Cross Hedging Agricultural Commodities

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Many agricultural commodities do not have an active futures market. This presents a problem if someone wants to reduce price risk through hedging. One alternative is to cross hedge, that is, hedge the cash commodity in the futures market of a different commodity.

Before cross hedging, all alternatives and risks involved should be analyzed to determine the optimal alternative. Other pricing methods such as cash marketing, forward contracting, or deferred pricing may better match market plans.

The local cash prices should be compared to the futures price series being considered for cross hedging beforehand to determine the historical relationship between the two. This requires collection and analysis of historical cash and futures prices. Though time consuming, it is important to analyze the relationship between futures and cash prices and be aware of and understand the alternative markets and marketing techniques available to manage price risk.

Cross hedging will generally work well for reducing price risk if (1) the price of the commodity being cross hedged and the price of the futures commodity are closely related and follow one another in a predictable manner, meaning hedged price risk is less than unhedged price risk and (2) large enough quantities are being traded to meet cross hedged futures contract size specifications. Hedged price risk refers to the price actually received by hedging relative to what was expected, and unhedged price risk refers to general price level variability.

Production risk also adds to the risk of cross hedging. When forward pricing a crop that has yet to be harvested, production risk may be large enough to discourage fully hedging. Hedging 100 percent of expected production in advance of harvest can increase the variability of total revenue (price times quantity). Hedging relationships reported here do not address this concern. However, if a storage or buy hedge is being placed, where the amount of commodity is known, the entire quantity can be hedged without the risk of being over- or under-hedged.

Cross hedging is not a good strategy and may not reduce price risk if the price of the cash commodity does not follow the futures market price in a predictable manner. In such situations, hedged price risk may be greater than unhedged price risk.

This publication has several objectives: to introduce the concept of cross hedging, to present examples of markets that can be used to cross hedge specific commodities, and to recommend strategies for cross hedgers. Applicable cross hedging techniques are presented for milo (grain sorghum), sunflowers, feeder cattle, cull cows, alfalfa, and millfeed. These techniques are applicable to both long hedgers wanting to reduce input price risk and short hedgers trying to set selling prices. They can be applied to marketing strategies involving either futures or options markets.

Cross Hedging Issues

When conducting research to establish whether cross hedging provides price risk reduction, several issues must be addressed. First, the futures contract in which to cross hedge the commodity must be determined. For example, to cross hedge grain sorghum, should oats, corn, soybeans, wheat, or some other futures contract be used? Second, the size of the futures position to take needs to be determined. Finally, the riskiness of the cross hedging relationship should be carefully considered.

In general, the futures contract to use is one with a price pattern that is similar to the cash commodity being hedged. For example, the corn futures contract is the most likely choice for cross hedging grain sorghum because milo prices follow corn prices closely, as they are strong substitutes in feed rations. These prices tend to move in similar patterns because individuals purchase the underpriced commodity or sell the overpriced commodity.

For example, cattle feedlots will substitute sorghum for corn and vice-versa depending upon the corn price relative to the sorghum price. This substitution causes the two prices to converge toward each other, creating a relatively stable price relationship.

Similarly, when cross hedging feeder calves, a likely market to consider is the feeder cattle futures contract. Hedging feeder calves using feeder cattle futures is considered a cross hedge when the sex or weights of the cattle do not match the specifications of the futures contract. Since the commodities are substitutes for one another and are both driven by the same fed cattle price, feeder calf prices have a predictable relationship with feeder cattle prices.

Determining which contract to use when cross hedging a specific commodity is not always obvious and may require analysis comparing relative price patterns of several different futures contracts. For example, when cross hedging a commodity such as alfalfa, corn futures, soybean meal futures, or a combination of the two may be considered.

Once the appropriate futures contract has been defined, the size of futures position to take to cover a particular cash position needs to be determined. For example, when hedging corn using corn futures, the general recommendation is to use one 5,000-bushel contract for each 5,000 bushels of corn to be hedged. However, when cross hedging grain sorghum in corn futures, the one-to-one relationship is not necessarily the optimal futures-to-cash hedge ratio. It may be less risky to take a larger or smaller position in the futures market than the cash market position being hedged.

Determining the Hedge Ratio

Determining the size of the futures position to take requires calculating a hedge ratio. The hedge ratio is found by estimating the relationship between the futures price and the cash price of the commodity being hedged according to the following equation:

$$\textit{Expected Cash Price} = \beta_0 + \beta_1 \textit{(Futures Price)} \quad (1)$$

where β_0 is the intercept or expected basis and β_1 is the hedge ratio. This equation identifies the historical relationship between the futures price and cash price and allows the hedger to determine the cash price that could be expected by cross hedging.

The hedge ratio (β_1) is the futures contract quantity position divided by the cash market quantity being hedged. It is an estimate of the relative price change between the futures market and the cash market. A hedge ratio of 1.0 implies a one-for-one hedge where for every $1 per unit change in the futures price, the cash price of the commodity being hedged also changes by $1 per unit in the same direction. A hedge ratio of 1.5 implies that for each $1 per unit change in the futures price, the cash price of the commodity being hedged changes by $1.50 per unit. A hedge ratio of 0.8 implies that for each $1 per unit change in the futures price, the cash price changes by 80 cents per unit.

