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Estimating Long-Term Idaho Hay Prices Using Multiple Data Sources

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Introduction

DAIRY INDUSTRIES IN IDAHO and several other US Western states (including California and New Mexico) experienced periods of rapid expansion during the early 2000s. Such expansion in the dairy cow inventories can have substantial effects on markets for other agricultural commodities, especially those used for dairy feed such as alfalfa hay. Findings from the recently published study by Hatzenbuehler et al. (2021) show that for all analyzed states (California, Idaho, and New Mexico) hay and milk prices move together to a greater degree in the period after a dairy expansion than before it. Thus, long-term (i.e., several months) future Idaho hay prices can be estimated using Idaho milk prices. This bulletin explains how this estimation can be done and how two key hay market-related variables, stocks and exports, can reduce the benefit of using milk prices to estimate future hay prices if/when certain conditions apply.

Figure 1 plots annual dairy cow inventory (as of January 1) data for Idaho for 1990–2021. Idaho had a period of rapid expansion from the early 1990s through 2006. Year-to-year changes in inventories were commonly greater than 20,000 during this period. From 2007 onward, year-to-year changes were usually still positive but much lower in magnitude in most years. The observed substantial increase in the number of dairy cows in Idaho impacts the hay market in two main ways: 1) increases the demand for hay for feeding and for hay stocks held for future feeding; and 2) makes hay demand more price inelastic, such that the quantity demanded is less responsive to price changes than was the case prior to the dairy industry's expansion. With greater and more price-inelastic hay demand, hay prices should be more responsive to milk price changes after the dairy industry expansion than was the case before it.

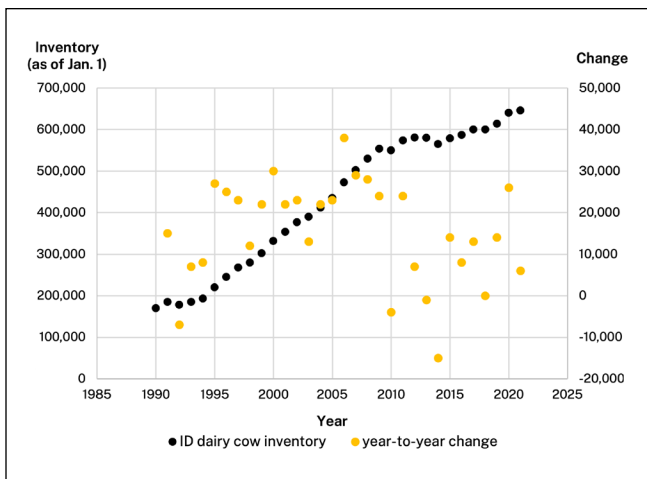


Figure 1. Idaho dairy cow inventories (as of January 1) and year-to-year changes, 1990–2021. Source: United States Department of Agriculture-National Agricultural Statistics Service (USDA-NASS).

