliminary examination of how expanding the proportion of ethanol allowed to be mixed in U.S. fuels from 10% (i.e., E-10), to 11% (E-11) and 15% (E-15) over the next decade would impact U.S. corn supply-demand balances.

This information was first presented at the 14th Annual Distillers Grain Symposium in Indianapolis, Indiana on May 12-13, 2010 (http://www.distillersgrains.org/symposium/), sponsored by the Distillers Grain Technology Council (http://www.distillersgrains.org/). A copy of the original presentation is available on the K-State AgManager.info website (http://www.agmanager.info).

The February 2010 USDA Agricultural Baseline Projections of grain and livestock supply, use and agricultural commodity prices for the 2010 through 2019 period is used as a basis for this analysis. United States corn and livestock supply-use projections were taken "as is" from this source with only minor adjustments. See USDA Agricultural Baseline Projections (http://www.ers.usda.gov/briefing/baseline/).

Key findings of this analysis are as follows:

a) **Adequate Livestock Feed Use Capacity Exists for DDGS**

At current levels of U.S. ethanol production and allowable inclusion levels in U.S. fuel blends (10% or E-10), the U.S. livestock industry appears to have the capacity to make full use of the estimated production of distillers dried grains and solubles (DDGS) in feed rations for the next decade.

- This holds true for the current Renewable Fuels Standard, with 10% fuel blends (E-10) and for the projected increase in U.S. corn-starch ethanol production to 15 billion gallons per year by 2015.
- It also holds true for both E-11 (11% ethanol mixture) and E-15 fuel blends in the next decade should they be allowed in the United States. After adjustment for projected DDGS exports, domestic use of DDGS under E-11 and E-15 is projected to meet 61% and 75%, respectively, of full potential DDGS feed use in the U.S. by the 2019-20 U.S. corn marketing year.
    i. This analysis assumes that 1.3 billion gallons of ethanol and 3.95 million short tons of DDGS are produced for each 1% increase in ethanol allowed in U.S. fuel blends. (note: increased removal of corn oil will likely decrease this tonnage)

b) **Feed Cost Savings from Using DDGS instead of Corn** Assuming that DDGS is a competitive replacement for corn in U.S. livestock feed rations on a 1-to-1 or pound-for-pound basis, and that DDGS are priced at 88.5% of corn on a per pound basis, then the amount of cost savings for domestic

and international livestock feed users from feeding lower cost DDGS versus corn over the 2010-19 period is estimated to be $596 to $686 million annually for E-10, $659 to $746 million annually for E-11, and $913 to $985 million annually for E-15 motor fuel blends.

c) **Impact of E-11 or E-15 on Corn + DDGS Supply-Use Balances** Expansion in allowable ethanol fuel blends from E-10 to either E-11 or E-15 is projected to have a marked impact on total supply and use of both corn and distillers grains. By combining U.S. corn and DDGS (in corn equivalents) into one inclusive supply-use balance sheet, the projected impact and tradeoffs of expanded grain ethanol production and DDGS use can be shown.

- **E-11 Scenario**: Assuming no change in U.S. corn production, ending stocks, or exports from the USDA Agricultural Baseline Projection for the 2010-19 period, expansion in ethanol use (and production) from E-10 to E-11 ethanol blends has a small to moderate impact on U.S. corn supply-use balances over time.

  For E-11 ethanol fuel blends, increases in corn use for ethanol production of nearly 470 million bushels annually are projected to directly offset declines in corn feed and residual use of the same amount. Over the same period, the use of DDGS (measured pound-for-pound as a substitute for corn in terms of "DDGS $_{\text{cn equiv}}$") is projected to increase by 110 million DDGS $_{\text{cn equiv}}$ "bushels" annually. The net result: a tighter corn supply than with E-10 because the increased DDGS bushels don't fully offset reduced corn feeding. Part of the increase in DDGS may replace exports.

- **E-15 Scenario #1**: Assuming no change in U.S. corn production, exports, or ending stocks from the USDA Agricultural Baseline Projection for the 2010-19 period, expansion in ethanol use (and production) from E-10 to E-15 ethanol blends has a very sizable impact on U.S. corn supply-use balances over time.

  i. If E-15 ethanol fuel blends are adopted with no changes in other selected U.S. corn supply-use factors, increases in corn use for ethanol production of nearly 2.32 billion bushels annually are projected to directly offset declines in corn feed and residual use of the same amount (with an even larger decline of 2.52 billion bushels in corn feed and residual use from USDA projections in the 2015-16 marketing year). Over the same period, the use of DDGS is projected to increase by 560 million DDGS $_{\text{cn equiv}}$ "bushels" annually.

- **E-15 Scenario #2**: If E-15 ethanol fuel blends are adopted and lower U.S. corn exports (a decrease of 1.25 bb / year) and U.S. corn ending stocks (a decrease of 500 mb / year from USDA projections) occur, then increases in corn use for ethanol production of nearly 2.32 billion bushels annually are projected to lead to declines of only 510 to 570 million bushels per year in U.S. corn feed and residual usage. Over the same period, the use of DDGS is projected to increase by 560 million DDGS-corn equivalent "bushels" annually. The following sections explain the methods used in this analysis of the impact of U.S. ethanol and DDGS supply and use on U.S. corn supply-use balances.

USDA Agricultural Projections for 2010-2019

As stated by the USDA Economic Research Service (http://www.ers.usda.gov/briefing/baseline/), the USDA Agricultural Projections for 2010-19, released in February 2010, provide long run projections for the United States farm sector for the next decade.

