Multiple Year Pricing Strategies for Soybeans

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Once every few years, supply and demand conditions for soybeans are such that prices reach historically high levels. These high prices are usually caused by reduced supply from poor yields during the summer, but have also been caused by excessive rainfall. These historically high prices provide producers with unique pricing opportunities. This publication explains how to take advantage of these favorable prices by pricing three years production at one time. The methods, the returns, and the risks associated with the three-year strategies will be explained.

When prices reach historically high levels in the first (current) year, two things generally happen in the following two years. First, the high prices in year one lead producers to expand acreage in year two. Second, the high prices in year one have a tendency to reduce feed usage because of fewer numbers of livestock and poultry on feed. The combination of increased supply and reduced feed demand leads to lower prices in years two and three. The multiple year pricing strategy takes advantage of these tendencies by selling three years of expected production during the first year when prices are high.

Figure 1 shows daily November soybean futures prices from 1982 to 1993. In 1983 and 1988, November soybean futures prices traded above $8.00 per bushel. In each case, prices were substantially lower in the two following years. With multiple year pricing, the producer prices three years of expected production in the first year in order to increase prices across all three years. Obviously this strategy involves substantial risks. What if prices go higher after pricing three years of production? What if prices move to a new price

Figure 1. Daily Nov. Soybean Futures

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level and do not return to historical equilibrium levels? These are important questions. The strategies presented are based on research designed to minimize these risks.[1]

Historical Price Distribution

The best way to minimize the risks of higher prices is to only enter into the strategy when the probability of prices going substantially higher is low. Table 1 is the historical distribution of November soybean closing prices on the 1974 through 1993 contracts. Table 1 shows the historical probability of prices being in specified 20- cent intervals from $4.50 to $10.29 per bushel. The table indicates the most frequent price is between $6.10 and $6.29 per bushel. From 1974 to 1993, 12.2 percent of November soybean futures prices were in this range. The cumulative percentage column indicates that 56.16 percent of all November soybean futures prices traded at or below $6.29 per bushel between 1974 and 1993.

Table 1 indicates that historically the probability of prices trading at or above $8.10 per bushel is 6.0 percent (the sum of all probabilities above $8.10 is 1.7 + 1.6 + 0.9 + 0.6 + 0.5 + 0.3 + 0.2 + 0.1 + 0.1). In other words, if a producer prices at $8.10 per bushel, there is only a 6 percent probability that prices would go higher. Table 1 indicates prices could go $2.19 cents a bushel above $8.10, although the probability is small.

Trigger Price

To determine the most desirable price level (called the trigger price) to enter the three-year strategy, the strategy was evaluated using trigger prices at the top 5, 10, and 15 percent level of the historical distribution. These trigger price levels are based on prices from previous years. For example, in 1980, only prices from the November 1974 through November 1979 contracts are used. The research indicates that the 5 percent trigger level is best early in the season. If the three-year strategy is implemented relatively early (before May 10) in the growing season, poor yields during the summer could increase futures prices by $1-2 per bushel. Such price increases would generate margin calls of $5,000-10,000 per contract. The margin call problem is addressed by adjusting the trigger price to reflect expected yields after May 10 each year.

Expected Yield and Trigger Price

The USDA announces expected production for the next season starting around May 10 each year. The May and June *World Agricultural Supply and Demand Estimates* (*WASDE*) reports reflect historical trendline yields. The July through November *WASDE* reports, released around the 10th of each month give expected yields based on USDA's latest information and survey results. As expected yields decline relative to trendline yields, November soybean futures prices move higher.

A statistical model was estimated to predict the highest November soybean futures price between May 10 and November 1. The model is based on two variables. The first variable is the price of November soybean futures on May 10. This variable captures the current supply and demand conditions. It also reflects trendline yield expectations for the current growing season. The second variable is the difference between trendline yield and the latest USDA yield expectation. As yield expectations decline, futures prices increase and vice versa. Using data from 1974-1992, an equation was estimated that explains 79 percent of the variation in the highest November soybean futures using these two variables.