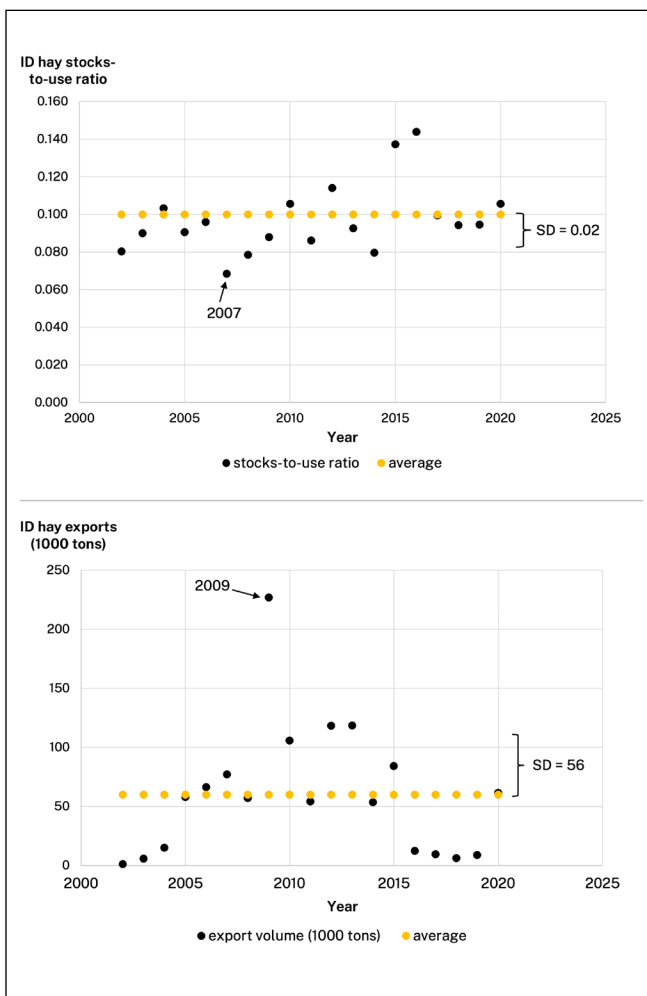


Figure 2. Western region hay stocks-to-use ratios and Idaho hay export volumes, 2002–20. Sources: USDA-NASS for hay stocks, use, and prices; US Department of Commerce for hay export values. Note: SD is standard deviation.

Although demand-related effects are expected to lead hay and milk prices to move together, findings from previous research imply that a couple of other factors could occasionally cause this to not be the case. First, as described by Wright (2011), when there are low stocks relative to total demand (i.e., low stocks-to-use ratios), it means that hay markets are very “tight” with little available sellable supply. In such cases, prices can either be more or less responsive to supply- and/or demand-related shocks than in normal conditions since regular buyers switch to substitute products (if available). The other factor that can lead hay markets to become “tighter” than normal, as described by Tejeda et al. (2019), is greater-than-normal hay exports. Specifically, Tejeda et al. (2019) found that hay export demand spikes (in California) had significant responsive effects on hay prices.

Based on these ideas, it was expected that

1. Hay and milk prices move together to a greater extent after the dairy industry expansion than was the case before it; and,
2. In periods in which there are low hay stocks-to-use ratios and/or greater-than-normal hay exports, the relationship between milk prices will be less predictable than in periods of normal stocks-to-use and hay exports.

These hypotheses were tested using a regression analysis that included monthly hay and milk price data from USDA-NASS for Idaho for 2002–19.¹ The cow inventory data in Figure 1 were used to define the “post-dairy expansion” period of 2007–19. Definition of these separate periods allowed for testing if hay and milk prices move together to a greater degree after the dairy industry expansion than before it.

To investigate whether stocks-to-use ratios and exports are also important, periods with low stocks-to-use periods and greater-than-normal exports were identified. Figure 2 includes plots of the data used to identify low stocks-to-use and greater-than-normal export periods. Stocks-to-use ratios were calculated using hay stocks and production data for all Western region states (Arizona, California, Colorado, Idaho, Montana,

Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming).² Periods in which stocks-to-use ratios were “lower-than-normal” were those for which stocks-to-use ratios were one standard deviation below the historical mean. The data in Figure 2 show that the mean stocks-to-use ratios over the observation period was 0.10 with a standard deviation of 0.02. This means that periods with stocks-to-use ratios that were below 0.08, such as 2007, have “lower-than-normal” stocks conditions. Similarly for exports, Idaho hay export data were used to identify periods in which hay exports from Idaho were “greater-than-normal.”³ These periods were those in which export volumes were one standard deviation greater than the historical mean. It is observed that the mean export volumes for the observation period of 2002–20 was 60,000 tons with a standard deviation of 56,000 tons. This implies that periods in which exports were greater than 116,000 tons, such as 2009, are periods with “greater-than-normal” exports.

The regression analysis results first show that, as expected, Idaho hay and milk prices do indeed move together over the long run. This means that if hay and milk prices move in different directions (e.g., one increases and the other decreases) for a brief period, then they will eventually move back toward each other. Second, Idaho hay and milk prices move together to a greater extent after the dairy industry expanded than before it. Lastly, there is evidence that hay and milk prices move in different directions during periods in which there were low stocks-to-use ratios in the Western region and greater-than-normal exports from Idaho. These estimates were not statistically significant for Idaho, but they were for California and New Mexico, and the Idaho estimates had the same signs as those for other states. Thus, it is worth monitoring Western region stocks-to-use ratios and export volumes data. Developments such as the first intermodal rail terminal in Pocatello, scheduled for operation around summer 2021 to ease exports of hay (and other agricultural products) out of ports in Tacoma and Seattle (Idaho Farm Bureau 2021), could increase export effects on Idaho hay prices in the future.