The hedge ratio definition also indicates that the futures contract quantity is the hedge ratio times the cash quantity being hedged. The following equation is used with the related futures contract to calculate the approximate amount of cash commodity being hedged.

$$\textit{Cash quantity hedged} = \frac{\underline{\textit{Futures contract quantity}}}{\beta_1} \quad (2)$$

In this equation, β_1 is the hedge ratio. The *Futures contract quantity* is the weight or bushel amount per futures contract. For example, a No. 2 Yellow Corn contract on the Chicago Board of Trade (CBOT) is 5,000 bushels. *Cash quantity hedged* is the effective amount of cash commodity being hedged per futures contract.

Every commodity will have a different hedge ratio and expected basis. Seasonality between the futures price of one commodity and the cash price of another may cause the hedge ratio and expected basis to vary for different contract months. Location also may create differences in hedge ratios and expected basis patterns.

For instance, grain sorghum at Kansas City will not have the same hedge ratio and basis behavior as grain sorghum at Garden City because local supply and demand conditions differ. Many of the hedge ratios and expected basis levels for the cross hedging examples in this publication have been calculated based on specific sites in Kansas, therefore the estimates provided may not be representative of other locations.

Cross Hedging Risk

Several statistics help measure the risk of a proposed cross hedge. The R-square, resulting from the estimation of equation 1, is the proportion of total variability in the dependent variable (cash price) explained by the independent variable (futures price). For example, when cross hedging sunflowers using the soybean oil futures market, the dependent variable is cash sunflower price and the independent variable is soybean oil futures.

An R-square value of 0.73 means 73 percent of the variation in cash sunflower price is explained by the soybean oil futures price. The higher the R-square, the stronger the relationship between the two commodities and the less risk the cross hedge will involve. An R-square value of 1.0 implies a perfect correlation between the dependent and independent variables.

Another statistic used to measure cross hedging risk is the Root Mean Squared Percentage Error (RMSPE), which is the Root Mean Squared Error (RMSE) as a percentage of the respective commodity's average cash price. The RMSE is a measure of the variation of the expected hedged price around the actual cash price. The RMSPE is a relative measure of the dispersion of the cash prices from their expected values for a given futures price. The more dispersed the cash prices are from their expected given futures prices, the greater the RMSPE and the poorer the fit of the regression equation.

An RMSPE value of zero implies a perfect relationship between the dependent and independent variables. As the RMSPE increases, the cross hedge risk increases. An RMSPE value of 10 percent can be interpreted to mean that 68 percent of the time the hedged cash price would be expected to lie within 10 percent of the expected cash price. Generally, as the R-squared values increase, the RMSPE values decrease.

Both of these measures of risk are computer generated. It is recommended that those considering cross hedging use some type of computer software to help estimate the expected risks associated. Discussion in this publication is based on hedge ratio relationships estimated using computer software to statistically estimate the hedge ratio and associated risks.

Data Used

Weekly price data were used for all analyses. Cash price data were gathered from several Kansas locations, covering varying time periods. Futures prices used were for the nearby futures contract. For grains, the futures contract was rolled to the next contract at the end of the previous month before it expired. For example, during February, the corn futures price was from the March contract; however, in March the corn futures price rolled to the May contract. Cattle futures contracts were rolled to the next contract following the third Wednesday of the month of expiration.

Cross Hedging Milo

This section explores cross hedging milo in corn futures for several Kansas locations. Hedging risk (basis plus hedge ratio) can be evaluated by the R-squares and RMSPEs reported in Table 1. R-square values close to 1.0 and RMSPE values close to zero indicate milo price is highly correlated with the corn futures price and basis risk is low. Locations with relatively high R-squares and low RMSPEs have lower risk associated with hedging milo in corn futures. Although the R-square values are consistently close to 1.0 across all contracts and locations, the RMSPE values vary from 6.38 percent to 27.22 percent, indicating there is risk associated with the cross hedge.

The differences in RMSPE values appear to be more pronounced across seasons than across locations. The September contract for each location has the highest RMSPE (roughly twice as large as all other time periods) and the lowest R-square value, implying it has the highest risk. RMSPEs and R-square values are similar across the remaining contract months.

An example of cross hedging milo in corn futures would work as follows. A milo grower in Hutchinson, Kan., wants to reduce price risk by hedging the selling price of milo using the December CBOT Corn futures contract. Given a December contract futures price for corn of $3.10 per bushel in August, referring to Table 1, the hedge ratio and expected basis (intercept) for Hutchinson are 1.674 and –0.340, respectively. Using equation 1, the expected milo cash price would be $4.85 per hundredweight ($-0.34 + 1.674 \times \$3.10$/bu). The amount to hedge can be found using equation 2. One December CBOT Corn contract represents 5,000 bushels, and using the hedge ratio of 1.674, the quantity of milo hedged per contract would be approximately 2,987 hundredweight ($5{,}000 \div 1.647$) or 5,334 bushels.

An alternative method that uses this same information to graphically illustrate the expected hedged price is shown in Figure 1. Weekly Hutchinson cash milo prices during December, January, and February were plotted against weekly March corn futures prices and an estimated line was fit through these points. To determine the expected cash price, move vertically from the futures price, on the horizontal axis, to the fitted line. Then, move horizontally to the associated expected cash price on the vertical axis. This is the expected cash price for milo given the corn futures price. The more dispersed the actual prices are around the line, the more risk the cross hedger faces that the expected and realized cross hedged prices will not be the same.