Table 2 presents the estimated high November futures price under various combinations of May 10 prices and yield deviations. For example, assume November soybean futures are $7.00 per bushel on May 10. The *WASDE* report on May 10 indicates trendline yields are 33 bushels. On August 11, USDA announces expected yields for the year are 31 bushels. Hence, expected yields are 2 bushels below trendline yields. The yield difference is -2.0 bushels per acre. Under these circumstances, the estimated high price for November soybean futures is $9.30 per bushel. If a subsequent USDA report lowers expected yield to 29 bushels per acre, the yield difference increases to -4.0 bushels (29-33), and the November soybean futures high price estimate increases to $10.02 per bushel.

The top 5 percent of the historical distribution price level and the high price estimated by the yield equation (Table 2) were combined to set the trigger price level. Prior to May 10, the trig-

[1] "Multiple Year Pricing Strategies for Corn and Soybeans Using Cash, Futures, and Options Contracts," unpublished M.S. thesis by Chuck Beckman, Department of Agricultural & Applied Economics, Virginia Tech, May 26, 1995. This research was funded by the Virginia Soybean Board.

Table 1. November Soybeans Futures Price Distributions, 1974-1993.[a]

Price Interval ($/bu)		Percent of Prices[b]	Cumulative Percent[c]
Lower	Upper		
4.50	4.69	0.3	0.26
4.70	4.89	2.1	2.40
4.90	5.09	5.7	8.07
5.10	5.29	5.2	13.26
5.30	5.49	6.0	19.22
5.50	5.69	4.7	23.96
5.70	5.89	8.9	32.82
5.90	6.09	11.1	43.94
6.10	6.29	12.2	56.16
6.30	6.49	7.9	64.04
6.50	6.69	6.0	69.99
6.70	6.89	4.6	74.54
6.90	7.09	4.2	78.75
7.10	7.29	5.9	84.66
7.30	7.49	4.6	89.21
7.50	7.69	2.3	91.46
7.70	7.89	1.3	92.80
7.90	8.09	1.1	93.94
8.10	8.29	1.7	95.67
8.30	8.49	1.6	97.23
8.50	8.69	0.9	98.18
8.70	8.89	0.6	98.81
8.90	9.09	0.5	99.29
9.10	9.29	0.3	99.59
9.30	9.49	0.2	99.76
9.50	9.69	0.1	99.82
9.70	9.89	0.1	99.92
9.90	10.09	0.0	99.95
10.10	10.29	0.0	100.00

[a] Total number observations (daily closing price) equals 6654.
[b] Percent of prices between corresponding lower and upper level.
[c] Percent of prices equal to or less than corresponding upper level.

Table 2. Trigger Price Estimates Based on May 10 Futures Price and Yield Expectations ($/bu)[a]

Yield Difference[b] (bu/ac)	November Futures Price on May 10			
	$7.00	$7.50	$8.00	$8.50
	Trigger Price			
0	8.59	8.86	9.12	9.39
-.5	8.77	0.04	0.30	9.58
-1.0	8.94	9.21	9.47	9.75
-1.5	9.13	9.39	9.65	9.93
-2.0	9.30	9.57	9.83	10.11
-2.5	9.48	9.75	10.01	10.29
-3.0	9.66	9.93	10.19	10.47
-3.5	9.84	10.11	10.37	10.65
-4.0	10.02	10.29	10.55	10.83
-4.5	10.20	10.47	10.73	11.01
-5.0	10.38	10.65	10.91	11.19

[a] Equation is NOVHIGH = 4.86 - 0.357 * YIELD DIFFERENCE + 0.533 * MAY PRICE.
[b] Yield difference = expected yield - trendline yield.

ger price is based only on historical prices. After the release of the May *WASDE* report, the trigger price is the higher of the historical based trigger and the yield equation high price. The three-year strategy is only implemented if current November soybean futures exceed the higher of the two prices, referred to as the combined price trigger.

Figure 2 illustrates how the combined price trigger works. From November 7 of the previous year to May 10, the only trigger is the top 5 percent price of the historical distribution. The historical trigger prices are based only on previous prices. In the illustration, the top 5 percent occurs at the price of $8.25 per bushel. If November soybean futures close above $8.25 between November 7 and May 10, the three-year strategy is implemented.