Implications for Idaho Hay Producers/Sellers and Livestock Feed Buyers

The magnitudes of the estimates for the hay and milk price regressions are of interest because they represent *how much* the hay price would be expected to change if the milk price changes. The regression estimates imply that, on average, a \$1/cwt increase (decrease) in the milk price is expected to translate into about a \$7/ton increase (decrease) in the hay price. Since these are averages and there is some period-to-period variation in the extent to which this relationship holds, using a range of \$6–\$8/ton increase (decrease) in the hay price for each \$1/cwt increase (decrease) to form estimates may be appropriate; that is, \$7 plus or minus \$1/ton. However, estimates that account for Western region hay stocks-to-use and Idaho hay exports imply that if these stocks-to-use ratios are lower-than-normal and/or exports are greater-than-normal, milk prices will be less informative for hay prices. In such periods, paying more regular attention to hay prices is recommended as there will likely be greater volatility.

Considerations for Estimating Long-Term Idaho Hay Prices

The “Decision Tree” (see sidebar) provides a guide for how to formulate long-term (i.e., several months or perhaps the interval between the release of USDA “Crop Production” reports)⁴ Idaho hay prices using Idaho milk prices. It may be helpful to create an Excel spreadsheet to keep track of the data gathered when moving through the steps outlined in the Decision Tree over time. The first step is to get the current hay price, such as that from the USDA-Agricultural Marketing Service (AMS) “Idaho Direct Hay Report”⁵ or other source. The hay price of \$160/ton from the USDA-AMS report for May 21, 2021, was used in the example. The second step is to check current Western region hay stocks-to-use ratios and Idaho hay exports. For the USDA Crop Production report for May 12,

2021, Western region stocks were an estimated 2.99 million tons, which were lower than those in 2020 of 3.71 million tons and the average for 2002–20 of 3.75 million tons. Thus, Western region hay stocks may be low for 2021 and, consequently, the hay market somewhat tight. The stocks-to-use ratio value for 2021 will be unknown until the use-level estimates can be calculated using data on December 2021 stocks from the USDA Crop Production report released in January 2022. For Idaho hay exports, the most recent estimate available from the US Department of Commerce runs through March 2021. These levels were estimated at over 18,000 tons for January 2021–March 2021. If this export pace continued through the rest of the year, total Idaho hay exports would be over 72,000 tons for 2021. This

level would be above the average value for 2002–20 of 60,000 tons, but not by a large amount relative to some years in the past. With both stocks lower than average and exports on pace to be slightly greater than average so far in 2021, this implies that Idaho and Western region hay markets may likely be “tighter” than normal in 2021. The extent of market tightness is conditional on the levels of consumption, especially by dairies and other livestock feeders. If the hay market is indeed tight, then there will likely be more price volatility than normal. Thus, in current market conditions, it is recommended to keep a closer eye on hay prices until Western region stocks-to-use levels and Idaho hay export volumes move back to normal as there will likely be high hay-price volatility until then.

Decision Tree for Estimating Long-Term Idaho Hay Prices Using Idaho Milk Prices

This four-step procedure provides the basics for estimating long-term Idaho hay prices using Idaho milk prices; a calculation example follows in the “When Stocks-To-Use Ratios and Exports Are ‘Normal’” section.

- Step 1.** Record the current hay price (e.g., from USDA-AMS).
- Step 2.** Check Western region hay stocks-to-use levels and Idaho hay export levels. If hay stocks-to-use levels are substantially “lower-than-normal” or Idaho hay exports are “greater-than-normal,” do not proceed to step 3. Rather, return to step 1 and monitor hay prices often, since these conditions are associated with greater volatility. If hay stocks-to-use levels and exports are near normal levels, proceed to step 3.
- Step 3.** Get the current and forecast milk price (e.g., from USDA-WASDE) and calculate the difference between the two for the expected change in milk price:

$$\text{Milk price difference} = (\text{forecast price} - \text{current price})$$

- Step 4.** Make a long-term hay price forecast:

$$\text{Expected hay price} = (\text{current hay price} + (\$7 \times \text{milk price difference}))$$

When Stocks-To-Use Ratios and Exports Are “Normal”

Current hay price (AMS, May 21, 2021): \$160/ton

Current milk price (WASDE, May 12, 2021): \$18.95/cwt

Forecast Q4 2021 milk price (WASDE, May 12, 2021): \$19.95/cwt

Milk price difference: \$1.00/cwt

Expected hay price = $160 + (7 \times 1.00) = \mathbf{\$166\text{--}\$168/\text{ton}}$

Calculating the Stocks-To-Use Ratio and Exports for 2021

Western region stocks levels (USDA Crop Production report, May 12, 2021): 2.99 million tons

This figure is lower than 2020's (3.75 million tons) and the average for 2002–20 (3.71 million tons). As a result, Western region hay stocks may be low for 2021. We will know more regarding 2021 consumption/use when the USDA Crop Production report is released in January 2022.