Using the corn futures price of $3.10 per bushel (point A), and moving vertically to the fitted line (point B), and horizontally to the cash price (point C), the expected cash price is approximately $4.85 per hundredweight. The hedge ratio is the slope of the fitted line, 1.674, interpreted to mean that an increase in corn futures price of $1 per bushel typically results in a cash milo price increase of about $1.67 per hundredweight.

This graphical method of estimating the hedge ratio and expected basis is rough and is provided merely to show the regression in an illustration, which helps to establish the expected cash price. The dispersion of the actual points around the line provides an indication of how dependable or risky the cross hedge is. Actual points dispersed far from the line suggest more hedging risk (basis and hedge ratio variability) than actual prices close to the fitted line.

Figure 1. Hutchinson Milo Cash Prices against March Corn Futures Prices, January 1985 through March 1997

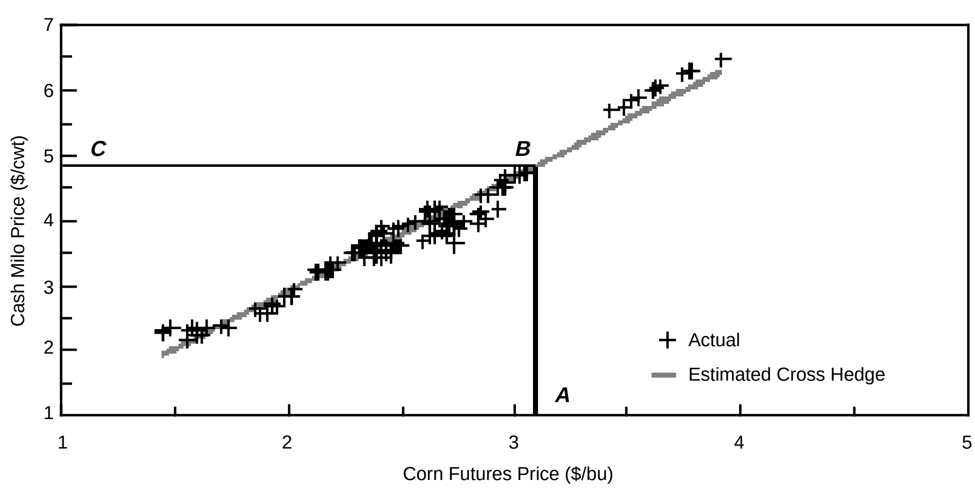


Table 1. Cross Hedge Estimates for Hedging Milo at Various Kansas Locations in Corn Futures, January 1985 through April 1997

Location/ Corn futures month	Hedge ratio [a]	Intercept	RMSPE [b]	R-square	Milo cwt hedged per 5,000-bu corn contract
Colby:					
March	1.711	–0.696	8.22	0.97	2,922
May	1.700	–0.665	10.76	0.97	2,941
July	1.809	–0.929	13.76	0.96	2,764
September	1.750	–0.516	27.22	0.88	2,857
December	1.597	–0.397	10.58	0.93	3,131
Dodge City:					
March	1.778	–0.672	9.73	0.95	2,812
May	1.775	–0.624	11.14	0.96	2,817
July	1.801	–0.641	14.70	0.95	2,776
September	1.790	–0.319	26.10	0.89	2,793
December	1.701	–0.370	9.76	0.94	2,939
Hutchinson:					
March	1.768	–0.637	9.08	0.96	2,828
May	1.728	–0.519	11.03	0.97	2,894
July	1.681	–0.405	13.60	0.96	2,974
September	1.671	–0.177	26.61	0.90	2,992
December	1.674	–0.340	8.39	0.95	2,987
Independence:					
March	1.693	–0.435	11.94	0.97	2,953
May	1.760	–0.653	12.00	0.98	2,841
July	1.616	–0.217	10.94	0.97	3,094
September	2.036	–0.991	22.17	0.91	2,456
December	1.655	–0.285	12.19	0.93	3,021
Topeka:					
March	1.862	–0.761	6.38	0.97	2,685
May	1.843	–0.706	6.84	0.98	2,713
July	1.775	–0.528	9.63	0.98	2,817
September	1.816	–0.488	25.85	0.94	2,753
December	1.747	–0.500	11.48	0.94	2,862

[a] Milo prices are given in $/cwt and corn futures prices are given in $/bu.

[b] RMSPE is a root mean squared percentage error, which is RMSE as a percentage of the respective average milo price.

Cross Hedging Sunflowers

This section examines cross hedging sunflowers using soybean oil futures. As shown in Table 2, the RMSPE values are 13 percent to 14 percent in contract months early in the year and decline in August through December. The R-square values are between 0.70 and 0.81. The average hedge ratio is 0.58, indicating that when placing a hedge, the cash sunflower quantity being hedged is the soybean oil futures contract quantity divided by 0.58.

Consider the example of a sunflower grower wanting to hedge using March soybean oil futures. Given a March soybean oil futures price in July of $26 per hundredweight and a hedge ratio and intercept of 0.629 and –4.57, respectively (Table 2), using equation 1, the expected cash sunflower price is $11.78 per hundredweight (–4.57 + 0.629 × $26/cwt). The amount to be hedged is found using equation 2. A soybean oil futures contract on the CBOT is 600 hundredweight, therefore the cash sunflower quantity hedged is approximately 954 hundredweight (600 ÷ 0.629) per contract.