Sometime around May 10, USDA will release its *WASDE* report. From the *WASDE* report the trendline yield of 34 bushels is determined. Since the trendline yield and expected yield are usually the same in May, the projected price is not affected by yield. Assume November futures are $7.00 per bushel on May 10. The equation predicts a high November futures price of $8.59 (Table 2). The combined trigger price is always the higher of the historical distribution price and the yield equation price. So from May 10 until the next *WASDE* report, the trigger price is $8.59.

In June, USDA estimates yields at 32 bushels per acre, which is 2 bushels less than trendline yield. The yield equation forecasts a high price of $9.30, which becomes the new trigger price. In June, when November soybean futures close above the 5 percent trigger price of $8.25, the strategy is not implemented because November futures are less than the $9.30 yield equation price.

In July, November futures close above the

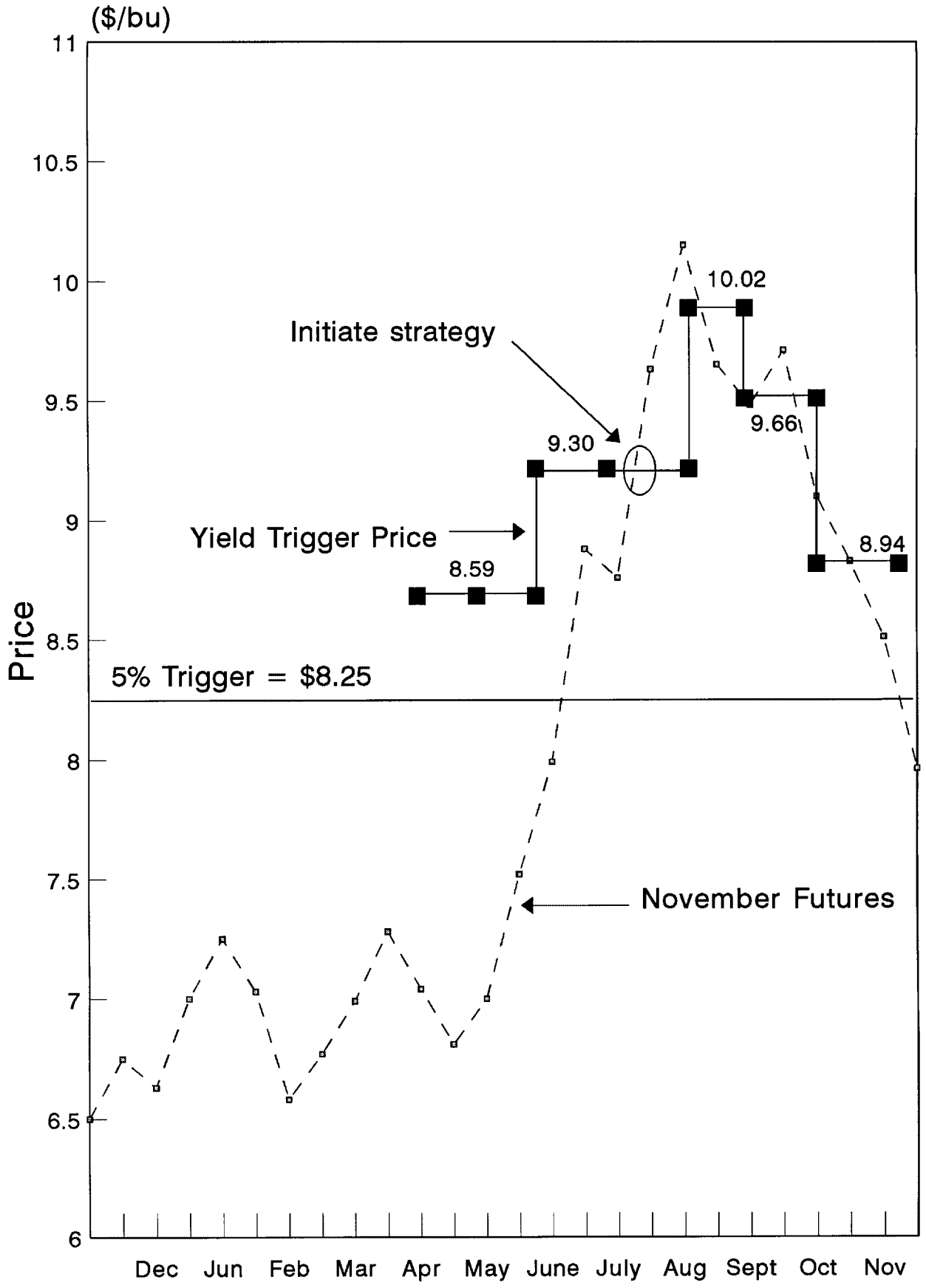

Figure 2. Trigger Price for Three Year Strategy.

