PUT OPTIONS ON COTTON FUTURES CONTRACTS AND ALTERNATIVE MARKETING STRATEGIES.

Al-Sakkaf, Ghazi Ahmed

PUT OPTIONS ON COTTON FUTURES CONTRACTS AND ALTERNATIVE MARKETING STRATEGIES

The University of Arizona M.S. 1986

PUT OPTIONS ON COTTON FUTURES CONTRACTS AND ALTERNATIVE MARKETING STRATEGIES

by

Ghazi Ahmed Al-Sakkaf

A Thesis Submitted to the Faculty of the

DEPARTMENT OF AGRICULTURAL ECONOMICS

In Partial Fulfillment of the Requirements
for the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

1 9 8 6

STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at the University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the library.

Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgement of source is made. Request for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgement the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: _____

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Robert S. Firch — March 19, 1986

ROBERT S. FIRCH — Date

Professor of Agricultural Economics

ACKNOWLEDGEMENTS

I would like to express my sincere thanks and appreciations to my advisor Dr. Robert S. Firch, without whom I would never have started this particular project.

My gratitude and thanks to my committee members -- Dr. Paul Wilson and Dr. Merle Faminow for their assistance in the final review of this thesis.

Appreciation is expressed to the Department of Agricultural Economics of University of Arizona for giving me the opportunity to do my graduate study.

Special appreciation goes to the Yemenies government and people for their financial support during this course.

Last, but not least, thanks to all individuals who had helped me in one way or another to finish this research work.

TABLE OF CONTENTS

TABLE OF CONTENTS--Continued

LIST OF TABLES

LIST OF TABLES--Continued

LIST OF ILLUSTRATIONS

ABSTRACT

The main objective of this study was to evaluate alternative marketing strategies involving options on cotton futures contracts during the period of 1973-84. To predict the options premiums that would have occurred at various points in this period of time, the study did intensive research on market premiums of options on cotton futures contracts from the beginning of trading on October 30, 1984 to the end of June, 1985. The research showed that market premiums conformed closely to the premiums implied by Black Model of option pricing. This allowed an evaluation of alternative cotton marketing strategies. The results showed that, over the 12 year period, forward contracting and hedging by selling futures contracts would have lowered average income relative to simple cash sales. On the other hand the results showed that hedging by buying put options would have raised income over simple cash sale. Options may not only provide protection from falling price but may also raise farmers' average income.

CHAPTER I

INTRODUCTION

Cotton is the basic field crop in Arizona with most farmers needing a profitable cotton crop to be successful unless they have unusually low water costs. Arizona produces more cotton than any other state in the United States except Texas, California and Mississippi.

In the period from 1954 through 1972 the market price of cotton was primarily set by the Government price support program with its non-recourse loan program. During this period the farmer had very little opportunity to sell his cotton at more than the support price because the Government owned large quantities of cotton which would be sold at price slightly above the support price. The cotton grower could forfeit the cotton that was under loan to the Government at the support price. Therefore, this was a period when alternative marketing strategies were not utilized by farmers.

Beginning in 1973, rising inflation in the United States and other world-wide conditions caused the market price of cotton to rise substantially above the Government support price. With minor exceptions the market price of cotton has remained above the support price until 1985. In

this period, beginning in 1973 and ending in 1985, market forces rather than government programs have dominated the pricing of cotton. In this period of primarily free-market prices farmers had opportunities to increase or reduce their income from cotton sales by using alternative marketing strategies. For instance, in 1973 a farmer using the strategy of hedging by selling futures contracts in December, before planting his cotton crop, could have reduced his gross income by about 60 percent relative to simply selling on the cash market in December after harvest. The same hedging strategy on the 1974 crop could have very nearly doubled gross income. This indicates that the choice of marketing strategies can affect gross income and even more decisively effect net income.

C. Curtis Cable (1979) looked primarily at alternative marketing strategies available for cotton producers by explaining the advantages and disadvantages of each one of these strategies. This might provide cotton-producers the knowledge to evaluate alternative marketing strategies in order to find the best way to market their crops. These strategies include selling spot cotton at ginning time, storing baled cotton for later sale, cash contracting before ginning, using cotton futures contracts, and cooperative marketing of cotton. His conclusion was that growers should look carefully and become familiar with

alternative marketing strategies before changing their marketing strategy.

Firch (1982) investigated whether forward contracting of cotton in Arizona raised or lowered grower's prices relative to the available spot price in Phoenix during the period of 1973-79. His conclusion was that farmers raised their average price by slightly more than one cent per pound through their forward contracting during the study period. However, he mentioned that, this result may not provide a good experience for predicting what will happen in the futures because, on the 1973-79 crops, forward contracting worked well when the spot price of the preceding cotton crop was very high during its harvest period.

Thompson and Hudson (1983) analyzed the cotton marketing alternatives used by Louisiana growers during the period of 1979-81. The source of their data were mail questionnaires and personal interviews. However, they concentrated more on the interview results. The marketing alternatives included selling cash, forward contracting at a fixed price, storing for later sale, price deferring, and selling through a cooperative. The study shows that selling for cash at harvest, forward contracting at a fixed price, and storing for later sale were the most alternative marketing strategies used by the growers and a large proportion of the crop sold through these strategies.

Forward contacting with a call price and selling through a cooperative were not used by a large number of producers. However, these two marketing alternatives represented a large proportion of the crop sold because in general they were used by a large scale producers. Their conclusion was growers change their marketing strategies with response to the economic and market conditions.

Bailey and Richardson (1985) used a whole-farm simulation model (FLIPSIM) to evaluate alternative marketing strategies for cotton farmers in the southern high plains of Texas over a ten-year period (1983-92). These strategies included discretionary hedging, no hedging, hedge and hold, and seller's call contracts. They compared these strategies with respect to their impact on the farm's (1) probability of survival, (2) probability of success, (3) after-tax net present value, (4) present value of ending net worth, and (5) ending leverage ratio. After-tax net present values were evaluated using stochastic dominance to rank the alternative marketing strategies for risk-averse and risk-neutral producers. Their results showed that the no hedge strategy using a sixty-two-day channel of cash prices to signal cash transactions has a high level of probability to survive and succeed and also generate the highest level of after-tax net present value. This strategy was the most preferred strategy by both the risk-averse and risk-neutral

producers. The cash sale strategy using no technical indicator was one of the least preferred strategy by the risk-averse and the risk-neutral producers.

Futures contracts on cotton have been traded for many years although the level of trading reached very low levels during periods when Government programs effectively set the price of cotton. Forward contracts have been widely used by Arizona cotton growers since 1973. The forward contract prices are closely related to futures contract prices since the buyer of forward contracts will usually hedge by selling futures contracts or at least use the futures market price as an indicator of what the price of cotton may be at various points in the future. The trading of options on futures contracts on agricultural commodities was prohibited in the United States from 1935 to 1983. Trading in options of cotton futures contracts began on October 30, 1984.

Options are a new marketing tool that agricultural producers may use to reduce price risk and improve their profit potential. The profit is equal to total revenue minus total cost. For the one input-one output case in a perfectly competitive market, the profit function is:

$\pi = TR-TC$ or

$\pi = P\ f(X) - rx - b$

where:

P = price of output

f(X) = quantity of output which is a function of input where $f'(X)>0$ and $f''(X)<0$,

r = price of input

x = quantity of input

b = fixed cost

The first-order condition for profit maximization is:

$P\ f'(X) = r$ or

$VmP_x = r$

Therefore, the condition for maximizing profit is the value marginal product (VMP) of each input equal to its price. In the real world this condition might not hold because of the variability of commodity prices. Commodity price instability is a major source of risk to farmers.