Figure 2 presents a graphical method of finding the expected cash price and hedge ratio. Moving vertically from the soybean oil futures price (point A) to the fitted line (point B), and horizontally to the sunflower cash price (point C), the expected price is the same as the previously calculated example, $11.78 per hundredweight. The hedge ratio is the slope of the fitted line, 0.629. The dispersion of the actual points around the line provides an indication of how dependable or risky the cross hedge is. Actual points dispersed far from the line suggest more hedging risk (basis and hedge ratio variability) than actual prices close to the fitted line.

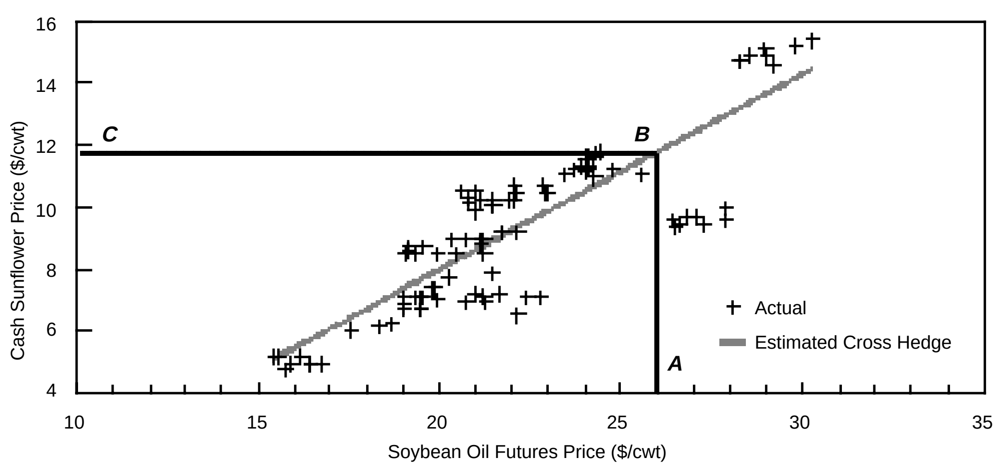
Table 2. Cross Hedge Estimates for Hedging Northwest Kansas Sunflowers in Soybean Oil Futures, January 1986 through April 1997

Soybean oil futures contract month	Hedge ratio [a]	Intercept	RMSPE [b]	R-square	Sunflower cwt hedged per 600-cwt contract
January	0.554	–2.96	13.56	0.73	1,083
March	0.629	–4.57	14.19	0.73	954
May	0.689	–5.84	13.24	0.78	871
July	0.580	–3.23	14.40	0.72	1,034
August	0.533	–2.07	12.19	0.80	1,126
September	0.578	–2.56	12.72	0.81	1,038
October	0.529	–2.02	11.46	0.81	1,134
December	0.565	–3.09	10.83	0.79	1,062

[a] Sunflower and soybean oil prices are both in $/cwt.

[b] RMSPE is a root mean squared percentage error, which is RMSE as a percentage of the respective average sunflower price.

Figure 2. Northwest Kansas Sunflower Cash Prices Against March Soybean Oil Futures Prices, January 1986 through April 1997



Cross Hedging Feeder Cattle

This section examines cross hedging feeder steers and heifers of varying weight using Chicago Mercantile Exchange (CME) feeder cattle futures. Table 3 displays the hedge ratios and components of hedging risk for steers of different weight classes, and Table 4 provides the same information for heifers. The RMSPE and R-square values for the lighter-weight cattle indicate a riskier cross hedge relative to heavier-weight cattle. There also is seasonality involved with this cross hedge as the RMSPEs are largest in August. The R-squared values are generally greater than 0.90, especially for heavier weighted cattle.

Both steers and heifers can be hedged in feeder cattle futures with similar risk. This can be seen by comparing the RMSPE and R-square values from Table 3 and Table 4. The tables also can be used to calculate the amount of cash commodity hedged per futures contract. Given an October futures contract price of $77 per hundredweight in April, an expected October cash price for 600- to 700-pound steers in Dodge City can be calculated using the intercept of –6.52 and a hedge ratio of 1.116 (Table 3). Using these numbers in equation 1, the expected cash price is $79.41 per hundredweight ($-6.52 + 1.116 \times \$77$/cwt). Transferring the hedge ratio to Equation 2 and using a feeder cattle contract from the CME that represents 50,000 pounds, the pounds of 600- to 700-pound steers hedged per contract would be approximately 44,802 or 69 steers weighing 650 pounds ($44{,}802 \div 650 \approx 69$).

Figure 3 presents a graphical method to find the expected cash price and hedge ratio. The expected cash price of $79.41 per hundredweight can be found by moving vertically from the feeder cattle futures price (point A) to the fitted line (point B) and horizontally to the cash price (point C). Once again, the hedge ratio is the slope of the fitted line, 1.116. The dispersion of the actual points around the line provides an indication of how dependable or risky the cross hedge is. Actual points dispersed far from the line suggest more hedging risk (basis and hedge ratio variability) than actual prices close to the fitted line.

