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**Put Options on Cotton Futures Contracts  
as Low Price Insurance**

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The value of buying put options on futures contracts on cotton has not yet been realized to any substantial extent. The futures price at the beginning of trading of the options on October 30, 1984, was only slightly above the government loan price for cotton, and it has declined since that time. This lack of downside price risk has contributed to the lack of trading in options.

For those cotton growers who are eligible for the loan program, the low price protection achieved by buying put options will have little or no value until the price of cotton moves substantially above the loan price. The latter is not likely to happen in the next 12 months as carryover stocks are currently projected to be very high next August 1.

Until the options started trading in late 1984, we could only guess at the level of the premium that would occur. Now we have at least some limited experience on which to base expectations on premiums that will occur in the future. However, the premiums that have been paid so far are probably somewhat below normal because the futures price of cotton has been so close to the government loan price.

As the futures price of cotton goes up, the premiums also rise. As the strike price rises for any given futures price, the premium rises. As the days till expiration of the option decline, the premium declines. As interest rates rise, the premiums decline, and as the volatility of the futures contract price increases, the premium increases.

Table 1 shows estimates of put option premiums on March futures contracts based upon research on market premiums of recent months. The table holds constant interest rates and volatility while showing the effects of level of futures price, length of time to maturity and the relationship between strike price and futures price.

An option is said to be "at the money" when the option strike price is equal to the futures price. An option is said to be "out of the money" when the strike price of the put option is below the futures price. An option is said to be "in the money" when the strike price of a put option is above the futures price. In the latter case, the premium includes a component called "intrinsic value," which is what the option is worth if it were exercised immediately and is the difference between the futures price and the strike price.

All options have "time value" which is based upon the probability that the option will have some intrinsic value before expiration, but only those options that are "in the money" have intrinsic value. There is a mathematical model called the Black model that incorporates all of these variables, and its estimates of option premiums are very similar to the premiums of actual transactions in options.

**Table 1. Estimated Premiums on Put Options on March Cotton Futures Contracts Purchased in December or March**

cents in or out of money	Purchased in December		Purchased in March	
	futures 60 cents	futures 80 cents	futures 60 cents	futures 80 cents
	----- cents per pound -----			
out 5.00	0.44	0.92	0.32	0.72
out 4.00	0.63	1.18	0.49	0.96
out 3.00	0.88	1.48	0.72	1.24
out 2.00	1.19	1.83	1.01	1.58
out 1.00	1.57	2.23	1.38	1.98
out .50	1.78	2.45	1.59	2.20
at .00	2.01	2.69	1.83	2.44
in .50	2.26	2.93	2.08	2.68
in 1.00	2.53	3.19	2.35	2.95
in 2.00	3.10	3.74	2.94	3.52
in 3.00	3.74	4.34	3.61	4.14
in 4.00	4.43	4.98	4.33	4.81
in 5.00	5.16	5.67	5.10	5.52

Table 1 suggests that a put option can be purchased for less than one-half cent per pound when the March cotton futures contract is at 60 cents in March (12 months before the end of trading of the futures contract) and the strike price chosen is 55 cents per pound. At the other extreme, March futures contracts at 80 cents in December (more than a year before the March futures contract stops trading) and a strike price of 85 cents would command a premium of nearly 6 cents per pound.

In order for put option purchase to be effective as low price insurance, the options at close-out should have a value after allowance for their direct costs that substantially offsets the shortfall in income resulting from low prices. Six of the 12 years in the 1973-84 period had income from spot sales of cotton below the average for the period.

Table 2 shows that in 5 of these 6 years of below average income, the options had a net value after allowance for their costs that was positive. In 1983 the put option strategy would have failed to perform as insurance. Rather than offsetting at least part of the income shortfall, the option purchase actually further reduces net income by 3.1 percent of the average spot market income for the period.

The failure in 1983 derives from the fact that March 1984 futures contracts in March of 1983 were at the lowest level of any March (data adjusted for inflation) in the period and the futures price rose only slightly to November, December and January. The rise in futures price during 1983 caused the options to have no intrinsic value at close-out, but the rise in price was not enough to allow spot prices to reach their average level.

**Table 2. Effects of Put Options Purchase in Years of Below Average Income from Spot Cotton Sales, 1973-84**

Year	Spot market income shortfall	Gain from March purchase of options
	percent of average spot market income	
1974	25.9	45.6
1977	12.2	33.9
1981	29.8	27.5
1982	29.8	8.2
1983	12.0	(-)3.1
1984	31.5	10.1

1982, 1983, and 1984 were years when the futures price was relatively low at the time the option hedge began. While the hedge is in place, the futures price moves relatively little up or down. This basically explains the relatively poor performance of options as insurance in those three years. This is consistent with theoretical analysis of options which tells us that options hedging should perform better than other strategies when prices are highly variable from beginning to end of the hedge, and options are the worst strategy when prices change very little from start to end of the hedge period.

The conclusion must be that options have very great potential to function as "low price insurance" when prices are as highly variable as they were in the 1973-81 period. Since it is impossible to forecast future price variability except when Government programs are firmly in control of prices, farmers and agricultural lenders should seriously consider the purchase of

put options for low price insurance when the prices are not obviously controlled by government.

This research suggests that the cost of the options strategy will run from about 3 to 7 percent of average gross income from the sale of the cotton. This includes the premium, brokerage charges and interest charge on the money invested in this strategy.

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**The Economics of Linear-Move Irrigation: Preliminary Results**

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The development of linear-move irrigation systems arose from attempts to (1) reduce irrigation labor costs, (2) stabilize the cost of irrigation water and (3) increase irrigation efficiencies (Etcheverry; Lyle and Bordovsky). Linear-move systems were originally a modification of drip and center pivot irrigation systems.

In combining components of these two irrigation methods, linear-move irrigation represents a technology which attempts to irrigate and fertilize the crop based on plant growth requirements while keeping investment costs at lower levels relative to other irrigation technologies (e.g. drip). Therefore, as Arizona growers evaluate more efficient irrigation technologies a linear-move system may prove to be a viable candidate (Fangmeier).

Linear-move irrigation systems can be divided into two parts: the inlet manifold, and pump and generator platform; and the distribution manifold. The machine moves linearly across the field with the manifold spanning across the width of the field. The platform carries the pump and generator. A diesel engine runs a generator which powers both the pump and the electric motors on each manifold tower. Water is typically drawn from a ditch beside the platform with the ditch being filled by a well or surface water source.

The manifold distribution system is a six- or eight-inch pipe supported 12 feet above the ground by trusses 120 to 140 feet