A "simple" risk model developed by Sandmo (1971) deals with theory of the competitive market under price uncertainty and risk aversion. The model assumes that a risk averse firm maximizes expected utility of profit. The utility function follows:

$u = u(\pi)$

where:

u = utility

π = profit

The first order condition for the above function is:

$$r \leq \mu f_x$$

where:

$$\mu = E(P).$$

In this case the expected marginal value product of each input exceeds its price. In other words, the optimal quantity demanded for each input is lower than the certainty case (fig. 1) and furthermore, less output is produced and consequently less profit is realized. Therefore, agricultural producers could use options as an alternative strategy to reduce price risk and achieve increase profit potential.

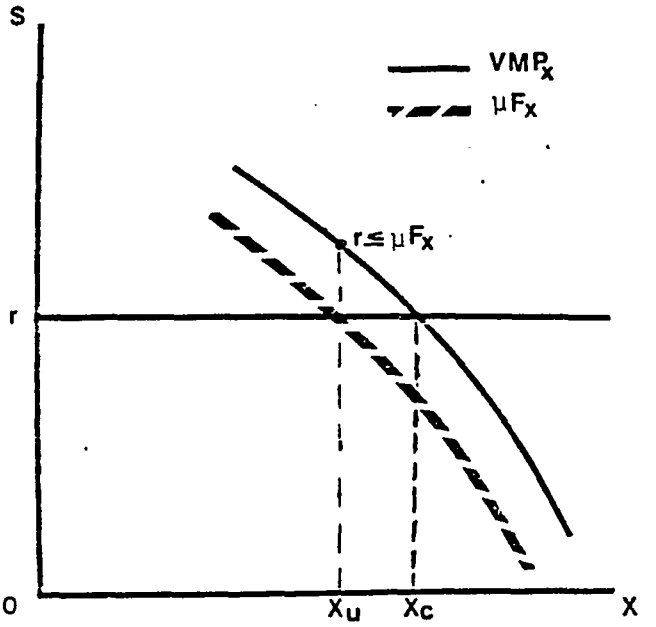

figure 1. The optimal quantity demanded of input (X) under certainty and uncertainty equilibrium.

Until very recently, evaluation of marketing strategies involving options on cotton futures contracts could not be done with confidence because the premiums (the purchase price of the options) were unknown. A mathematical model existed which purported to predict the amount of the premiums under various levels of the variables of time to maturity, interest rates, volatility, level of the futures price and difference between the futures price and the strike price. The research reported below will show that after 2 months of trading the premiums on options on cotton futures contracts have been very compatible with premiums predicted by the mathematical model.

Chapter two will explain the characteristics of options on futures contracts and define the terminology used in options. Chapter three will report on intensive research on premiums on options on cotton futures contracts during the first 8 months of trading. Chapter four will outline seven strategies that will be used to evaluate the effectiveness of options if they had existed during the 1973-84 period. Chapter five will present the results of evaluating the marketing strategies. Chapter six will discuss the potential future role that options on cotton futures contracts may play in the marketing of cotton in Arizona.

CHAPTER II

CHARACTERISTICS OF OPTIONS

An option is a contract that gives the buyer the right--but not the obligation--to buy or to sell a futures contract at a specified price during a specified time period (Kenyon, 1984). The right to sell a futures contract at a fixed strike or exercise price within a specified period of time is a put option. The right to buy a futures contract at a fixed strike or exercise price within a specified period of time is a call option. The price at which the option can be exercised is the strike or exercise price. The cost of purchasing an option is the premium. It is the amount an option buyer pays the option seller and is not refundable. However the premium is not all the money that the option buyer pays. Option buyers and sellers also pay a fee to their brokers. However, this fee is not a substantial cost to the option buyers and sellers. The brokers charges on the purchase or sale of options might be a separate commission for each purchase and each sale, and it might be a fixed fee or a percentage of the price with a minimum and/or maximum fee. Usually an additional fee is charged if the option is exercised.

In options, unlike the futures contracts, the buyer of an option does not have to pay a margin deposit or receive margin calls. However, the option seller (writer), like a futures trader, is required to make an initial margin deposit and pay additional margin or allowed to withdraw margin according to the movement of the premiums against or with his position. If the price of the underlying futures contract of a call options rises, the seller must make additional margin deposit equivalent to the decline in the value of his position.

An option hedger (buyer) is one who owns the commodity or is in the process of producing the commodity and buys put options. The option hedger may also be someone who has definite plans to buy a commodity sometime in the future and wants to avoid paying prices substantially above those currently available in the cash market. This hedger would activate the hedge by buying call options.

An option seller (writer) is someone who expects to earn the premium paid by the option buyer for risking relatively unlimited losses if the futures price rises substantially after selling a call option or the futures price falls substantially after selling a put option. Professional option sellers commonly "hedge" their exposed positions in options by taking appropriate positions in futures contracts and arbitraging good gains with limited

risk. Other option sellers operate in what is called covered options by selling call options representing quantities of the commodity equal to the quantity actually owned or purchased in futures contracts.

The right to buy or sell at strike or exercise price is good until the option expires. The expiration date is the day when the owner of the option loses the right to exercise the option, and so after this date the option is worthless. The options expire several weeks before the last day of trading of underlying futures contracts.

Gains or losses by hedgers in futures contracts are offset by equal cash market losses or gains. The option hedger, unlike the futures hedger, has the right to sell (put option) a futures contract at the strike price which effectively sets a minimum selling price for the spot commodity that has been hedged, but the put option hedger gains all of the benefits of rises in the value of his spot commodity if the price goes up after he has paid the premium and brokerage. If the prices fall, the hedger will exercise the option and obtain a price higher than the market price. If the price increases the hedger will not exercise his option and he loses only the premium and brokerage fee for the purchase transaction. Therefore, with put options, the farmer could eliminate the risk of declining market price without eliminating the opportunity to gain most of the benefit from higher market prices.

The right to buy a futures contract at the strike price (call option) establishes a maximum buying price without eliminating the opportunity to gain most of the benefit from a falling market price after the option is purchased. Through options farmers can establish protection against undesirable price changes while they are allowed to gain most of the advantage from favorable price changes. Therefore, buying options might be similar to buying insurance against price changes (Anderson, 1985).

Options are usually traded at several different strike prices on each futures contract that is currently being traded except that the expiration of the option usually comes several weeks before the last day of trading of the underlying futures contract. When the strike price exceeds the current futures price in a put option and is less than the current futures price in a call option, the option is said to be "in the money" and the difference is the intrinsic value of the option. It is what the option is worth if exercised at current futures and strike prices. When the strike price is equal to the current futures price the option is said to be "at the money". The option is said to be "out of the money" when the strike price is less than the current futures price in a put option and the strike price is greater than the current futures price in a call option. At-the-money and out-of-the-money options have no intrinsic value, but they do have time value.

The option price (premiums) are the sum of their intrinsic value and time value. The intrinsic value depends on two variables; the strike price and the current futures price. If the strike price is above the futures price on a put option the intrinsic value is equal to the strike price minus the futures price. If the strike price is below the futures price on a put option the intrinsic value is equal to zero.

The time value depends on five variables: the price of the underlying futures contract, the difference between the strike price and the futures price, the time to maturation, the price volatility and the interest rate. The time value of options rises as the level of the futures price rises. The time value of options declines as the difference between the futures and strike prices becomes larger. The shorter the time to maturity the lower the time value, assuming other factors are constant, because the probability of the option taking on intrinsic value is reduced with the shorter length of time to expiration. The time value will rise with increased price volatility, because the probability of the option taking on intrinsic value is increased and therefore the option seller will insist upon a higher premium. The time value of options will decline with increases in interest rates since the purchase of options becomes less attractive to the purchaser

because he must pay the premium at time of purchase and the benefits of the option, if any, come some time later.