> These annual projections cover agricultural commodities, agricultural trade, and aggregate indicators of the sector, such as farm income and food prices. Important assumptions for the projections include:

- Prospects for the agricultural sector in the near term reflect continuing U.S. and global adjustments to the recession of 2008-09 and the subsequent economic recovery.
- A resumption of steady global economic growth will support increases in consumption, trade, and prices in the longer run.
- Additionally, long run developments for global agriculture reflect continued demand for biofuels, particularly in the United States and the European Union.

Key results in the projections include:

- Prices for corn, oilseeds, and many other crops remain at historically high levels over the next decade.
- The livestock sector continues to make adjustments in the first several years of the projections in response to high grain and soybean meal prices in 2007 and 2008, followed by weak meat demand caused by the global economic recession. The result is lower production at higher prices, which improves net returns and provides economic incentives for moderate expansion in the sector later in the projection period.
- Sustained biofuel demand and strengthening global food demand after the global economic recession provide a major impetus for strengthening cash receipts and moderate gains in net farm income.
- Retail food prices in the United States are projected to rise faster than overall inflation in 2010 through 2012. For the last half of the projection period, U.S. consumer food prices are expected to rise less than the general inflation rate.

Source: http://www.ers.usda.gov/briefing/baseline/

These baseline projections were used "as is" in this analysis with two of exceptions. First, the U.S. Renewable Fuels Standard requirement of increasing grain-based U.S. ethanol use (i.e., and implicitly, ethanol production) to 15 billion gallons annually by year 2015 was explicitly "forced" into the projection of U.S. corn supply-use for the period. Increases in U.S. corn use for ethanol production were directly offset by decreases in U.S. corn feed and residual use to maintain the projections of U.S. corn exports and ending stocks in the base 2010-19 U.S. Agricultural Baseline Projections.

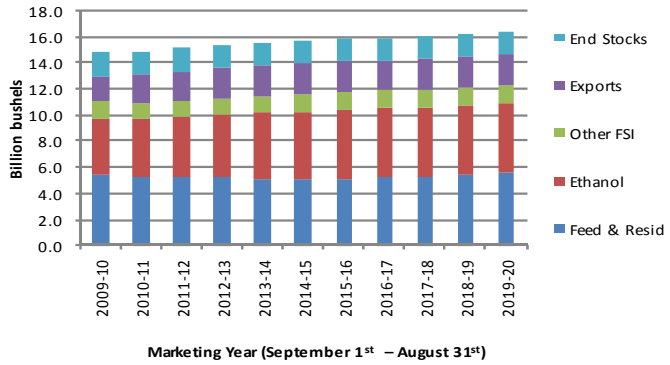
Second, some livestock population estimates by specific species and class were not explicitly identified in the U.S. Agricultural Baseline Projections. Annual estimates of these non-identified livestock species and class populations were developed by estimating the historic relationship between the broader aggregates used in the USDA projection and historic species populations during the 2007-2009 period, and then projecting those relationships forward in the 2010-19 time period.

U.S. Corn Supply-Use Baseline

Adjusted baseline assumptions of U.S. corn use and ending stocks for the 2009-10 through 2019-20 marketing years are given in Figure 1.

Figure 1. Baseline U.S. Corn Supply-Demand

RFS adjusted: Scaled to 15 bln gal. by 2015-16



Corn feed and residual use is projected to average 5.2 billion bushels (bb) per marketing year over this 10 year period, increasing to 5.5 bb in 2019-20 after first declining to 5.0 bb in MY 2014-15. One cause for this decline is a short run downward trend in total livestock numbers in the United States, followed by increasing livestock numbers thereafter. Uses of corn for non-ethanol food, seed and industrial production is projected to average 1.3 bb per marketing year, increasing to 1.4 bb in MY 2019-20. Exports of U.S. corn are projected to average 2.3 bb per marketing year, increasing to 2.4 bb in MY 2019-20. Under current U.S. ethanol production policy (i.e., 15 billion gallons of ethanol used by year 2015, level production thereafter), use of U.S. corn and grain sorghum for ethanol production is projected to increase to 5.357 bb in MY 2015-16. Assuming 50 million bushels (mb) of annual use of U.S. grain sorghum for ethanol, then U.S. corn use for ethanol production would reach 5.307 bb in MY 2015-16 and succeeding years through MY 2019-20. Ending stocks of U.S. corn are projected to average 1.8 bb per marketing year, declining from highs of 1.9 bb in MY 2011-12 and MY 2012-13.

U.S. Ethanol & DDGS Production Under Differing Ethanol Use Policy Scenarios

For each 1% increase of ethanol allowed in U.S. gasoline blends, it is assumed that 1.3 billion gallons more ethanol will be produced each year with requisite increases made in the U.S. Renewable Fuels Standard (RFS). Figure 2 illustrates how 1% increases in allowable U.S. ethanol use in blended fuels (i.e., from E-10 to E-11, etc.) would affect U.S. ethanol production in each U.S. corn marketing year. Figure 2 likely overstates the ability of the U.S. ethanol industry to quickly ramp up production to supply the amount of ethanol required to fully supply higher ethanol blends (say, E-14 or E-15) during the early years of adjustment, but is instructive in showing the potential impact of such changes. Total U.S. ethanol production would be projected to increase to as much as 21.36 billion gallons by corn MY 2015-16 under an E-15 ethanol inclusion policy regime.