$9.30 trigger price. At this price, the strategy should be implemented by selling or buying the appropriate number of cash contracts, futures, and/or options to cover the desired portion of the next three years expected production.

In August, USDA lowers their yield expectation to 30 bushels per acre. The equation estimates a high futures price of $10.02 per bushel based on a May 10 futures price of $7.00 and a 4-bushel difference between expected and trendline yield. Even though the effective trigger price increases to $10.02, the positions established in July are maintained. If the producer desires, additional positions can be added to price a larger percent of expected production. Under the situation illustrated, the producer will receive margin calls during July and August if the futures strategy is used. But without the yield equation, the strategy would have been implemented at a much lower price, both lowering average price and increasing margin calls.

Options Advantages and Disadvantages

Another way to avoid margin calls from higher prices is to use options instead of futures. Buying a put option avoids margin calls if prices move higher. But put options can be expensive, especially when prices are extremely volatile, which they usually are at historically high price levels.

The use of options in the three-year strategy has another significant advantage. If futures prices do not return to typical historical levels, the producer can sell at higher cash prices and lose only the initial premium. This is a substantial advantage over futures if the producer believes there is a significant risk that prices will not return to historical price levels.

There are two problems with using options. First, soybean options were not traded prior to 1985. This problem can be handled by estimating option premiums prior to 1984 using the Black pricing formula, a well-researched and accurate method of estimating premiums. The second problem is that options are frequently only available for six to eight months into the future. In the three-year strategy, the producer needs to be able to price 12 months into the future. This problem is handled by using a May option first and then rolling over to a November option later. This rollover procedure doubles commission costs compared to using futures. More details on this option rollover procedure will be provided later.

The other way to avoid some margin calls is to use cash contracts for the first of the three years. In most cases, cash contracts are not available for the second and third year, so futures or options must be used for years two and three. If cash contracts are available for the second year, they could be used to further reduce potential margin calls.

Our research compared average returns and risks for 49 strategies using various combinations of trigger prices and various combinations of cash, futures, and options contracts. The rest of this publication concentrates on analyzing in detail the returns and risks associated with the best three-year strategies analyzed during years 1980-1993.

Pricing With Futures

The highest returns are obtained by selling futures to cover the next three years production when current November futures prices reach the combined trigger level as illustrated in Figure 2. The transactions necessary to implement this strategy are illustrated in Table 3 using 1988 as an example. In 1988, the trigger price for November soybean futures between May 10 and June 9 was $8.29 per bushel. On June 2, 1988, November 1988 soybean futures closed at $8.34, 6 cents above the trigger price—the signal to sell three years production. On June 2 or the day after, the producer sold three November 1988 futures contracts at $8.34. These three contracts (15,000 bushels) are sold to price 5,000 bushels of soybeans to be produced in 1988, 1989, and 1990. Producers will need to decide based on their own yield variability what percentage of expected production to forward price.

Once these contracts are sold, they are held until harvest which is assumed to be November 1. On November 1, 1988, the three November 1988 contracts are bought back at $7.77. On that same day, two November 1989 contracts are sold at $7.28 to price 5,000 bushels of the 1989 and 1990 crops. These two contracts are held until November 1, 1989, when they are bought back for $5.62. On November 1, 1989, one November 1990 contract is sold for $5.86 to cover the 1990 crop. The November 1990 contract is bought back on November 1, 1990, completing the three-year strategy.

The 1988 three-year strategy returned $24,657 on 15,000 bushels produced across three years (1988, 1989, 1990), for an average price in-

Table 3. Market Transactions Using Futures, 1988-1990.