Options can be bought and sold on any weekday that is not a holiday. An option buyer can always offset his option by trading out of the option any time before the expiration date. The option buyer does not need to exercise his option unless that is more beneficial to him than closing with an offsetting transaction. Just as those who deal in futures contracts rarely make or receive delivery of the actual commodity the buyer of the option will usually close the position by selling the same option and telling the broker that it is a closing transaction. After sale of the option, the net proceeds to the person who previously purchased the option would be the option premium at sale minus the premium at purchase minus a brokerage charge for each of the transactions.

CHAPTER III

RESEARCH ON OPTION PREMIUMS

Research on option premiums is needed so that the pricing of options can be understood and predicted for periods in the past when options were not traded and when they may be traded in the future. Options on cotton futures contracts began trading on October 30, 1984. As discussed in a previous chapter intrinsic value of a put option is simply the difference between the strike price and the futures price when the strike price is above the futures price, and it can be known exactly when the strike and futures prices are specified. The determinants of the time value (TV) are complex, and prediction of TV requires specific research.

To predict the TV this study computed daily time values of the December and March put options using futures prices, strike prices, and the premiums of each one of these strike prices from the beginning of trading until June 30, 1985. The time value is simply the premium minus the intrinsic value. The TV was then made a function of the strike price minus the futures price (S-F). The study then fitted special regression functions to the daily time values aggregated by months. As we discussed in Chapter II, the time value depends on five variables: the price of

underlying futures contract, the difference between the strike price and the futures price, the time to maturation, the price volatility and the interest rate. The market data that we have are the strike prices, the futures prices, and the time to maturation which is constant for each underlying futures contract. To get the implicit values of interest rate and volatility we need to summarize the market data. Therefore, the study fitted these regression functions to summarize the relationships between time values and strike price and futures prices. The regression equation follows:

$$TV = b_0 + b_1(S-F)d1 + b_2(S-F)^2 d1 + b_3(S-F)d2 + b_4(S-F)^2 d2 + e$$

where d1 and d2 are dummy variables assuming:

d1 = 1 if S-F < Zero; d1 = 0 if S-F > Zero;

d2 = 1 if S-F > Zero; d2 = 0 if S-F < Zero;

d2 = 1 if S-F = Zero; d1 = 1 if S-F = Zero.

This regression function with specially structured dummy variables allowed the fitting of a continuous function to the data in which the TV has its highest value when S-F = zero, and TV declines at a decreasing rate as S-F takes on larger positive or negative values. Other forms of continuous regression functions obviously fit the data at S-F = zero very poorly. Fitting one regression function to S-F > zero data and another regression function to S-F < zero data produced conflicting predictions of TV when S-F = zero

with the specially structured dummy variables fit the data very well, produced single (non-contradictory) predictions of TV when S-F = zero. The prediction of the TV when the options are at-the-money is simply the intercept value of the equations. Another interesting characteristic of this regression equation is that it fits different slopes and curvature to the two sides of the function if that is what is appropriate to the data. These regression functions were fitted for each month of cotton put options beginning with November of 1984 (the first month of trading) and ending with June of 1985. Table 1 reports estimated coefficients, standard errors, and adjusted R2 of each month of option time values for the December put options. Table 2 shows the estimates for the March put options.

Table 1. The Estimated Coefficients, Standard Errors, and Adjusted R^2 of Each Month of Option Time Values for the December Put Options.

Month	Constant	$(S-F)d_1$	$(S-F)^2d_1$	$(S-F)d_2$	$(S-F)^2d_2$	AdjR2
November	2.0168[a]	0.5591	0.0668	-0.6487	0.0581	0.7610
	0.0768[b]	0.0839	0.0189	0.0816	0.0172	
December	2.1948	0.6490	0.0750	-0.7029	0.0713	0.9040
	0.0587	0.0740	0.0186	0.0583	0.0115	
January	1.9123	0.4964	0.0369	-0.5678	0.0491	0.9250
	0.0389	0.0403	0.0082	0.0408	0.0087	
February	1.6323	0.5662	0.0625	-0.4519	0.0194	0.9710
	0.0228	0.0251	0.0054	0.0271	0.0064	
March	1.5741	0.4830	0.0449	-0.5014	0.0390	0.9830
	0.0149	0.0170	0.0037	0.0186	0.0045	
April	1.4838	0.4548	0.0419	-0.5189	0.0469	0.9520
	0.0190	0.0206	0.0042	0.0234	0.0058	
May	1.4541	0.4956	0.0538	-0.4952	0.0461	0.9600
	0.0182	0.0275	0.0082	0.0189	0.0040	
June	1.5911	0.5082	0.0552	-0.4891	0.0409	0.9730
	0.0152	0.0238	0.0075	0.0153	0.0031	

Source: Fitted Regression Functions.

[a]The estimated coefficient of the constant.

[b]The estimated standard error of the coefficient.

Table 2. The Estimated Coefficients, Standard Errors, and Adjusted R^2 of Each Month of Option Time Values for the March Put Options.

Month	Constant	$(S-F)d_1$	$(S-F)^2d_1$	$(S-F)d_2$	$(S-F)^2d_2$	AdjR2
November	2.5623[a]	0.4615	0.0372	-0.9474	0.1236	0.7360
	0.0867[b]	0.0971	0.0221	0.0944	0.0207	
December	2.7780	0.7495	0.0621	-0.9830	0.1071	0.8730
	0.0872	0.1072	0.0266	0.0920	0.0191	
January	2.4322	0.3816	0.0103	-0.5150	0.0233	0.9390
	0.0403	0.0400	0.0080	0.0424	0.0091	
February	2.1861	0.4533	0.0271	-0.5071	0.0175	0.9630
	0.0303	0.0336	0.0071	0.0348	0.0081	
March	2.0119	0.4921	0.0371	-0.5756	0.0384	0.9170
	0.0419	0.0457	0.0095	0.0526	0.0130	
April	1.8240	0.4757	0.0374	-0.6121	0.0529	0.9480
	0.0307	0.0316	0.0065	0.0325	0.0069	
May	1.7160	0.4626	0.0398	-0.5159	0.0396	0.9010
	0.0456	0.0453	0.0092	0.0489	0.0104	
June	1.5528	0.4389	0.0389	-0.5218	0.0479	0.9380
	0.0226	0.025	0.0055	0.0257	0.0059	

Source: Fitted Regression Functions.

[a]The estimated coefficient of the constant.

[b]The estimated standard error of the coefficient.

The intercept (constant) and slope coefficients in Tables 1 and 2 were used to estimate the time value of put options at-the-money and options in-the-money and out-of-the-money by .5, 1, 2, 3, 4 and 5 cents. These are reported in Tables 3 and 4 for December and March options. For

example, calculation of the estimate of the time value for a December put option in November, 5 cents out-of-the-money is as follows:

$$TV=2.0168 + .5591(1)(-5) + .0668(1)(-5)^2 - .6487(0)(-5) + .0581(0)(-5)^2.$$

Table 3. The Estimated Time Values for December Options.