Increases in U.S. ethanol production associated with increasing gasoline blend proportions would bring about increases in DDGS production (Figure 3). For each 1.3 billion gallons of addition ethanol produced (i.e., plus 1% of allowable ethanol in gasoline fuel blends), an additional 464.3 mb of corn is used (1.3 bln. gal ÷ 2.8 gallons per bushel). If for each bushel of corn used in ethanol production, 17 pounds of DDGS are produced, then a 1% increase in allowable ethanol mixture in gasoline blends will produce 7,893.9 million pounds of DDGS (3.95 million short tons). According to these calculations, whereas with current U.S. ethanol policy (i.e., E-10), 44.5 million tons of DDGS production from U.S. corn are projected for MY 2015-16, for E-15 an additional 19.7 million tons (i.e., 64.2 million tons) of DDGS would be produced during the same time period.

Figure 2. U.S. Ethanol Production from Corn
Assumed Adjustments from Baseline RFS to E-15

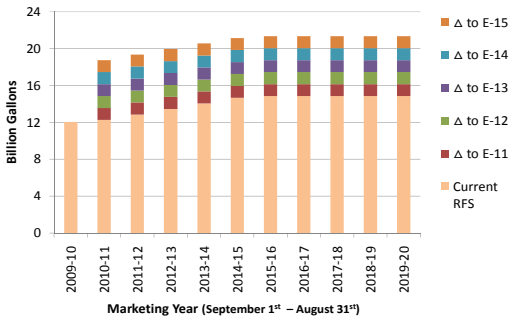
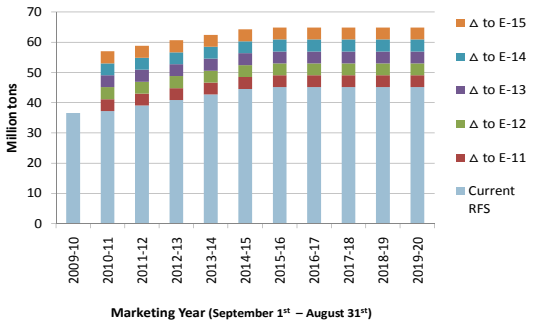


Figure 3. U.S. DDGS Production: Corn Ethanol
Changes from Baseline RFS to E-15 (17 lb DDGS / bu)



Potential U.S. DDGS Use by Livestock Species

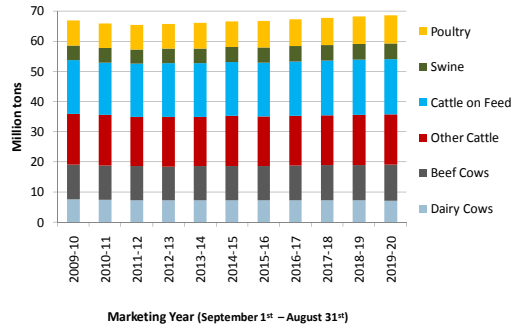
Using U.S. livestock inventory projections provided by and implied from the USDA Agricultural Baseline Projections for 2010-19, and consensus University analyst assumptions about maximum DDGS

inclusion and daily feed intake rates, it is possible to project the maximum amount of DDGS that can be used in feed rations by the U.S. livestock industry annually for the next decade. Figure 4 shows projected maximum U.S. livestock feed use by species groups and selected major categories within those species groupings for the 2010-11 through 2019-20 U.S. corn marketing years. The categories represented include a) dairy cows, b) beef cows, c) other cattle (feeder cattle, beef breeding stock, etc.), d) cattle on feed, e) swine (including both breeding and market swine), and f) poultry (including layers, broilers, pullets and turkeys). Projected species population numbers are available in the USDA Agricultural Baseline Projection for inventories of milk cow numbers, all cattle, beef cows, December 1st hog inventories, federally inspected young chicken and turkey slaughter. The species population numbers not expressly available in the USDA Agricultural Baseline Projection were estimated using historic relationships between meat or egg production by species and livestock populations.

For the period of corn MY 2010-11 through MY 2019-20, average maximum consumption of DDGS for dairy cattle is projected to be 7.3 million tons (mt) (10.9% of total maximum DDGS use). Beef cows' average MY maximum DDGS use is 11.5 mt (17.2% of total DDGS). Average MY maximum DDGS use by other cattle is 16.5 mt (24.7% of total DDGS). Cattle on feed average MY maximum DDGS use is 17.9 mt (26.8% of total DDGS). Average MY maximum DDGS use by swine is 5.0 mt (7.4% of total DDGS). Average MY maximum DDGS use by poultry is 8.7 mt (13.0% of total DDGS). Taken together, beef cattle account on average for 45.9 mt and 68.7% of maximum potential DDGS use in the U.S. during the 2010-19 period.

Figure 4. Potential U.S. DDGS Use - Grouped

Ag Baseline Livestock #s + Base DDGS Feed Rations*



The DDGS inclusion rates and average daily amounts of DDGS fed to dairy cattle, beef cows, other cattle, cattle on feed, breeding swine and market swine (Figures 5a and 5b) were taken from University studies by Berger and Good (2007) and Dooley (2008). The "base" rations represented the amounts used in the primary maximum DDGS use calculations in this study. The "base + 10% DDGS" and "base + 25% DDGS" scenarios represent the maximum DDGS inclusion rates (Figure 5a) and maximum per animal DDGS use (lbs. / head / animal) with 10% and 25% increases in daily DDGS feed intake, respectively.