Figure 3. Dodge City Steer Cash Prices (600–700 lbs) against Feeder Cattle Futures Prices, September 1986 through October 1996

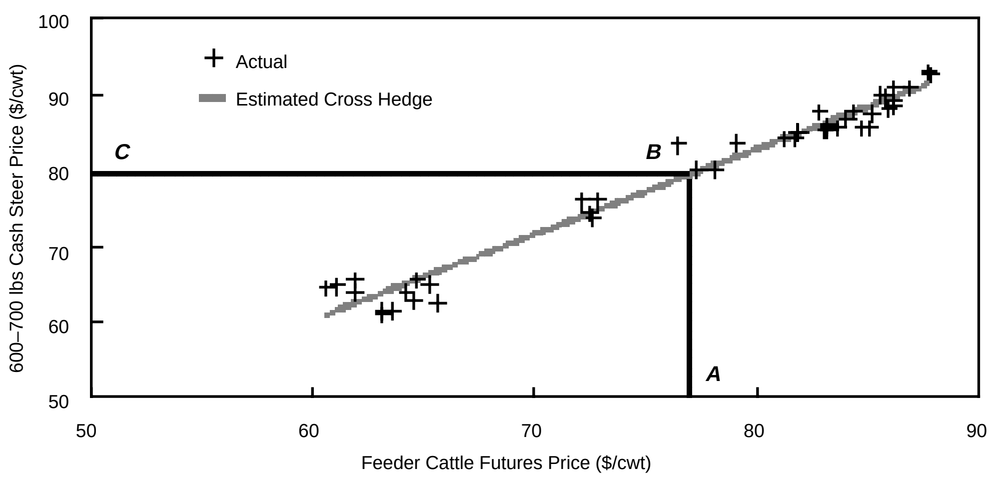


Table 3. Cross Hedge Estimates for Hedging Dodge City, Kan., Feeder Steers in Feeder Cattle Futures, January 1986 through May 1997

Weight (lbs)/ Feeder cattle futures contract month	Hedge ratio	Intercept	RMSPE [a]	R-square	Pounds of steer hedged per 50,000-lb feeder cattle contract
300–400:					
January	1.668	–32.84	5.64	0.89	29,976
March	1.773	–35.58	4.91	0.93	28,201
April	1.652	–25.13	4.77	0.94	30,266
May	1.636	–23.94	4.60	0.95	30,562
August	1.602	–25.06	6.47	0.85	31,211
September	1.344	–5.68	6.70	0.69	37,202
October	1.418	–12.34	4.84	0.87	35,261
November	1.586	–26.15	4.10	0.92	31,526
400–500:					
January	1.538	–28.22	4.90	0.91	32,510
March	1.595	–26.48	4.85	0.92	31,348
April	1.514	–18.46	4.59	0.94	33,025
May	1.532	–19.23	3.48	0.97	32,637
August	1.493	–22.76	6.30	0.87	33,490
September	1.383	–14.59	5.45	0.85	36,153
October	1.542	–28.34	4.59	0.92	32,425
November	1.484	–25.15	3.72	0.94	33,693
500–600:					
January	1.299	–17.19	4.04	0.93	38,491
March	1.300	–13.74	4.40	0.92	38,462
April	1.375	–15.18	4.26	0.95	36,364
May	1.307	–9.89	3.53	0.96	38,256
August	1.329	–16.21	5.26	0.90	37,622
September	1.324	–17.21	4.88	0.90	37,764
October	1.244	–12.96	4.08	0.92	40,193
November	1.242	–13.02	3.52	0.94	40,258
600–700:					
January	1.128	–7.53	2.58	0.96	44,326
March	1.114	–6.06	2.41	0.97	44,883
April	1.176	–9.26	2.48	0.98	42,517
May	1.187	–9.27	2.90	0.97	42,123
August	1.254	–15.59	3.42	0.95	39,872
September	1.125	–6.36	1.95	0.98	44,444
October	1.116	–6.52	2.39	0.97	44,803
November	1.084	–4.63	2.36	0.97	46,125
700–800:					
January	1.022	–0.28	2.50	0.96	48,924
March	1.033	–1.71	1.98	0.98	48,403
April	1.050	–3.58	1.82	0.99	47,619
May	1.053	–3.22	2.04	0.98	47,483
August	1.219	–8.23	2.82	0.96	41,017
September	1.029	–1.01	1.28	0.99	48,591
October	1.012	–0.14	1.42	0.99	49,407
November	0.988	2.06	1.67	0.98	50,607
800–1,000:					
January	0.988	0.28	2.70	0.95	50,607
March	0.987	–0.72	2.17	0.97	50,659
April	0.995	–2.70	1.71	0.99	50,251
May	1.004	–3.12	2.16	0.98	49,801
August	1.063	–6.20	2.96	0.96	47,037
September	0.962	1.45	2.34	0.96	51,975
October	0.931	3.49	1.81	0.98	53,706
November	0.899	6.25	2.35	0.96	55,617

[a] RMSPE is a root mean squared percentage error, which is RMSE as a percentage of the respective average steer price.