Month	At-The-Money	Out-Of-The-Money					
	0	-0.50	-1.00	-2.00	-3.00	-4.00	-5.00
	Cents Per Pound						
November	2.02	1.75	1.52	1.17	0.94	0.85	0.89
December	2.19	1.89	1.62	1.20	0.92	0.80	0.82
January	1.91	1.67	1.45	1.07	0.76	0.52	0.35
February	1.63	1.36	1.13	0.75	0.50	0.37	0.36
March	1.57	1.34	1.1	0.79	0.53	0.36	0.28
April	1.48	1.27	1.07	0.74	0.50	0.34	0.26
May	1.45	1.22	1.01	0.68	0.45	0.33	0.32
June	1.59	1.35	1.14	0.80	0.56	0.44	0.43

Month	At-The-Money	In-The-Money					
	0	0.50	1.00	2.00	3.00	4.00	5.00
	Cents Per Pound						
November	2.02	1.71	1.43	0.95	0.59	0.35	0.23
December	2.19	1.86	1.56	1.07	0.73	0.52	0.46
January	1.91	1.64	1.39	0.97	0.65	0.43	0.30
February	1.63	1.41	1.20	0.81	0.45	0.14	-.14
March	1.57	1.33	1.11	0.73	0.42	0.19	0.04
April	1.48	1.24	1.01	0.63	0.35	0.16	0.06
May	1.45	1.22	1.01	0.65	0.38	0.21	0.13
June	1.59	1.36	1.14	0.78	0.49	0.29	0.17

Source: The Intercept (constant) and slope coefficients.

Table 4. The Estimated Time Value for March Options.

Month	At-The-Money	Out-Of-The-Money					
	0	-0.50	-1.00	-2.00	-3.00	-4.00	-5.00
	Cents Per Pound						
November	2.56	2.34	2.14	1.79	1.51	1.31	1.18
December	2.78	2.42	2.09	1.53	1.09	0.77	0.58
January	2.43	2.24	2.06	1.71	1.38	1.07	0.78
February	2.19	1.97	1.76	1.39	1.07	0.81	0.60
March	2.01	1.78	1.56	1.18	0.87	0.64	0.48
April	1.82	1.60	1.39	1.02	0.73	0.52	0.38
May	1.72	1.49	1.29	0.95	0.69	0.50	0.40
June	1.55	1.34	1.15	0.83	0.59	0.42	0.33

Month	At-The-Money	In-The-Money					
	0	0.50	1.00	2.00	3.00	4.00	5.00
	Cents Per Pound						
November	2.56	2.12	1.74	1.16	0.83	0.75	0.92
December	2.78	2.31	1.90	1.24	0.79	0.56	0.54
January	2.43	2.18	1.94	1.50	1.10	0.75	0.44
February	2.19	1.94	1.70	1.24	0.82	0.44	0.09
March	2.01	1.73	1.47	1.01	0.63	0.32	0.09
April	1.82	1.53	1.26	0.81	0.46	0.22	0.09
May	1.72	1.47	1.24	0.84	0.52	0.29	0.13
June	1.55	1.30	1.08	0.70	0.42	0.23	0.14

Source: The intercept (constant) and slope coefficients.

A 1973 article in the Journal of Political Economy reported the development of a mathematical model for estimating option premiums on options on shares of corporate stocks. (Black and Schoales,1973) In 1976 Black reported the development of a mathematical model for estimating the premiums on options on commodity contracts. (Black,1976) The Black model estimates the option premium as a function of the variables of time to maturity, interest rate, volatility, level of futures prices, and difference between the futures prices and strike prices. Black suggested that the appropriate interest rate for the model was a riskless interest rate, and other researchers have inserted their judgment of the riskless interest rate. (APPENDIX B provides the equation and variables that are used in the Black Model.)

In the research reported here the assumption was made that the appropriate interest rate and volatility are those perceived by the people trading the options and not values that can be computed outside the context of the Black model. Essentially an infinite number of combinations of interest rate and volatility will cause the Black model to estimate a single point on the time value function. Since this is a nonlinear function, a particular combination of values for the interest rate and volatility variables will cause the Black model to more closely match several values

on the time value function than any other combination of the two variables.

Therefore, this study used the Black model to experimentally find the particular values of interest rate and volatility that best fit the regression function estimates of time value for each month of trading for put options at-the-money and .5, 1, 2, 3, and 4 cents in-the-money. The criteria for "best fit" was that combination of interest rate and volatility that had the smallest sum of the absolute errors. The decision was made to omit the 5 cent in-the-money time value because the market is far less consistent in pricing these options than options less far in or out-of-the-money. The time values of out-of-the-money put options were omitted in an effort to reduce the effects of the downward bias on premiums due to the fact that market prices were only slightly above the government support price while the market time values for the regression functions were generated.

The interest rates and volatilities implied by the Black model and the regression function time values are reported in Table 5. The estimated interest rates for November and December seem exceedingly high. Perhaps this can be attributed to a learning process since this was the first two months that options on cotton have ever been traded in a formal market. It was decided to ignore the

first two months of trading and base the computation of option premiums for later parts of the research on the average interest rate and volatility values for the December put options for the months January through June. The average of interest rates is 7.09, and the average of volatilities is 8.56. The implied interest rates on the March put options were substantially higher and more erratic than those for the December options. This can be explained by the fact that the volume of trading and open interest in the March options was much smaller for the December options. The market premiums reported by the New York Cotton Exchange were frequently nominal values for the March options without basis in actual trading. The December option premiums were always based on actual trades.

Table 5. Interest Rates and Volatility Implied by Black Model.

Month	December Options		March Options	
	Interest Rate	Volatility	Interest Rate	Volatility
November	17.00	8.82	29.30	11.85
December	21.00	10.35	51.30	16.90
January	9.70	8.55	8.05	9.34
February	7.26	7.65	11.70	9.20
March	7.80	8.00	15.00	9.17
April	8.20	8.00	16.75	8.70
May	4.00	8.50	7.75	8.15
June	5.60	10.65	6.90	8.05

Source: Regression Function Time Value, Futures Prices, and Strike Prices Using Black Model.

This study used the average of interest rates and volatilities that were implied by the regression functions time values using the Black Model to predict the premiums in the past when options were not traded. The actual premiums might be higher or lower than the predicted premiums. With strike and futures prices both at 70 cents/pound and days to maturity held constant at 240, a 10 percent change in interest rates (for example, if the interest rate is 10% per annum, this implies a change to annual interest rates of 9% or 11%) in the Black Model produces only a .5 percent change in premiums in the opposite direction and a 10 percent change in volatility produces a 10.3 percent change in the

premium in the same direction. Therefore, it seems that interest rate variations have a small effect on premiums and these variables move in opposite directions. On the other hand, the variation of the volatility seems to have greater effect on the premiums in the same direction. Table 5 shows that there are small variations in the volatility during the first 8 months of trading options. This is reported to give the reader some insight to the variations of the interest rate and volatility which might effect the option premiums that were used in this study.

CHAPTER IV

ASSUMPTIONS ON ALTERNATIVE MARKETING STRATEGIES

Base Strategy: Cotton Sold Only on Cash Market

The cotton harvest begins in Arizona in late September, reaches full-scale operations in mid October, then begins to slow in early December and effectively ends by the end of January. With lags in ginning, large quantities of cotton are not available for sale until late October and nearly all of the crop is available for sale by the last week of January. Increased module storage of cotton in recent years has tended to cause cotton to be ginned slightly later on average than was true in earlier years. Some farmers deliberately postpone selling at least a part of their crop until after January 1st to delay income tax payments. Heavy involvement in managing the harvest operations may also tend to cause some lag between the time of harvest and time of sale. A comprehensive 1984 research study by Ethridge and Caillavet showed that as a general policy delaying sale of cotton by use of the Government loan program resulted in reduced income, after allowance for added costs, in the period 1974 to 1983.