Figure 5a. DDGS Inclusion %: Dairy, Beef, Swine

% Feed Ration Inclusion Rates

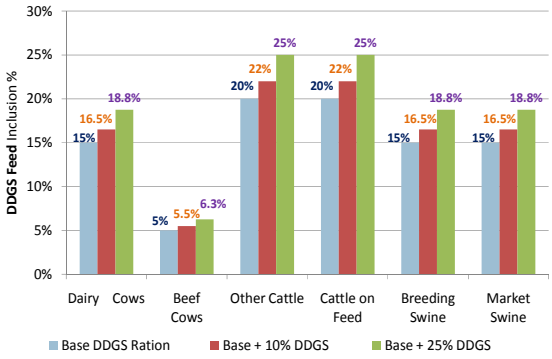
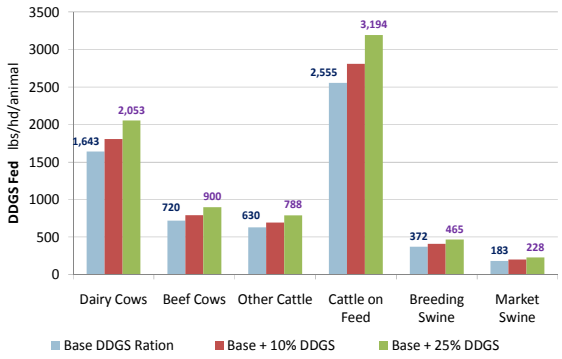


Figure 5b. DDGS Fed: Dairy, Beef, Swine

DDGS Fed (lbs / head / animal)



The DDGS inclusion rates and average daily amounts of DDGS fed to broilers, layers, pullets and turkeys are provided in Figures 6a and 6b (Berger and Good – 2007, and Dooley – 2008). Interpretation of "base" rations versus "base + 10% DDGS" and "base + 25% DDGS" scenarios are identical to those in Figure 5a and Figure 5b above.

Figure 6a. DDGS Inclusion %: Poultry

% Feed Ration Inclusion Rates

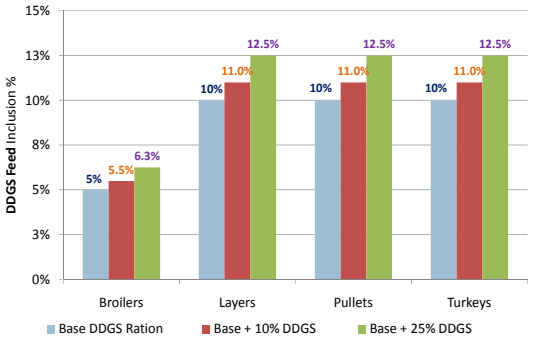
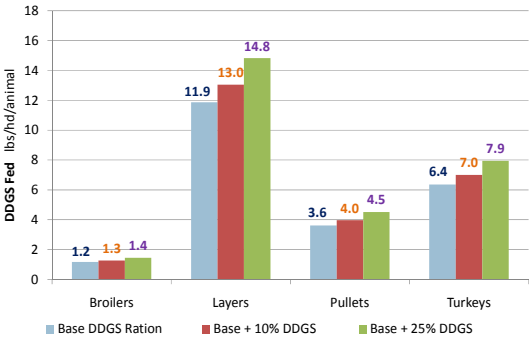


Figure 6b. DDGS Fed: Poultry

DDGS Fed (lbs / head / animal)



Combined Corn and DDGS Supply-Demand Balance Sheet

The combined corn and DDGS supply-demand balance sheet in Table 1 is patterned after the U.S. corn supply-demand tables provided in monthly USDA World Agricultural Supply-Demand Estimates (WASDE) reports (http://www.usda.gov/oce/commodity/wasde/). Along with estimates of corn usage for ethanol production, non-ethanol food, seed and industrial use, exports, and feed and residual use, this table also provides estimates of DDGS production, feed use and exports. A 1 pound of DDGS to 1 pound of corn weight relationship is assumed in this combined table, allowing for DDGS to be represented on the basis of 56 pound or "bushel" equivalent units (i.e., DDGS $_{\text{cn equiv}}$). Four corn marketing years are used to represent the baseline combined "corn + DDGS $_{\text{cn equiv}}$" supply-demand balance sheet in Table 1, i.e., the current 2009-10 marketing year, MY 2012-13, MY 2015-16 (i.e., when the current 15 billion gallon ethanol RFS will be fully implemented), and MY 2009-20 (i.e., the last period in the 10 year projection).

Table 1. U.S. Corn + DDGS Supply-Demand

Base Ethanol & Livestock Feed Scenario (Billion Bushels)

Item	2009-10	2012-13	2015-16	2019-20
Corn Production	13.13	13.53	14.02	14.59
DDGS Prodn. (Corn equivalent)	1.31	1.46	1.61	1.61
Feed & Residual: Corn	5.45	5.19	5.12	5.52
Feed : DDGS (Corn equivalent)	1.03	1.15	1.27	1.27
Ethanol: Corn	4.30	4.81	5.31	5.31
Non-Ethanol FSI: Corn	1.27	1.32	1.34	1.38
Exports: Corn	1.90	2.25	2.33	2.43
Exports: DDGS (Corn equivalent)	0.27	0.31	0.34	0.34
Total Use: Corn+DDGS	**14.22**	**14.72**	**15.36**	**15.90**
End Stocks: Corn + DDGS(=0)	**1.90**	**1.86**	**1.74**	**1.76**
% End S/U: Corn + DDGS	**13.4%**	**12.4%**	**11.1%**	**11.0%**