Table 4. Cross Hedge Estimates for Hedging Dodge City, Kan., Feeder Heifers in Feeder Cattle Futures, January 1986 through May 1997

Weight (lbs)/ Feeder cattle futures contract month	Hedge ratio	Intercept	RMSPE [a]	R-square	Pounds of heifer hedged per 50,000-lb feeder cattle contract
300–400:					
January	1.548	–36.48	6.44	0.88	32,300
March	1.708	–43.06	6.01	0.91	29,274
April	1.658	–35.71	4.63	0.96	30,157
May	1.525	–25.58	4.87	0.94	32,787
August	1.596	–35.01	7.26	0.83	31,328
September	1.695	–44.83	6.00	0.85	29,499
October	1.396	–22.43	4.95	0.90	35,817
November	1.470	–29.62	4.76	0.92	34,014
400–500:					
January	1.465	–33.51	4.27	0.94	34,130
March	1.467	–29.27	5.57	0.91	34,083
April	1.510	–29.12	4.06	0.96	33,113
May	1.472	–25.38	3.71	0.97	33,967
August	1.526	–34.74	6.06	0.91	32,765
September	1.458	–30.89	5.24	0.92	34,294
October	1.416	–29.25	4.02	0.95	35,311
November	1.369	–26.86	4.65	0.92	36,523
500–600:					
January	1.295	–23.90	3.25	0.96	38,610
March	1.260	–19.18	3.63	0.95	39,683
April	1.309	–20.35	3.28	0.97	38,197
May	1.295	–18.38	2.89	0.98	38,610
August	1.374	–27.53	4.39	0.94	36,390
September	1.276	–21.31	3.39	0.96	39,185
October	1.260	–21.13	3.33	0.96	39,683
November	1.249	–20.92	3.19	0.96	40,032
600–700:					
January	1.114	–10.46	2.45	0.97	44,883
March	1.127	–11.40	2.61	0.97	44,366
April	1.144	–12.96	2.14	0.98	43,706
May	1.138	–12.00	2.42	0.98	43,937
August	1.188	–15.76	3.15	0.96	42,088
September	1.057	–6.22	2.09	0.98	47,304
October	1.028	–4.51	2.04	0.98	48,638
November	1.059	–6.93	2.16	0.97	47,214
700–800:					
January	1.019	–3.92	2.82	0.95	49,068
March	1.036	–5.78	2.60	0.96	48,263
April	1.050	–7.54	1.58	0.99	47,619
May	1.039	–6.45	2.21	0.98	48,123
August	1.121	–12.15	3.29	0.95	44,603
September	0.986	–1.43	2.02	0.97	50,710
October	0.965	–0.64	2.11	0.97	51,813
November	1.009	–3.49	1.69	0.98	49,554

[a] RMSPE is a root mean squared percentage error, which is RMSE as a percentage of the respective average heifer price.

Cross Hedging Cull Cows

This section examines cross hedging cull cows in the 90-percent lean beef trimmings futures contract. Estimated hedging relationships are presented in Table 5 for three different grades of cull cows. The R-square values range from 0.81 to 0.95 with no specific quality grades showing the strongest relationship, however the Boner grade tends to have a slightly lower RMSPE.

Cross hedging cull cows in the 90-percent lean futures would work as follows. Using the February 90-percent lean trimmings contract, given a futures price in June of $110 per hundredweight, the hedge ratio for Dodge City, Breaker cows of 0.416, and the intercept of –2.59 (Table 5), the expected cow price is approximately $43.17 per hundredweight (–2.59 + 0.416 × $110/cwt). Using equation 2, roughly 48,077 pounds (20,000 ÷ 0.416) or 48 cows weighing 1,000 pounds are effectively hedged per 20,000-pound lean boneless beef futures contract.

Figure 4 presents a graph of cull cow cash price as a function of the 90-percent lean futures price. An alternative method of finding the expected cash price and hedge ratio can be completed using this graph. Moving vertically from the 90-percent lean futures price (point A) to the fitted line (point B), and finally horizontally to the Breaker, cull cow price (point C), the expected price is approximately $43.17 per hundredweight. The dispersion of the actual points around the line provides an indication of how dependable or risky the cross hedge is. Actual points dispersed far from the line suggest more hedging risk (basis and hedge ratio variability) than actual prices close to the fitted line.

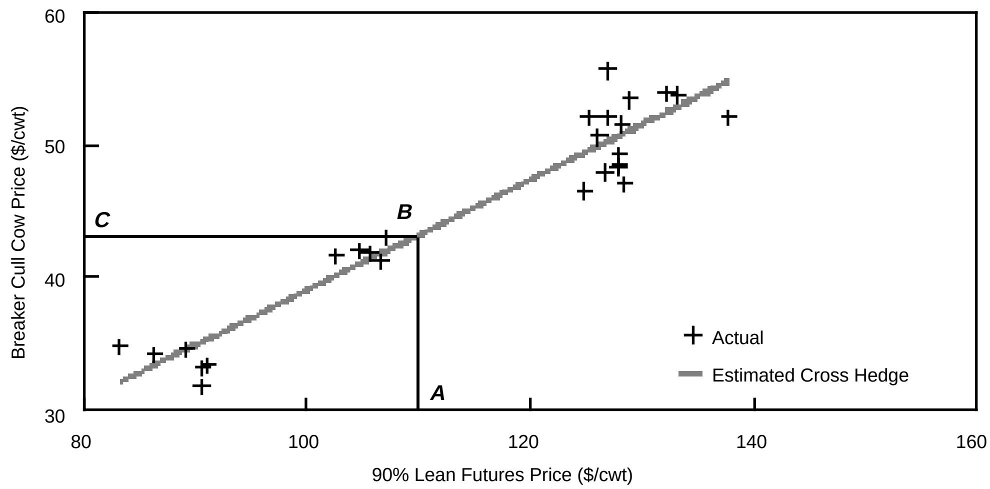
Table 5. Cross Hedge Estimates for Hedging Dodge City, Kan., Cull Cows in Boneless Beef — 90% Lean Futures, February 1991 through December 1996