It is assumed in this study that farmers sell their cotton as early as it is convenient with some consideration

for deliberate delay to January for tax reasons. Specifically, it is assumed that a representative situation would have a farmer selling on the cash market 200 bales of cotton in the week before Thanksgiving, 200 bales the week before Christmas and 200 bales the last full week of January. The typical gross weight of a cotton bale is 500 pounds, but since cotton is sold on a net-weight basis there is about 480 pounds per bale after adjustment for weight of bagging and ties.

All of the cotton sold is assumed to be SLM grade (strict low middling). In most years Arizona sells more bales of M (middling) than the lower grade SLM. A substantial amount of the Arizona crop is sold at grades lower than SLM in contrast with very little sold at grades above M. Assuming all Arizona cotton is SLM understates the value of the average cotton sold somewhat. It is assumed that all cotton sold is 1-1/16 inch in length. Most cotton sold in Arizona is longer than 1-1/16 than shorter. Therefore, assuming that all of the Arizona cotton is SLM and 1-1/16 somewhat understates the real value. The principal reason for the SLM and 1-1/16 assumption is that the only U.S. futures contract that is traded in substantial volume is the New York contract based on SLM and 1-1/16 inch cotton. The futures contracts on 1973 crop cotton were M and 1-1/16 cotton, and since the 1973 crop the New York

futures contracts have all been SLM and 1-1/16 cotton. The futures contract prices on the 1973 crop were adjusted by the average differences in the cash market between SLM and M cotton. The options contracts are based upon the New York futures contract. Although the SLM 1-1/16 assumption does understate the average value of Arizona cotton the prices of various grades and lengths do tend to move together fairly closely, and the SLM 1-1/16 price may at least be a reasonable index of the average Arizona cotton price.

An important issue in marketing strategies involving futures contracts and forward contracts is that these are for fixed quantities while the quantity to be fixed in price is variable and cannot be known very precisely until harvest and ginning are completed. This leads to recommendations such as only one-half of expected production should be fixed in price. This research avoids this potentially complex optimization problem by assuming that this decision can be made independently of marketing strategies and the quantities that are forward priced are less than total realized production.

Sell Cotton on Forward Contract in December

Forward contracting became a commonly used marketing practice by Arizona farmers beginning at planting time for the 1973 cotton crop. It was at this time that market prices rose substantially above the Government support-price

for the first time in several years. In the period from 1973 to 1985 the market price has generally been sufficiently above the support-price and forward contracting has been an available and meaningful strategy. Forward contracts have been written as much as two years before the cotton to be delivered on the contract was harvested. The most common time to forward contract is at the time the crop is being planted. Buyers on forward contract will usually hedge their commitments on forward contract by selling futures contracts for a similar quantity of cotton. Also buyers on forward contract will contract to sell finished product at the time of forward contracting to substantially reduce their price risks. Some cotton on forward contract is not hedged in futures or sale of finished product. Futures contracts start trading about 18 months before their expiration date.

Forward contracts in Arizona are based upon M and 1-1/16 cotton with specified premiums and discounts for cotton of better or worse grade or staple length. This does pose some price uncertainty for the buyer on forward contract because the futures contract that is used in hedging is for SLM rather than M grade. Forward contracts have characteristics similar to futures contracts but essentially every forward contract is unique while every December futures ccntract is interchangeable with every

other December futures contract expiring the same year. The forward contract in Arizona usually is written for a specified number of bales, and the seller is responsible for delivering that number of bales even if he must buy cotton in the cash market to fulfill the contractual responsibility. In other areas of the country contracts are written that allow/require the farmer to deliver all the cotton harvested from specified fields without regard to yield per acre. These acre-contracts have only rarely been available in Arizona. Forward contracting has no transaction costs that are not otherwise applicable to cotton sold on the cash market.

In strategy 2a it is assumed that farmers forward contract their next cotton crop in December as they are completing the harvest of the previous crop. A survey of the people who are the agents and write nearly all of the forward contracts in Arizona indicates that 4.50 cents per pound is considered to be a normal differential between the December futures price (SLM and 1-1/16) and the price available in Arizona on forward contract for cotton that is SLM and 1-1/16 inch. The forward contract price in this strategy is found by computing the average of the daily closing prices on December futures contracts in the week before Christmas and subtracting 4.50 cents per pound.

Sell Cotton on Forward Contract in March

Strategy 2b. would be exactly like 2a. except that the forward contracts would be written in March, which is in the planting season, rather than December. The forward contract price in this strategy is found by computing the average of the daily closing prices on the futures contracts in the week nearest the middle of March and subtracting 4.50 cents per pound.

Sell December and March Futures Contracts in December

Hedging is the process of selling futures contracts when you own the actual (cash) commodity and buying futures contracts when you sell the cash commodity. Rarely is it more beneficial to the hedger to deliver his commodity on the futures contract than to buy the futures contract and sell the commodity that he owns on the cash market. In this analysis the farmer is assumed to sell all of the commodity that he owns on the cash market rather than delivering it on the futures contract. The process of hedging allows the farmer to fix the price for his commodity, at the time that he sells the futures contracts, as that futures price minus the difference between the futures price at the time he sells the cash commodity and the cash price in his local market. Relatively few Arizona cotton growers hedge by selling futures contracts. This is probably because forward

contracting has had more appeal than hedging using futures contracts.

Hedging works to effectively set the price that the farmer receives because the cash and futures prices normally move up and down closely together. If the prices decline, the value of the hedged commodity declines, but the loss in value is approximately offset by gains that are realized when the futures contracts are bought. If prices increase, the value of the hedged commodity increases, but this gain is approximately equal to the loss on the futures contracts when the futures contracts are bought. Hedging using futures contracts reduces the price risks associated with price changes relative to the risks of simple cash sale without any forward price fixing. The remaining price risk is a function of variations in the difference between the futures price and the local cash market price at the time the cash commodity is sold.

A typical brokerage charge for buying and selling one cotton futures contract is $90. The brokerage charge is typically not paid until the futures position is closed with the purchase of futures contracts, and therefore there are no opportunity costs associated with the payment of brokerage charges on hedging by selling futures contracts. Before a hedger is allowed to sell a futures contract he is required to make a margin deposit with his broker to

guarantee that any loss in value of the futures position will be paid. If the futures price goes up after the hedger has sold futures contracts the futures position has lost value because to close out the position by buying at then current futures price would result in a loss. When the futures position is in a loss situation as explained here the hedger must deposit additional funds in the margin account to compensate the loss. If instead the futures price decrease after the hedger has sold futures contracts the futures position gains positive value because the position could be closed out at a gain by buying futures contracts at the now lower price. This surplus value in the margin account can be withdrawn from the margin account and invested for income.

The required margin account can generate costs from interest charges on borrowed money or opportunity costs, or it can generate added income if surplus margin money can be withdrawn and invested elsewhere. In the marketing strategies involving selling futures contracts it is assumed that $750 margin per futures contract is maintained during the entire period of the hedge, and if the futures price at buy is higher than at sell one-half of the difference is maintained on deposit during the entire period of the hedge. If the futures price at buy is lower than at sell one-half of the difference is withdrawn from the margin account and

invested for income. The applicable interest charge or return on investment is assumed to be 10 percent.