Table 1 shows that both corn use and DDGS $_{\text{cn equiv}}$ production, feed use and exports are projected to increase until MY 2015-16 (in accordance with the current U.S. RFS), but then remain steady through MY 2019-20. Exports of DDGS are assumed to be 21% of annual DDGS production, following assumptions used by Wisner (2010) in a similar set of distiller's grains supply-demand calculations (http://www.extension.iastate.edu/agdm/crops/outlook/dgsbalancesheet.pdf) on the Iowa State University Agricultural Marketing Resource Center website (http://www.agmrc.org/). As stated above, it is assumed in this supply-demand projection that U.S. corn exports and U.S. corn ending stocks are unchanged from original USDA Agricultural Baseline Projections. It is also assumed that all DDGS $_{\text{cn equiv}}$ produced are used in the same marketing year, i.e., that ending stocks of DDGS $_{\text{cn equiv}}$ do not accumulate in any appreciable amount due to their bio-degradable properties, and are therefore assumed to be equal to zero. Accordingly, only corn ending stocks are assumed to be non-zero in this corn + DDGS $_{\text{cn equiv}}$ supply-demand table.

Although appreciable ending stocks of U.S. DDGS $_{\text{cn equiv}}$ are assumed to not exist (equal to zero), positive amounts of DDGS $_{\text{cn equiv}}$ feed use and exports are accounted for in figuring total use of corn and DDGS $_{\text{cn equiv}}$. Consequently, the % ending stocks-to-use of corn plus DDGS $_{\text{cn equiv}}$ is marginally smaller than for corn alone (i.e., because total use of corn plus DDGS $_{\text{cn equiv}}$ is greater than total use of corn alone).

The conclusion can be drawn that if DDGS is a 1-to-1 substitute for corn in livestock rations, then standard U.S. corn supply-demand balance sheets at least marginally misrepresent livestock feed supply-demand balances in the U.S., implying a larger U.S. ending stocks-to-use ratio situation than actual exists when corn plus DDGS $_{\text{cn equiv}}$ are accounted for.

Projected DDGS Use Vs. Maximum Use Capacity

Current and projected use of DDGS for domestic feed and foreign export is less than either the maximum potential amount of projected U.S. feed use under a) the baseline inclusion rate and daily feed intake scenario, or b) the scenario in which daily feed intake of DDGS are increased by 25% (Figure 7a). Note also that in 2007 the USDA reported the results of a major survey of U.S. livestock feeders, estimating at that time the amount of DDGS being used in livestock feeding rations. The "red" line in Figure 7a projects the amount of DDGS that would be used if U.S. livestock feeders continued to feed DDGS at the lower rates indicated in the 2007 study. Taken together, these results indicate that domestic feed use of DDGS in the U.S. has expanded beyond the amounts farmers indicated they were feeding in the 2007 study, and that they are projected to continue to do so through MY 2019-20. It also indicates that total

DDGS use is less than the amount that would be used at either a) the base DDGS feed ration inclusion and daily feed intake levels, and/or b) with a 25% increase in daily DDGS intake across all livestock species.

Figure 7a. Base & +25% DDGS lb/day Scenario

Current Ethanol Production, Exports (21% DDGS)

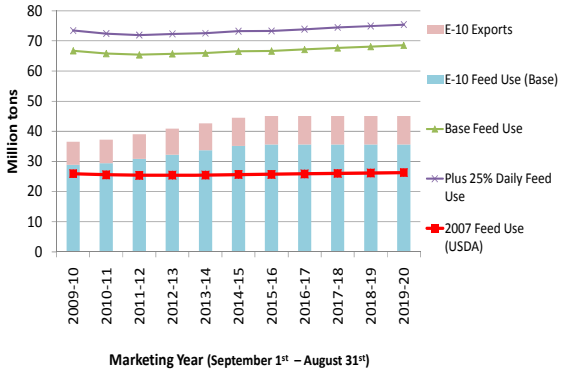
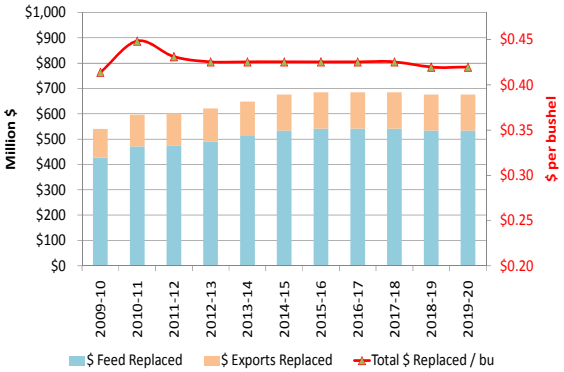


Figure 7b. Value of DDGS Substituting for Corn

DDGS value in Corn vs Own $ (Corn: $3.60-$3.90/bu)



Given the assumption that on a per pound basis U.S. DDGS prices are projected to be 88.5% of U.S. corn prices for the MY 2010-11 through MY 2019-20 period (based on historic price relationships in Iowa from early 2007 through early May 2010), then it can be projected that U.S. livestock feeders and foreign exporters will annually spend $656 million less on DDGS $_{\text{cn equiv}}$ ($518 million less for domestic feed use plus $138 million less for exports) than they would have otherwise spent on corn during the 2010-11 through 2019-20 period (Figure 7b). On a DDGS $_{\text{cn equiv}}$ basis, the difference in cost is averages approximately $0.43 per DDGS $_{\text{cn equiv}}$ bushel.