Date	Transactions	Price	Returns $/bu	Returns Total
6/2/88	Sell 3 Nov 88 futures	$8.34	—	
11/1/88	Buy 3 Nov 88 futures	7.77	0.57	$8,577
	Sell 2 Nov 89 futures	7.28	—	
11/1/89	Buy 2 Nov 89 futures	5.62	1.66	16,600
	Sell 1 Nov 90 futures	5.86	—	
11/1/90	Buy 1 Nov 90 futures	5.96	-0.10	-500

crease of $1.64 per bushel. Most of the increased cash flow occurred in years one (1988) and two (1989), $8,557 and $16,600, respectively. But the real value of this strategy occurred from pricing the 1989 and 1990 crops in the summer of 1988. The harvest price for the 1989 crop was $5.62.[2] The three-year strategy added $2.23 per bushel by making $0.57 in November 1988 futures and $1.66 in November 1989 futures. The harvest price in 1990 was $5.96 per bushel. The three-year strategy added $2.13 per bushel to this price by making $0.57 in November 1988 futures, $1.66 in November 1989 futures, and -$0.10 in November 1990 futures. Commissions and interest on margin money would lower these returns 6-10 cents per bushel.

Pricing With Options

Table 4 contains the transactions necessary to implement the three-year strategy on June 2, 1988, using options. The option strategy is based on buying put options with a strike price closest to the futures price on the day of the transaction. On June 2, 1988, November 1988 futures closed at $8.34, so three November $8.25 put options are purchased for $0.53 per bushel. Total premium expense on June 2, 1988, is $7,950 ($0.53/bu. x 15,000 bu). On October 15, 1988, the three November 1988 $8.25 puts are sold at $0.18 per bushel, for a loss of $0.35 per bushel on 15,000 bushels. On October 15, 1988, the producer would like to buy two November 1989 put options, but they are not trading. So the producer buys two May 1989 $8.25 put options for $0.47 per bushel based on a current May 1989 futures price of $8.32. On April 1, 1989, the producer rolls over the two $8.25 May puts by selling them and simultaneously purchasing two $7.00 November 1989 put options. The $7.00 November put is selected because November 1989 futures are trading for $7.02 on April 1, 1989. On October 15, 1989, the producer sells the two November $7.00 puts and buys one May 1990 put option. The May 1990 put is rolled over on April 1, 1990, to a November 1990 option which is sold on October 15, 1990. The premiums associated with each of these transactions are recorded in Table 4.

The option strategy requires about twice

[2] Harvest price is equal to November futures on November 1.

as many transactions and has higher commission expense, but there are no margin calls. Table 5 contains the initial option premiums for this strategy.

The three-year option strategy across 1988, 1989, and 1989 returns $12,200 compared to $24,657 from the futures strategy. Producers will have to decide if the tradeoff between elimination of margin calls versus reduced returns is acceptable to them.

The potential for large margin calls is greatest in the first year since the expected production for three years has been priced. One way to reduce potential margin calls and large initial premium expense is to use a cash contract for the first or second year of the three-year strategy. Of course, using cash contracts eliminates the possibility of higher prices on the contracted bushels. Cash contract prices were assumed to be available at a basis 5 cents wider than the basis used for futures.

Table 4. Market Transactions Using Options, 1988-1990.

		Returns		
Date	**Transactions[a]**	**Premium**	**$/bu**	**Total[b]**
6/2/88	Buy 3 Nov 88 $8.25 Puts	$0.53	—	
10/15/88[c]	Sell 3 Nov 88 $8.25 Puts	0.18	-0.35	$-5,250
	Buy 2 May 89 $8.25 Puts	0.47	—	
4/1/89[d]	Sell 2 May 89 $8.25 Puts	1.15	0.68	6,800
	Buy 2 Nov 89 $7.00 Puts	0.29	—	
10/15/89	Sell 2 Nov 89 $7.00 Puts	1.53	1.24	12,400
	Buy 1 May 90 $5.75 Puts	0.24	—	
4/1/90	Sell 1 May 90 $5.75 Put	0.04	-0.17	-850
	Buy 1 Nov 90 $6.00 Put	0.19	—	
10/15/90	Sell 1 Nov 90 $6.00 Put	0.01	-0.18	-900

[a] Purchase option with strike price closest to current futures price.
[b] Total returns are net of premium expense.
[c] November options expire around October 20, therefore the rollover occurs on October 15 instead of November 1.
[d] May options expire around April 20, therefore the rollover occurs on April 1.