Each futures contract is for delivery of 50,000 pounds of cotton or about 100 bales of about 500 pounds each. Futures contracts mature (expire) approximately the 10th day of each of the months of March, May, July, October and December. The December contract has clearly the highest level of trading and is preferred by farmers who hedge or others who hedge forward contracts because it matures about the time the harvest is complete. Hedgers usually want to close out their futures positions before the last week of trading because these markets sometimes become somewhat erratic in the last few days of trading. A complete hedge requires that the futures contract be traded at least to the date of the cash commodity sale. The base strategy has the farmer selling 200 bales in the week before Thanksgiving, 200 bales in the week before Christmas and 200 bales the last week of January. Hedging this pattern of cash market sales would best be done by selling 2 December futures contracts and selling 4 March futures contracts. At the time of November cash sale of 200 bales 2 December futures contracts are purchased closing the position in December futures contracts. At the time of the December sale of 200 bales 2 March futures contracts are purchased. At the time of January sale of 200 bales 2 March futures contracts are

purchased closing the position in March futures contracts. In strategy 3a. the 2 December and 4 March futures contracts are sold at the average of the daily closing prices on the week preceding Christmas.

Sell December and March Futures Contracts in March

Strategy 3b. is identical with strategy 3a. except the December and March futures contracts are sold at the average of the daily closing futures prices in the week closest to the middle of March.

Buy Put Options on the March Futures Contract in December

The basic structure of options on futures contracts has been explained in a preceding chapter. The options on the December futures contract expire about November 1, and the options on the March futures contract mature about February 7. Hedging with options is most effective when the option expires soon after the sale of the cash commodity. Since the first cash commodity sale comes in the week preceding Thanksgiving it is not feasible to hedge using the option on the December futures contract. All of the cash commodity sales as outlined in the base strategy occur before the option on the March futures contract expires.

Representative brokerage charges on the purchase or sale of options is 5 percent of the premium paid for the option but not less than $25 nor more than $100 per option.

The brokerage charge must be paid immediately when the option is purchased. Therefore, an interest or opportunity cost must be assessed for the brokerage charge for buying and the premium for the option during the time the option is available for exercise. There is also a brokerage charge if the option is exercised, but since the exercise would occur at the time the cash commodity is sold there should be no opportunity cost charge on the brokerage if the option is exercised. Buying an option requires no margin deposit as was explained in futures contract transactions. Alternative strategies within strategy 4a. evaluate the relative effectiveness of buying put options at-the-money and .50, 1.00, 2.00, 3.00 and 5.00 cents in-the-money or out-of-the-money. The best level of in or out-of-the-money put options will be compared with the other marketing strategies.

In strategy 4a. 6 put options on the March futures contract are purchased in the week preceeding Christmas at the premiums developed in a preceding chapter. At the time of the cash sale of 200 bales of cotton 2 put options are exercised if they have intrinsic value. Two more put options are exercised at the time of the December cash sale. The remaining 2 put options are exercised at the time of the January cash sale if they have intrinsic value at that time. Time value is assigned to be equal to zero at exercise of

the options. This will slightly undertake the value of the options strategies.

Buy Put Options on the March Futures Contract in March

Strategy 4b. is identical with 4a. except the option on March futures contracts are purchased in the week nearest the middle of March.

CHAPTER V

RESULTS FROM ALTERNATIVE MARKETING STRATEGIES

This study looks at alternative marketing strategies that follow from the assumptions discussed in Chapter IV. These strategies include simple cash sale, forward contracting, hedging by selling futures contracts, and hedging by buying put options at-the-money and .50, 1.00, 2.00, 3.00, 4.00 and 5.00 cents in-the-money and out-of-the-money during the period of 1973 through 1984. This was a period in which the government loan price had minimal direct effect on market prices for cotton. To evaluate these alternative strategies the study calculates the average income and the variability of income of each alternative strategy. The measure of variability here is the standard deviation. The study reflects all marketing costs including brokerage costs in futures contracts, premiums and brokerage fees in option contracts, and the foregone interest on money used in margins on futures contracts or premiums on options and brokerage costs. The results of evaluating these alternative strategies will be presented in this chapter, and the best level of in or out-of-the-money put options will be compared with the other marketing strategies. The prices of cotton have been adjusted to the value of the dollar in 1984. (APPENDIX A)

Base Strategy--Cotton Sold Only on Cash Market

Table 6 shows the gross receipts of each year from simple cash sale, during the period of 1973-84. The average income and variability are equal to 252,916 and 78,923 dollars.

Table 6. The Gross Receipts of Each Year from Simple Cash Sale During the Period of 1973-84.

crop year	Cash Market Prices			Gross Receipts
	November	December	January	
	- - - - - dollars per pound - - - - -			dollars
1973	1.4117	1.6473	1.5174	439,334
1974	0.6823	0.6236	0.6474	187,517
1975	0.8734	0.9448	0.9771	268,349
1976	1.2106	1.1688	1.1688	340,627
1977	0.7524	0.7493	0.8109	222,010
1978	0.9333	0.9463	0.8755	264,490
1979	0.8639	0.8980	1.0428	269,251
1980	1.0456	1.0093	0.9921	292,512
1981	0.6071	0.5998	0.6432	177,610
1982	0.6101	0.6190	0.6203	177,542
1983	0.7851	0.7727	0.7609	222,595
1984	0.5950	0.6151	0.5936	173,155
mean[a]=	0.8642	0.8828	0.8875	252,916
S.D.[b]=	0.2545	0.3028	0.2724	78,923

Source: Phoenix market prices as we assume in chapter four and the prices have been adjusted to the value of dollar in 1984.

[a]The calculated average income.

[b]The calculated standard deviation.

Sell Cotton on Forward Contracts in December

Table 7 shows the gross receipts of each year from this strategy during the period of 1973-84. The calculated

average income and variability are equal to 246,180 and 53,741 dollars.

Table 7. The Gross Receipts of Each Year From Forward Contract in December During the Period of 1973-84.

crop year	December Futures	Forward Contract Price	Gross Receipts
	- dollars per pound -		dollars
1973	0.6291	0.5841	168,221
1974	1.2928	1.2478	359,366
1975	0.7750	0.7300	210,240
1976	0.9726	0.9276	267,149
1977	1.1016	1.0566	304,301
1978	0.8720	0.8270	238,176
1979	0.9321	0.8871	255,485
1980	0.9726	0.9276	267,149
1981	1.0158	0.9708	279,590
1982	0.7618	0.7168	206,438
1983	0.7210	0.6760	194,688
1984	0.7511	0.7061	203,357
mean[a] =	0.8998	0.8548	246,180
S.D.[b] =	0.1866	0.1866	53,741

Source: Phoenix market prices as we assume in chapter four and the prices have been adjusted to the value of dollar in 1984.

[a]The calculated average income.

[b]The calculated standard deviation.

Sell Cotton on Forward Contracts in March

Table 8 shows the gross receipts of each year from the strategy of forward contacting in March during the 1973-84 period. The calculated average income and variability are equal to 250,130 and 40,908 dollars.

Table 8. The Gross Receipts of Each Year From Forward Contract in March During the Period of 1973-84.

crop year	December Futures	Forward Contract Price	Gross Receipts
	- dollars per pound -		dollars
1973	0.7987	0.7537	217,066
1974	1.1449	1.0999	316,771
1975	0.8087	0.7637	219,946
1976	0.9839	0.9389	270,403
1977	1.1530	1.1080	319,104
1978	0.9436	0.8986	258,797
1979	0.9132	0.8682	250,042
1980	0.9703	0.9253	266,486
1981	0.9741	9.9291	267,581
1982	0.7776	0.7326	210,989
1983	9.7365	0.6915	199,152
1984	0.7576	0.7126	205,229
mean[a] =	0.9135	0.8685	250,130
mean[b] =	0.1420	0.1420	40,908

Source: Phoenix market prices as we assume in chapter four and the prices have been adjusted to the value of dollar in 1984.