Impact of E-11 Ethanol Fuel Blends on U.S. Corn + DDGS Supply-Demand

If the allowable inclusion rate for ethanol in blended fuels in the U.S. were to be increased from 10% (i.e., E-10) to 11% (i.e., E-11), increases are projected to occur in ethanol-related use of corn (464 mb per year) and DDGS production (140 mb DDGS $_{\text{cn equiv}}$), feed use (110 mb DDGS $_{\text{cn equiv}}$) and export use (30 mb DDGS $_{\text{cn equiv}}$) (Table 2). Assuming no alterations in USDA Agricultural Baseline Projections for U.S. corn exports and ending stocks, reductions of approximately 470 mb in annual corn feed use would occur. This preliminary analysis assumes that price rationing affects would not significantly alter these categorical corn usage estimates, i.e, corn feed use versus exports, ethanol or other non-ethanol food, seed and industrial usage.

Table 2. E-11 Scenario: U.S. Corn + DDGS S-D

E-11 Ethanol & Base Livestock Feed Scenario (Billion Bushels)

Item	2009-10	2012-13	2015-16	2019-20
Corn Production	13.13	13.53	14.02	14.59
DDGS Prodn. (Corn equivalent)	1.31	+0.14 1.60	+0.14 1.75	+0.14 1.75
Feed & Residual: Corn	5.45	(0.46) 4.73	(0.47) 4.65	(0.47) 5.05
Feed : DDGS (Corn equivalent)	1.03	+0.11 1.26	+0.11 1.38	+0.11 1.38
Ethanol: Corn	4.30	+0.46 5.27	+0.46 5.77	+0.46 5.77
Non-Ethanol FSI: Corn	1.27	1.32	1.34	1.38
Exports: Corn	1.90	2.25	2.33	2.43
Exports: DDGS (Corn equivalent)	0.27	+0.03 0.34	+0.03 0.37	+0.03 0.37
Total Use: Corn+DDGS	**14.22**	+0.45 **15.17**	+0.48 **15.84**	+0.48 **16.38**
End Stocks: Corn+DDGS	**1.90**	**1.86**	**1.74**	**1.76**
% End S/U: Corn+DDGS	**13.4%**	**12.4%**	**11.1%**	**11.0%**

Under the E-11 scenario, projected use of DDGS for domestic feed and foreign export would continue to be less than either the maximum potential amount of projected U.S. feed use under a) the baseline inclusion rate and daily feed intake scenario, or b) the scenario in which daily feed intake of DDGS are increased by 25%. After adjustment for projected DDGS exports, domestic use of DDGS under E-11 is projected to meet 61% of full potential DDGS feed use in the U.S. by the 2019-20 U.S. corn marketing year. It would also be more than would be used under 2007 USDA DDGS feed use estimates (Figure 8a).

Following earlier assumptions that on a per pound basis U.S. DDGS prices are projected to continue to be 88.5% of U.S. corn prices for the coming decade, then under the E-11 scenario it can be projected that U.S. livestock feeders and foreign exporters will annually spend an average of $715 million less on DDGS $_{\text{cn equiv}}$ ($565 million less for domestic feed use plus $150 million less for exports) than they would have spend on corn during the 2010-11 through 2019-20 period (Figure 8b). On a DDGS $_{\text{cn equiv}}$ basis, the difference in cost is averages approximately $0.43 per DDGS $_{\text{cn equiv}}$ bushel.

Figure 8a. E-11 Scenario: DDGS Use Estimates

Base DDGS Feed Rations

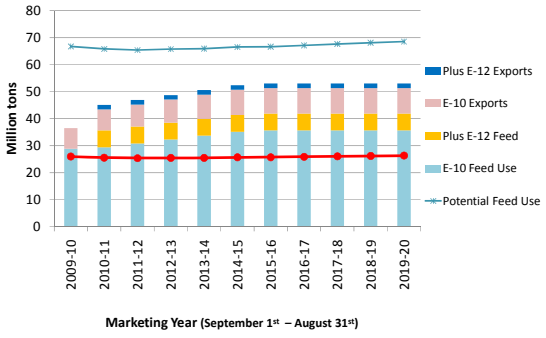
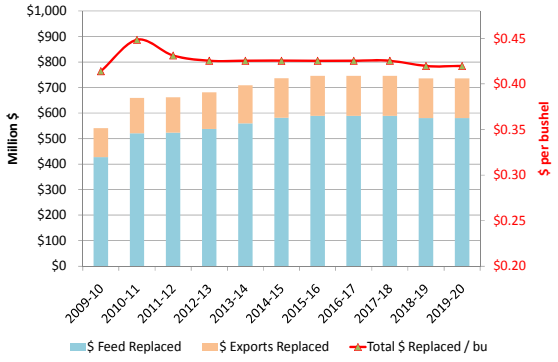


Figure 8b. Value of DDGS Substituting for Corn

E-11 Ethanol Production Scenario (Corn: $3.60-$3.90/bu)