Cow grade/ 90% lean beef futures contract month	Hedge ratio [a]	Intercept	RMSPE [b]	R-square	Pounds of cow hedged per 20,000-lb 90% lean contract
Breaker:					
February	0.416	–2.59	5.00	0.91	48,077
April	0.351	7.16	4.36	0.95	56,980
June	0.379	4.08	5.44	0.93	52,770
August	0.346	9.39	7.30	0.82	57,803
October	0.284	13.82	5.83	0.84	70,423
December	0.378	0.77	6.60	0.86	52,910
Boner:					
February	0.346	6.83	4.49	0.88	57,803
April	0.348	8.52	4.21	0.94	57,471
June	0.371	6.45	4.01	0.95	53,908
August	0.312	11.89	5.35	0.88	64,103
October	0.286	14.08	6.30	0.81	69,930
December	0.314	8.57	4.90	0.89	63,694
Cutter:					
February	0.394	–1.45	6.21	0.86	50,761
April	0.390	1.10	5.80	0.92	51,282
June	0.442	–3.74	5.80	0.93	45,249
August	0.372	3.09	6.07	0.89	53,763
October	0.373	2.15	4.43	0.94	53,619
December	0.426	–6.43	5.45	0.93	46,948

[a] Cull cow and boneless beef futures prices are both in $/cwt.

[b] RMSPE is a root mean squared percentage error, which is RMSE as a percentage of the respective average cull cow price.

Figure 4. Dodge City Breaker Cow Cash Prices against 90% Lean Futures Prices, February 1991 through February 1996



Cross Hedging Alfalfa

This section examines alternatives to cross hedge alfalfa. Several models were estimated to determine a cross hedge that offered the lowest amount of hedging risk for alfalfa. These models included cross hedging alfalfa in corn futures, soybean meal futures, and corn and soybean meal futures together. Although alfalfa could be cross hedged, none of these futures contracts, individually or together, provide a strong cross hedging relationship, therefore it would be quite risky to use corn meal futures, soybean meal futures, or a combination of the two to cross hedge alfalfa.

The alternative that provided the best relationship is cross hedging alfalfa in May corn futures, however even this alternative yielded a relatively low R-square of only 0.49 and a relatively high RMSPE of 9.91 percent. Most of the estimated hedging relationships had R-square values less than 0.30 and RMSPEs greater than 10 percent. In addition, the hedge ratio was highly variable over the contract months used, suggesting an unstable relationship between alfalfa and corn or soybean meal prices.

Because of this poor relationship, cross hedging alfalfa in corn or soybean meal futures is not recommended. Cross hedging alfalfa in these markets may increase price risk relative to remaining unhedged. Further analysis is warranted before recommendations can be made concerning opportunities for cross hedging alfalfa.

Cross Hedging Millfeed

This section examines alternatives to cross hedge millfeed. The option that provides the strongest relationship to cross hedge millfeed is hedging in both corn and soybean meal futures at the same time. This is different from the previous alternatives discussed because two positions are taken simultaneously in two different futures contracts.

Table 6 provides statistics for cross hedging Central States (Indiana, Illinois, Michigan, Mississippi, and Ohio) and Chicago millfeeds. The RMSPEs in the Central States range from a high of 18.77 percent to a low of 11.85 percent, while in Chicago the high is 15.75 percent and the low is 9.43 percent. The R-squares generally tend to be slightly higher in Chicago with the highest value being 0.88, while in the Central States the highest value is 0.79.

The futures contracts required were calculated per 100 tons of millfeed being hedged. For example, in January in the Central States, approximately 0.28 of a 5,000-bushel corn futures contract and 0.26 of a 100-ton soybean meal contract would be needed for every 100 tons of millfeed. This is approximately one futures contract of corn and soybean meal for every 400 tons of millfeed.

In some months, the hedge ratios vary greatly between corn and soybean meal contracts, and it is necessary to use a larger portion of one futures contract versus the other. For example, in Chicago in April, a much larger position must be taken in corn than in soybean meal futures. A hedger would need 0.48 of a corn futures contract and only 0.23 of a soybean meal contract for every 100 tons of millfeed to hedge, approximately two corn contracts and one meal contract for every 400 tons of millfeed.

In other months, the position may be so small that it would be more beneficial not to hedge with that contract because it would take several hundred tons of millfeed to complete a perfect hedge. An example of this would be in the Central States in May when only 0.11 of a soybean meal contract is required for every 100 tons of millfeed. In this instance, it would take approximately 1,000 tons of millfeed to have enough to complete one soybean meal contract.

The expected cash price can be found by modifying equation 1 to include another independent variable. Given a February corn futures price of $3.05 per bushel and a soybean meal futures price of $255.60 per ton while using Table 6, a Central States February corn hedge ratio of 18.721, a soybean meal ratio of 0.244, and an intercept of –20.79, the expected cash millfeed price is $98.68 per ton [–20.79 + (18.721 × 3.05) + (0.244 × 255.60)].

Millfeed cross hedging may be a viable option only for large producers or users of millfeed given the immense quantities required to complete a hedge. Unlike previously discussed commodities, this example cannot be portrayed graphically on a two-dimensional graph because two futures markets are involved.