[a]The calculated average income.

[b]The calculated standard deviation.

Tables 7 and 8 show that forward contracting in March was superior to forward contracting in December because it resulted in higher average of income and lower variability of income.

Sell December and March Futures Contracts in December and March

Table 9 shows the gross receipts from these two strategies for each year during 1973-84 period of time. The calculated average of income and variability of income for

selling futures contracts in December are equal to 242,019 and 59,082 dollars, and 247,039 and 44,163 for futures contract hedging in March.

Table 9. The Gross Receipts of Each Year From December and March Futures Contracts In December and March During the Period of 1973-84.

crop year	DECEMBER	MARCH
	- - - - - - dollars - - - - - -	
1973	136,864	191,151
1974	363,199	321,092
1975	199,286	210,343
1976	253,580	259,244
1977	308,934	325,188
1978	239,416	262,980
1979	254,118	249,658
1980	261,456	257,260
1981	276,847	263,795
1982	202,593	208,833
1983	200,525	205,702
1984	207,406	209,222
mean[a] =	242,091	247,039
S.D.[b] =	59,082	44,163

Source: Phoenix market prices as we assume in chapter four and the prices have been adjusted to the value of dollar in 1984.

[a]The calculated average income.

[b]The calculated standard deviation.

From Table 9 selling December and March futures contracts in March was superior to the selling of December and March futures contracts in December since it produced higher average income and lower variability of income.

Buy Put Options on March Futures Contracts in December

More than half of Arizona cotton crop is usually harvested and ginned after November 1. Therefore, it is not feasible to hedge using the option on the December futures contract because the trading on the December options ends about the first of November. However, buying put options on the December futures contracts would be appropriate on very early harvested cotton.

The gross receipts of each year from buying put options on March futures contracts in December at-the-money and .50, 1.00, 2.00, 3.00, 4.00 and 5.00 cents in-the-money and out-of-the-money is reported in Table 10 for the 1973-84 period if that option had been available in this period of time. This hedge would be in place from the December before the cotton crop is planted until the November, December and January after the harvest.

Buy Put Option on March Futures Contracts in March

The gross receipts of each year from buying put options on March futures contracts in March (one year before the end of trading in the March futures contract) at-the-money and .50, 1.00, 2.00, 3.00, 4.00, and 5.00 cents in-the-money and out-of-the-money are shown in Table 11 for the 1973-84 period. The table shows how those alternative strategies of buying put options would have performed during 1973 through 1984 period if options had been available in this period of time.

Table 10. The Gross Receipts of Each Year From Put Options on the March Futures Contracts in December During the Period of 1973-84.

crop year	Out-Of-The-Money -5	-4	-3	-2	-1
	dollars				
1973	437,519	436,826	435,968	434,865	433,548
1974	330,052	331,874	333,592	335,206	336,716
1975	265,280	265,399	263,359	262,146	260,760
1976	335,742	334,737	333,559	332,277	330,821
1977	283,212	285,138	286,925	288,574	290,118
1978	260,574	259,604	258,495	257,248	255,827
1979	265,721	263,707	262,564	261,282	259,861
1980	287,453	286,448	285,270	283,953	282,533
1981	249,574	251,534	253,356	255,039	256,584
1982	182,362	184,372	186,291	188,079	189,693
1983	219,955	219,163	218,195	217,017	215,631
1984	187,324	189,488	191,483	193,270	194,884

crop year	Out -.5	At 0	In-The-Money .5	1
	dollars			
1973	432,820	432,023	431,157	430,256
1974	337,462	338,170	338,878	339,553
1975	259,998	259,201	258,335	257,469
1976	330,059	329,262	328,396	327,530
1977	290,821	291,524	292,193	292,827
1978	255,065	254,268	253,402	252,535
1979	259,121	258,799	258,408	258,017
1980	281,736	280,939	280,107	279,206
1981	257,322	257,990	258,658	259,292
1982	190,430	191,133	191,767	192,401
1983	214,868	214,071	213,240	212,339
1984	195,656	196,325	196,993	197,592

crop year	In-The-Money 2	3	4	5
	dollars			
1973	428,281	426,098	423,824	421,415
1974	340,804	341,989	343,042	344,029
1975	255,528	253,499	251,387	249,110
1976	325,711	323,979	321,784	319,639
1977	294,078	295,197	297,240	297,138
1978	249,970	248,683	246,604	244,920
1979	257,130	256,176	256,058	255,830
1980	277,398	275,517	273,504	271,359
1981	260,499	261,618	262,605	263,460
1982	193,461	194,424	195,279	196,002
1983	210,398	208,306	206,128	204,388
1984	198,652	199,609	200,464	201,187

Source: Phoenix market prices as we assume in chapter four and and the prices have been adjusted to the value of dollar in 1984.

Table 11. The Gross Receipts of Each Year From Put Options on the March Futures Contracts in March During the Period of 1973-84.

crop year	Out-Of-The-Money -5	-4	-3	-2	-1
	dollars				
1973	436,760	436,001	435,003	433,825	432,439
1974	294,532	296,458	298,280	299,929	301,473
1975	265,643	264,849	263,844	262,632	261,246
1976	336,504	335,534	334,390	333,108	331,688
1977	299,346	301,306	303,093	304,777	306,287
1978	260,713	259,777	258,820	258,523	258,052
1979	265,682	264,747	263,673	262,425	261,005
1980	288,597	287,626	286,518	285,236	283,815
1981	238,535	240,565	242,456	244,208	245,753
1982	189,174	191,382	193,420	195,242	196,856
1983	220,417	219,691	218,784	217,606	216,254
1984	189,505	191,779	193,830	195,652	197,301

crop year	Out -.5	At 0	In-The-Money .5	1
	dollars			
1973	431,677	430,880	430,014	429,078
1974	302,879	302,879	303,513	304,114
1975	260,483	259,686	258,820	257,885
1976	330,891	330,094	329,227	328,326
1977	307,024	307,693	308,327	308,931
1978	257,765	257,408	257,017	256,599
1979	260,242	259,411	258,544	258,004
1980	283,053	282,221	281,355	280,454
1981	246,491	247,159	247,793	248,392
1982	197,594	198,297	198,931	199,495
1983	215,492	214,695	213,829	212,893
1984	198,039	198,742	199,376	199,940

crop year	In-The-Money 2	3	4	5
	dollars			
1973	427,138	424,979	422,801	420,425
1974	305,332	306,418	307,372	308,227
1975	255,944	253,829	251,651	249,308
1976	326,437	324,457	322,378	320,134
1977	310,149	311,235	312,189	313,044
1978	255,998	255,963	255,768	255,474
1979	257,049	255,969	254,807	254,288
1980	278,553	276,573	274,461	272,217
1981	249,495	250,515	251,403	252,193
1982	200,520	201,393	202,182	202,839
1983	210,918	208,351	207,717	206,258
1984	200,965	201,790	202,579	203,170

Source: Phoenix market prices as we assume in chapter four and the prices have been adjusted to the value of dollars in 1984.