Impact of E-15 Ethanol Fuel Blends on U.S. Corn + DDGS Supply-Demand

If the allowable inclusion rate for ethanol in blended fuels in the U.S. were to be increased from 10% (i.e., E-10) to 15% (i.e., E-15), and if no changes are made in the USDA Agricultural Baseline Projections of U.S. corn exports and ending stocks, then increases are projected for ethanol-related use of corn (2.32 bb per year) and for DDGS production (700 mb DDGS $_{\text{cn equiv}}$), feed use (560 mb DDGS $_{\text{cn equiv}}$) and export

use (140 mb DDGS $_{\text{cn equiv}}$) (Table 3a). Assuming no alterations in USDA Agricultural Baseline Projections for U.S. corn exports and ending stocks, reductions of approximately **2.32 bb** in annual corn feed use would occur (with corn use for ethanol during certain individual years being as much as 200 mb greater). It may be that price competition among users of corn in these various corn and DDGS $_{\text{cn equiv}}$ categories could affect prices in such a way so as to markedly affect this projected corn and DDGS $_{\text{cn equiv}}$ supply-demand outcome. Under this scenario this could especially be the case for livestock feeders, who would be experiencing marked decreases in total available corn plus DDGS $_{\text{cn equiv}}$ supplies if this scenario held true.

Table 3a. E-15 Scenario: No S-D Changes

E-15 Ethanol & Base Feed Scenario (Billion Bushels)

Item	2009-10	2012-13	2015-16	2019-20
Corn Production	13.13	13.53	14.02	14.59
DDGS Prodn. (Corn equivalent)	1.31	*+0.70* 2.16	*+0.71* 2.32	*+0.71* 2.32
Feed & Residual: Corn	5.45	*(2.32)* 2.87	*(2.51)* 2.80	*(2.32)* 3.20
Feed : DDGS (Corn equivalent)	1.03	*+0.56* 1.71	*+0.56* 1.83	*+0.56* 1.83
Ethanol: Corn	4.30	*+2.32* 7.13	*+2.32* 7.63	*+2.32* 7.63
Non-Ethanol FSI: Corn	1.27	1.32	1.34	1.38
Exports: Corn	1.90	2.25	2.33	2.43
Exports: DDGS (Corn equivalent)	0.27	*+0.14* 0.45	*+0.15* 0.49	*+0.15* 0.49
Total Use: Corn+DDGS	**14.22**	**14.72**	**15.36**	**15.90**
End Stocks: Corn+DDGS	**1.90**	**1.86**	**1.74**	**1.76**
% End S/U: Corn+DDGS	**13.4%**	**11.9%**	**10.6%**	**10.4%**

However, if while the allowable inclusion rate for ethanol in blended fuels in the U.S. were to be increased from 10% (i.e., E-10) to 15% (i.e., E-15), offsetting changes are allowed in the USDA Agricultural Baseline Projections of U.S. corn exports and ending stocks, the outcome for U.S. corn usage could be altered significantly. Assuming the same projected increases in ethanol-related use of corn (2.32 bb per year) and DDGS production (700 mb DDGS $_{\text{cn equiv}}$), feed use (560 mb DDGS $_{\text{cn equiv}}$) and export use (140 mb DDGS $_{\text{cn equiv}}$) as in the previous E-15 scenario (see Table 3a), but flexibility in corn exports and ending stocks yields a markedly different U.S. corn plus DDGS $_{\text{cn equiv}}$ supply-demand outcome in Table 3b. If on a MY basis U.S. corn exports are allowed to decrease by 1.25 bb annually and U.S. corn ending stocks are allowed to decrease by 500 mb annually, then the negative impact of increased corn-ethanol use and increased DDGS production on U.S. livestock feed use is markedly reduced from the scenario in Table 3a. Assuming these alterations in USDA Agricultural Baseline Projections for U.S. corn exports and ending stocks, reductions of approximately 57 mb in annual corn feed use would still occur.

Whereas in Table 3a, price pressure from domestic livestock feed users to maintain their level of corn use may be expected over time, in this scenario export buyers of U.S. corn and DDGS $_{\text{cn equiv}}$ are likely to be the parties "contending for bushels" to avoid such a drastic decrease in U.S. corn export usage. Taken together, these results indicate that if E-15 ethanol fuel use rules were adopted, it is likely that strong price competition will occur for the remaining limited supplies of U.S. corn and DDGS $_{\text{cn equiv}}$ between domestic livestock feeders, foreign corn export buyers, domestic ethanol producers and even domestic non-ethanol FSI users. All else being equal, the approval of E-15 would likely tighten price competition for U.S. corn and DDGS $_{\text{cn equiv}}$, and tend to "push" or allocate U.S. corn ethanol supplies to those segments of the corn use industry that find it most profitable to use U.S. corn and are therefore able to bid the most for U.S. corn supplies.

Table 3b. E-15 Scenario + 1.75 bb. S-D Δ's

E-15 Ethanol & Base Feed Scenario (Billion Bushels)

Item	2009-10	2012-13	2015-16	2019-20
Corn Production	13.13	13.53	14.02	14.59
DDGS Prodn. (Corn equivalent)	1.31	+0.70 2.16	+0.71 2.32	+0.71 2.32
Feed & Residual: Corn	5.45	(0.51) 4.62	(0.57) 4.55	(0.57) 4.95
Feed : DDGS (Corn equivalent)	1.03	+0.56 1.71	+0.56 1.83	+0.56 1.83
Ethanol: Corn	4.30	+2.32 7.13	+2.32 7.63	+2.32 7.63
Non-Ethanol FSI: Corn	1.27	1.32	1.34	1.38
Exports: Corn	**1.90**	(1.25) **1.00**	(1.25) **1.08**	(1.25) **1.18**
Exports: DDGS (Corn equivalent)	0.27	+0.14 0.45	+0.15 0.49	+0.15 0.49
Total Use: Corn+DDGS	**14.22**	+1.51 **16.23**	+1.55 **16.91**	+1.54 **17.44**
End Stocks: Corn+DDGS	**1.90**	(0.49) **1.37**	(0.50) **1.24**	(0.50) **1.26**
% End S/U: Corn+DDGS	**13.4%**	**8.4%**	**7.4%**	**8.2%**