Table 6. Cross Hedge Estimates for Hedging Central State and Chicago Millfeed in Corn and Soybean Meal Futures, January 1985 through May 1997

Location/ Month	Corn hedge ratio [a]	Soybean meal hedge ratio [a]	Intercept	RMSPE [b]	R-square	Corn futures contract per 100 tons of millfeed hedged	Meal futures contract per 100 tons of millfeed hedged
Central States:							
January	14.016	0.257	–3.29	16.27	0.61	0.28	0.26
February	18.721	0.244	–20.79	11.85	0.79	0.37	0.24
March	14.584	0.288	–16.76	13.49	0.76	0.29	0.29
April	25.615	0.169	–24.58	18.77	0.72	0.51	0.17
May	20.948	0.111	–9.54	15.24	0.73	0.42	0.11
June	23.097	0.157	–27.50	13.47	0.76	0.46	0.16
July	27.914	0.122	–28.20	14.43	0.77	0.56	0.12
August	26.743	0.067	–14.91	15.40	0.71	0.53	0.07
September	10.496	0.304	–14.52	13.32	0.73	0.21	0.30
October	8.283	0.344	–14.94	14.86	0.64	0.17	0.34
November	11.717	0.204	9.78	12.13	0.59	0.23	0.20
December	9.413	0.248	14.33	15.54	0.53	0.19	0.25
Chicago:							
January	14.937	0.373	–22.85	13.09	0.77	0.30	0.37
February	15.774	0.372	–30.14	9.43	0.88	0.32	0.37
March	18.679	0.330	–29.32	11.76	0.83	0.37	0.33
April	24.061	0.225	–27.52	15.68	0.76	0.48	0.23
May	17.682	0.174	–8.00	10.46	0.82	0.35	0.17
June	25.334	0.203	–34.89	9.69	0.87	0.51	0.20
July	27.195	0.143	–22.91	11.72	0.82	0.54	0.14
August	30.321	0.147	–28.58	10.38	0.88	0.61	0.15
September	17.538	0.350	–28.64	12.92	0.80	0.35	0.35
October	14.105	0.353	–18.49	12.94	0.73	0.28	0.35
November	17.798	0.239	–1.12	9.32	0.78	0.36	0.24
December	11.168	0.319	2.45	15.75	0.59	0.22	0.32

[a] Millfeed prices are in $/ton, corn futures prices are in $/bu, and soybean meal futures prices are in $/ton.

[b] RMSPE is a root mean squared percentage error, which is RMSE as a percentage of the respective average millfeed price.

Recommendations for Cross Hedgers

The cross hedging examples discussed in this publication are for specific locations and may not be representative of other regions. Different locations may have unique hedge ratios and basis behavior. This publication is primarily a guide for determining how to use hedge ratios when cross hedging. Individuals wanting to cross hedge should estimate the hedge ratios and relationships for their specific geographic locations.

Cross hedging will not eliminate price risk entirely because basis risk is present in any hedging program. However, basis fluctuations can be either beneficial or detrimental to the hedger depending upon whether a short or long hedge has been placed and on the direction of basis change. Before deciding to cross hedge, producers should consider the risk they can expect to face by cross hedging and compare this to the price risk they face if they remain unhedged.

This publication should help determine the equivalent price that could be hedged, the size of position to take for a given cash quantity, and the associated risk. However, it does not help indicate when to place a hedge. The decisions of if and when to hedge must be based on analyses of costs of production, desired returns, degree of risk aversion, current fundamental expectations, and other economic information. Not until this information has been gathered and analyzed should the producer be concerned with what size of position to take in the futures market.

After this information has been gathered, it may be determined that only a percentage of expected production (or purchases) should be hedged. However, futures contracts have fixed quantity specifications. For example, corn contracts are 5,000 bushels on the CBOT and 1,000 bushels on the MidAmerica Commodity Exchange (MIDAM). As a result, it is unlikely that hedges can be placed to cover the exact quantities of the commodity a producer may wish to hedge and either over- or under-hedging typically occurs. To determine which way to hedge, the relative risks and expected payoffs from taking a smaller or larger futures position must be weighed.

After the cross hedging transaction has been completed, the hedger should evaluate how it performed. The first aspect of the hedge to evaluate is how close the actual price received was to the expected price, after adjusting for any gains or losses in the futures market and any brokerage fees. The evaluation on the performance of the hedge should be done independently of the evaluation of the marketing strategy. Deciding whether it was wise to have taken a market position at the time it was taken should be evaluated with the strategy and not the performance of the hedge. In other words, a hedge is considered successful if the actual price is approximately equal to the expected price; whereas, a strategy is considered successful if it met the objectives of the market plan.

The information presented in this publication can be used to evaluate the merits of option positions on commodity futures contracts as well as to place hedges. Option positions offer more flexibility to the option holder than do futures positions. Therefore, producers considering hedging also should consider the possibility of using options to set an expected minimum selling or maximum buying price.

The hedge ratios reported in the tables can be used to determine the size of the option position to take. In addition, purchasing options can help reduce a significant portion of adverse basis risk due to the fact that options can always be left to expire if they have no value, costing the producer only the premiums, opportunity costs on the premiums, and associated brokerage fees.

Although there are a limited number of cross hedging suggestions outlined in this publication, it is conceivable that any commodity could be cross hedged in any futures contract. However, it must be remembered that cross hedging relationship risk may be greater than expected price risk if unhedged and thus should be examined before a cross hedge is placed.

Cross Hedging Agricultural Commodities

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