Table 5. Option Premium Expense When Using All Options Strategy[a]

Date	Amount
6/2/88	$7,950
10/15/88	4,700
4/1/89	2,900
10/15/89	1,050
4/1/90	950

[a] Assumes 5,000 bushels priced for 1988, 1989,and 1990.

Comparison of Strategy Returns

The returns for four of the best strategies analyzed are reported in Table 6. The three-year strategies are all initiated using the combined 5 percent trigger price and yield equation price in 1980, 1983, and 1988. The F/F/F strategy means futures contracts are used for each of the three years. The C/F/F strategy means a cash contract is used in year one and futures are used for years two and three. C/O/O means a cash contract is used in year one and options are used for years two and three. The one-year hedge uses the combined trigger price mechanism but only prices the current year using futures. The harvest price on November 1 is equal to November futures.

Table 6 indicates the three-year futures strategy (F/F/F) increases soybean prices $1.25 per bushel compared to cash sale at harvest and increases price $1.03 per bushel compared to pricing one instead of three years. Substituting a cash contract for futures in the first year reduced returns 2 cents a bushel, but reduced margin calls by $2,800 to $8,400 in the first year (see Table 7). The option strategy (O/O/O) and combined cash contract and option strategy (C/O/O) increases average price by $0.91 and $1.07 per bushel respectively compared to cash. The C/O/O strategy returns are 18 cents per bushel lower than the all futures strategy. Of course, the options strategy involved no margin calls.

Table 6 indicates the three-year strategy achieves its greatest gains in the second and third year. For example, under the futures strategy (F/F/F), the average increase in price per bushel compared to cash is $0.03 in year one, $1.31 in year two, and $2.42 in year three. The option strategy has a similar pattern with larger returns in years two and three. These results confirm that the real gains from the three-year strategy accrue from hedging more than one year's expected production when current prices reach historically high levels.

Margin Calls

The three-year strategy using futures will involve margin calls. The dates and amounts of margin calls for the all futures strategy (F/F/F) are reported in Table 7. These margin call calculations are based on selling 5,000 bushels each for years one, two, and three. Margin calls are received at each 21 cent price increase above the entry price. The largest single margin call is $6,300 on both June 16 and June 20, 1988. The accumulated margin calls for the 1980-1982 three-year strategy is $19,900. The accumulated margin calls for 1983-1985 is $10,500 and for 1988-1990 is $31,600. During the three-year periods, an average of seven margin calls were received, but during 1988-1990, eleven separate margin calls were received. During 1980, 1983, and 1988, the accumulated margin calls would have been reduced by $5,250, $2,800, and $8,400, respectively, by using a cash contract for the first year.

Since margin calls will occur when using futures, producers should thoroughly discuss this pricing strategy with their banker <u>before</u> entering into the futures market. The discussion needs to include the procedures for placing, lifting, and rolling over contracts and the likely amount of margin calls. The strategy results presented assume that once the initial position is taken, no selective hedging occurs. The producer could price additional amounts of expected production, but no premature lifting of futures contracts is assumed. If the producer and banker do not have complete agreement on how the strategy is to be implemented and maintained, the producer should either finance the strategy personally or use the option strategy (O/O/O) or the combined cash contract/option strategy (C/O/O).

Summary

Pricing three years of expected production when November soybean futures reach the top 5 percent level of historical futures prices or exceed the yield equation high price would have increased producer prices $1.25 per bushel compared to selling for cash at harvest. Since 1980, the strategy would have been implemented three times—in

Table 6. Comparison of Returns by Strategy ($/bu).