Under the E-15 scenario, projected use of DDGS for domestic feed and foreign export would continue to be less than either the maximum potential amount of projected U.S. feed use under a) the baseline inclusion rate and daily feed intake scenario, or b) the scenario in which daily feed intake of DDGS are increased by 25%. After adjustment for projected DDGS exports, domestic use of DDGS under E-15 is projected to meet 75% of full potential DDGS feed use in the U.S. by the 2019-20 U.S. corn marketing year. Use of DDGS would also be more than the amount estimated under 2007 USDA DDGS feed use estimates (Figure 9a).

Following earlier assumptions that on a per pound basis U.S. DDGS prices are projected to continue to be 88.5% of U.S. corn prices for the coming decade, then under the E-15 scenario it can be projected that U.S. livestock feeders and foreign exporters will annually spend an average of $957 million less on DDGS $_{\text{cn equiv}}$ ($756 million less for domestic feed use plus $201 million less for exports) than they would have spend on corn during the 2010-11 through 2019-20 period (Figure 9b). On a DDGS $_{\text{cn equiv}}$ basis, the difference in cost is averages approximately $0.43 per DDGS $_{\text{cn equiv}}$ bushel.

Figure 9a. E-15 Scenario: DDGS Use Estimates

Base DDGS Feed Rations

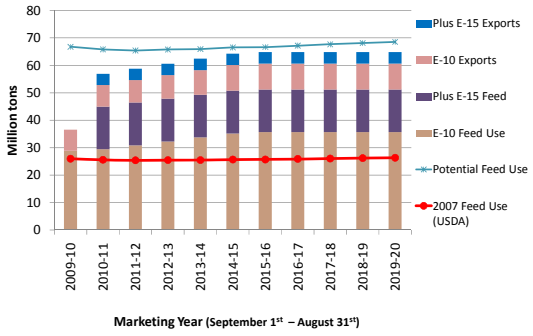
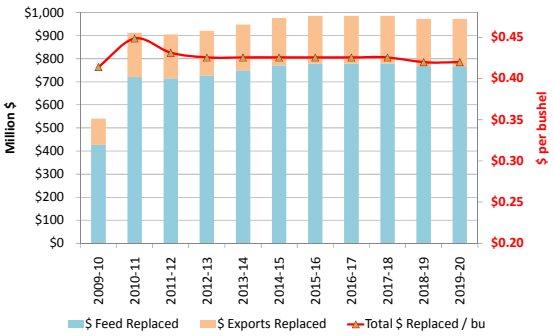


Figure 9b. Value of DDGS Substituting for Corn

E-15 Ethanol Production Scenario (Corn: $3.60-$3.90/bu)



Conclusions

This analysis addresses a number of current, key issues facing the U.S. corn, ethanol, livestock and export industries. First, findings indicate that at current levels of U.S. ethanol production and allowable inclusion levels in U.S. fuel blends (10% or E-10), adequate livestock feed use capacity seems to exist to make full use of projected DDGS production over the next decade. This finding also holds true for possible expansion to E-11 ethanol fuel blends. Although by calculations adequate use capacity exists for DDGS use under an E-15 ethanol fuel blend scenario, the potential market for DDGS use is closer to being saturated, and would be more vulnerable to local/regional oversupply and saturation problems near DDGS production centers.

This analysis also shows that DDGS may be profitably used as a competitive replacement for corn in U.S. livestock feed rations if DDGS can be substituted for corn on at least a 1-to-1 or pound-for-pound basis, and if DDGS continues to be priced at a discount to corn on a per pound basis. However, under an E-15 scenario, tight competition may exist among livestock feeders, exporters, and other users of corn and DDGS to purchase these products for feed use versus other purposes (depending on how market forces work to ration tight feed supplies). This competition between corn and DDGS users may affect or eliminate the DDGS price discount to corn in the future.

Expansion in allowable ethanol fuel blends from E-10 to either E-11 or E-15 is projected to have a marked impact on total supply and use of both corn and distillers grains. The larger the allowable inclusion rate for ethanol in blended fuels, the more potential exists for intense price competition and fundamental restructuring of the U.S. corn supply-demand balance sheet in ways and means not even contemplated in this limited analysis. Finally, by combining U.S. corn and DDGS (in corn equivalents) into one broadly inclusive supply-use balance sheet, the projected impact and tradeoffs of expanded grain ethanol production and DDGS use can be shown.

Future work on this subject may best involve an integrated, comprehensive grain and livestock market segment analysis and modeling effort to better capture and represent the competitive tradeoffs and directional changes in corn and DDGS use that may occur if and when higher ethanol inclusion rates are adapted. Whereas this analysis looked at the tradeoffs that would need to occur between alternative uses of corn and DDGS in order to maintain certain levels of U.S. corn exports and ending stocks over the coming decade should higher levels of ethanol use be allowed in blended fuels, it is likely that a more comprehensive modeling effort could better assess the relative profitability of alternative corn and DDGS uses over time, and also do a better job of determining which segments of the U.S. and World corn and DDGS use industry will be able to compete most readily and either retain or expand their share of U.S. corn and DDGS use over time (likely at the expense of their competitors).