US Department of Commerce data show that exports for 2021 (as of March 2021) were over 18,000 tons. If that pace continues for all of 2021, exports will be over 72,000 tons, a higher figure than the average for 2002–20 of 60,000 tons, but by less than one standard deviation (56,000 tons) (Figure 2). Thus, both lower stocks and greater exports point to tighter hay markets in 2021 relative to 2020, conditional on consumption/use and production during the remainder of 2021.

Given these conditions, regularly (e.g., weekly) checking hay prices (repeating step 1) is recommended, since volatility is expected for 2021. Checking hay prices more often is recommended until stocks-to-use and export volumes return to normal.

Extra Advice

It may be helpful to create an Excel spreadsheet to keep track of the data gathered when moving through the steps over time. Keeping a spreadsheet and occasionally adjusting the formula, such as changing the range of hay-price changes to milk-price changes to greater or less than \$6–\$8/ton, to reflect the information gathered and to make forecasts, can help reduce the forecast-error incidence over time.

If you would like additional data or advice on Western region hay stocks-to-use ratios and Idaho hay exports, please email Patrick Hatzenbuehler (phatzenbuehler@uidaho.edu).

For a printable version (PDF) of the Decision Tree, [click here](#).

To finish the example, in step 3 you calculate the difference between the forecasted milk price and the current milk price (i.e., forecasted milk price minus current milk price). In the USDA World Agricultural Supply and Demand Estimates (WASDE) Report⁶ for May 12, 2021, the current milk price for the second quarter of 2021 was \$18.95/cwt and the projected prices for the fourth quarter \$19.95/cwt. Thus, the milk price difference is \$1.00/cwt, reflecting the USDA forecast of a \$1.00/cwt milk price increase by the end of 2021. The \$1.00/cwt milk price increase translates into an expected hay price of \$166–\$168/ton or \$6–\$8/ton greater than the May 2021 hay price of \$160/ton.

There are other considerations, such as the seasonality of hay prices and adjustments for quality premiums, that will also be important but will vary across operations and specific locations. There will also be errors in all forecasts. Keeping a spreadsheet and occasionally adjusting the formula, such as changing the range of hay-price changes to milk-price changes to greater or less than \$6–\$8/ton, to reflect the information gathered and used to make forecasts can help reduce the forecast-error incidence over time.

Additional Outputs and Resources

This analysis uses two main types of data that are not regularly reported for easy access among Idaho hay market stakeholders. These are Western region stocks-to-use ratios and Idaho hay export data. While these data are publicly available, they are not yet in a combined location and require additional calculations to obtain the values. For example, calculating total consumption (use) for hay is done using both annual production estimates and stocks values in December of the current and previous year. The export data do not require any additional calculations, but the average and standard deviation values will adjust as new data are released and so they should be updated over time. If you would like additional data or advice on Western region hay stocks-to-use ratios and Idaho hay exports, please email Patrick Hatzenbuehler (phatzenbuehler@uidaho.edu).

Notes

- 1 Hatzenbuehler et al. (2021) also included California and New Mexico in the empirical analysis, but the results for Idaho are the focus of this Extension bulletin.
- 2 For calculation of the stocks-to-use ratios, the stocks portion of the stocks-to-use ratio is the stocks value reported as of May 1 by USDA-NASS. The “use” or consumption portion of the ratio was calculated by adding the current-year production and previous-year December 1 stocks values together and subtracting off current-year December 1 stocks.
- 3 The source for Idaho state-level export data is the US Department of Commerce. The HS code associated with these data is 1214: rutabagas, hay, clover, and other forage products.
- 4 Current and historical USDA Crop Production reports are catalogued online at <https://usda.library.cornell.edu/concern/publications/tm70mv177>.
- 5 Current and historical USDA-AMS Idaho Direct Hay Reports are catalogued online at <https://mymarketnews.ams.usda.gov/viewReport/3056>.
- 6 Current and historical USDA-WASDE Reports are catalogued online at <https://www.usda.gov/oce/commodity/wasde>.

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Further Reading

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