Year[a]	Cash[b]	One Year Hedge[c]	Three Year Strategies[d]			
			F/F/F	C/F/F	O/O/O	C/O/O
80	9.15	7.87	7.87	7.82	7.39	7.82
81	6.57	8.49	7.03	7.03	7.99	7.99
82	5.40	5.40	7.89	7.89	8.04	8.04
83	8.23	9.03	9.03	8.98	8.55	8.98
84	6.32	6.32	7.60	7.60	7.39	7.39
85	5.16	5.16	7.87	7.87	7.26	7.26
88	7.77	8.32	8.32	8.27	7.70	8.27
89	5.62	5.62	7.81	7.81	6.98	6.98
90	5.96	5.96	8.03	8.03	7.11	7.11
Average	6.69	6.91	7.94	7.92	7.60	7.76

[a] Only compares years when three-year pricing strategy used.
[b] Cash price is November futures on November 1.
[c] Hedge one year when trigger price is met.
[d] F=futures, C=cash contract, and O=options. C/O/O means use cash contract in year 1 and options in years 2 and 3.

1980, 1983, and 1988. Hence, during 1980-1995, nine out of the sixteen years would have been priced using this strategy.

If futures contracts are used, there will be margin calls. Based on the historical price distribution, margin calls could be as much as $10,000 per contract. These margin calls can be avoided by using put options instead of futures. However, during the nine years priced using this strategy between 1980-1995, average returns were reduced $2400 using options (C/O/O) compared to using futures (C/F/F). Producers will have to decide if a $2400 reduction is acceptable in return for avoiding margin calls of $10,000-$30,000 across a three year time period.

In April 1996 when this report was written, November 1996 soybean futures were trading around $7.80 per bushel. Based on historical November futures prices since 1974, the 5 percent trigger price for the three-year strategy in 1996 is $8.22 per bushel. If November 1996 soybean futures reach this trigger price before May 10, 1996, producers need to consider selling a portion of their expected production in 1996, 1997, and 1998.

After May 10, the trigger price becomes the higher of the 5 percent trigger ($8.22) and the computed high prices in Table 2. The trendline yield for 1996 is expected to be about 34.8 bushels per acre. The May 10 *WASDE* report will reveal USDA's estimate of trendline yield. Subsequent reports around the 10th of each month will contain a new yield estimate that can be used to calculate the yield difference. With the yield difference and the November 1996 futures price on May 10, the equation at the bottom of Table 2 or the table values themselves can be used to predict the high price until the next report.

Each producer will need to carefully evaluate the potential risk of these strategies and decide on what combination of cash contracts, options, and futures to use. **Only producers who**

Table 7. Margin Calls Using all Futures Strategy (F/F/F).[a]

Year	Date	Contract Mo/Yr	Contract No.	Amount	Cumulative Total
1980	7/29	Nov 80	3	$3,150	$3,150
	9/2	Nov 80	3	3,150	6,300
	9/18	Nov 80	3	3,150	9,450
	10/22	Nov 80	3	3,150	12,500
	10/28	Nov 80	3	3,150	15,950
	11/18	Nov 80	2	2,100	17,800
	11/20	Nov 80	2	2,100	19,900
1981	none	—	—	—	19,900
1982	none	—	—	—	19,900
1983	8/24	Nov 83	3	3,150	3,150
	8/26	Nov 83	3	3,150	6,300
	12/27	Nov 84	2	2,100	8,400
1984	5/18	Nov 84	2	2,100	10,500
1985	none	—	—	—	10,500
1988	6/3	Nov 88	3	3,150	3,150
	6/6	Nov 88	3	3,150	6,300
	6/15	Nov 88	3	3,150	9,450
	6/16	Nov 88	3	6,300	15,750
	6/20	Nov 88	3	6,300	22,050
	6/21	Nov 88	3	3,150	25,200
1989	3/17	Nov 89	2	2,100	27,300
	11/14	Nov 90	1	1,050	28,350
1990	4/20	Nov 90	1	1,050	29,400
	4/26	Nov 90	1	1,050	30,450
	5/9	Nov 90	1	1,050	31,600

[a] Margin calls received at each 21 cent per bu. increment above entry price. Assume initial sale of three contracts (15,000 bu.) to cover 5,000 bushels of production in each of the three years.

fully understand futures and options trading and the risks associated with the three-year strategy should use them. But history shows that this strategy has the potential to raise prices by over $1.25 per bushel when it is implemented.

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