The results of evaluating the relative effectiveness of buying put options on the March futures contracts in December and March at-the-money and .50, 1.00, 2.00, 3.00, 4.00, and 5.00 cents in-the-money and out-of-the-money are shown in Table 12 for the 1973-84 period of time. The table shows how those alternative strategies of buying put options could have performed during the 1973 through 1984 period if options had been available in this period of time. The table shows that buying put options on March futures contracts in December at three, four, and five cents out-of-the-money in the period of 1973-84 would have been inferior to some of the other alternative strategies of buying put options shown in the same table. In those cases the result was lower average income and higher variability of income. However, the other alternative put options strategies with March put options purchased in December show at-the-money and .50, 1.00, 2.00 and 3.00 cents out-of-the-money and .50, 1.00, 2.00, 3.00, 4.00, and 5.00 cents in-the-money have no clearly superior strategy among them because those strategies with higher levels of average income have higher levels of variability of income. And the strategies which have lower levels of variability of income have lower levels of average income. The table also shows that buying put options on the March futures contracts in March has results similar to buying put options on March futures contracts in December. Buying put options at 3.00, 4.00, and 5.00 cents

out-of-the-money in the period of 1973-84 would have been inferior to some of the other alternative strategies of buying put options shown in same table because these lead to lower average income and higher variability of income. However, none of the other alternative option strategies is clearly superior to any other because the strategies with higher average income have higher levels of variability of income, and the strategies that have lower variability of income have lower average income. A choice among these alternative put options strategies would depend on the individuals willingness to trade average for variability.

Table 12. Average Income and Variability of Income From Alternative Put Options Strategies For Cotton Grown in 1973-84.

	Forward Pricing In:			
	December		March	
in or out of-the-money:	average income	standard deviation	average income	standard deviation
	dollars			
-5	275,313	69,875	273,784	74,724
-4	275,608	69,341	274,143	67,076
-3	275,755	68,831	274,343	66,445
-2	275,746	68,346	274,430	65,846
-1	275,581	67,892	274,347	65,279
-.5	275,447	67,678	274,303	65,036
0	275,308	67,463	274,097	64,751
.5	275,128	67,252	273,896	64,500
1	274,918	67,051	273,676	64,252
2	274,326	66,706	273,208	63,784
3	273,743	66,333	272,623	63,365
4	273,160	66,026	272,109	62,794
5	272,373	65,620	271,465	62,287

Source: Table 10 and 11

Because of the difficulty in determining the best of the put options strategies this study arbitrarily chooses six put options strategies of 2 cents out-of-the-money, at-the-money, and 5 cents in-the-money on March futures contracts purchased in December or March. Table 13 compares the previous six put options strategies with the other alternative marketing strategies including simple cash sale, forward contracting and hedging by selling futures contracts. Initiating the strategies in December versus March is also assessed in this table.

Table 13 shows that if we ignore the options strategies the best alternative marketing strategy seems to be forward contracting in March. Forward contracting in December or March produced higher average income and lower variability of income than hedging in futures contracts. Forward contracting in March seems to be superior to simple cash sale without any forward pricing because it reduced the variability by nearly 50 percent while reducing the average income by about one percent in the period of 1973-84.

Table 13 also shows that options seem to be superior to simple cash sale without any forward pricing because it increased the average income substantially. The options strategies also would have produced higher average income increased the average income substantially. The options strategies also would have produced higher average income than forward contracting and futures contract hedging if

options had been available in the period of 1973-84. However, the variability seems only slightly less than for simple cash sale and higher than for forward contracting and futures contracts, but the characteristics of variability are substantially different. The worst that can happen for a hedger in put options is that he loses the premium and brokerage fees that he has paid. Therefore, it seems to be that hedging by buying put options on cotton futures contracts may be a very valuable marketing tool when cotton markets get back to the relatively free market conditions that existed in the 1973-84 period.

Table 13. Average Income and Variability of Income From Alternative Marketing Strategies for Cotton Crops Grown in 1973-84

	Forward Pricing in:			
	December		March	
Strategy:	average income	standard deviation	average income	standard deviation
	---------dollars---------			
cash sale in Nov.,Dec.,Jan.	252,916	78,923	252,916	78,923
forward contract	246,180	53,741	250,130	40,908
hedge by selling futures contracts	242,019	59,082	247,039	44,163
hedge by buying put options:				
.02 out of money	275,746	68,346	274,430	65,846
at the money	275,309	67,463	274,097	64,751
.05 in the money	272,373	64,620	271,465	62,287

CHAPTER VI

POTENTIAL USE OF OPTION ON COTTON FUTURES CONTRACTS IN MARKETING COTTON IN ARIZONA

Arizona cotton growers have been using forward contracting since the early 1970's. Forward contracting became a commonly used marketing practice by Arizona farmers beginning at planting time for the 1973 cotton crop. The most common time to forward contract is at the time the crop is being planted. Hedging by selling futures contracts on cotton has been used by relatively few Arizona cotton growers. This is probably because forward contracting is much easier for farmers to apply than hedging using futures contracts. Hedging by buying options on cotton futures contracts has not been a common marketing strategy by Arizona cotton growers. Because the futures prices have been only slightly above the government support price there has been very little down-side risk for farmers eligible for the loan program. Also the cotton growers have a lack of knowledge about the options.

The results of evaluating the alternative marketing strategies for cotton crops grown in 1973-84 period have been presented in the previous chapter. These strategies included simple cash sales, forward contracts, hedging by selling futures contracts and hedging by buying put options

at various levels of in-the-money and out-of-the-money. These results suggested that if options had been available in the period of 1973-84 and cotton growers had hedged in options every year they could have increased their gross income by nearly 10 percent, after allowance for transaction costs and opportunity costs of money. Table 16 shows that if the options had been available in the period of 1973-84 and the cotton growers had hedged in options every year, they could have received higher average incomes than if they had used one of the other alternative marketing strategies shown in the same table. Option premiums in January through June of 1985 may have been unusually low because the price of cotton was only slightly above the government support price. The predicted options premiums that were used in this study might be higher or lower than the actual premium in the past when options were not traded. However, even doubling the cotton option premiums over what was used in this study would leave about 5 percent increase in gross income after allowance for all costs associated with the option hedging.

Table 14. Average Income From Alternative Marketing Strategies for Cotton Crops Grown in 1973-84 with December and March Forward Pricing

	December	March
Strategy:	average income	average income
	- - - - - percent of cash sale average - - - -	
cash sale	100.0	100.0
Forward contract	97.3	98.9
Futures contract	95.7	97.7
Option Hedge:		
.02 out of money	109.0	108.5
at the money	108.9	108.4
.05 in the money	107.7	107.3

In options strategy, we can not judge which years are good for cotton growers to hedge using put options. Therefore, probably the best way for cotton growers to hedge in put options is consistently every year regardless of whether the futures prices are high or low at execution of this strategy. Hence, buying put options might be like buying insurance. The producer can achieve insurance against declining prices by buying put options and establishing an option hedge. To establish this insurance the option hedger must pay a premium. The insurance against declining prices (option hedge) pays off if the futures

prices are below the strike price when the insured commodity is sold and the hedge is ended by selling the put option.

Although analogies to insurance have been frequently used to explain futures contract hedging, it is not a perfect analogy. With the availability of put options on cotton futures contracts there is a readily available trading instrument that does have many of the characteristics of a "insurance." If put options had been available in the 1973-84 period, how well would it have performed as insurance? Table 17 shows the effect of put options in each of the years when receipts from the cash sale would have been below the average for the 1973-84 period.

Table 15. 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

In order for put option purchase to be effective as 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. 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. 1982, 1983, and 1984 were years when the futures price was relatively low at the time the option hedge begins, and 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 relatively well when prices are

highly variable from beginning to end of the hedge, and options are relatively poor strategies when prices change very little from start to end of the hedge period.

The question raised here is whether hedging by buying put options on cotton futures contracts will work in the future as well as it would have worked in the 1973-84 period. That 12-year period had 7 years with prices rising from start to end of the option hedge and the option hedge loosing money relative to simple cash sale. With the variability of prices that existed in the 1973-84 period it seems that it would probably require as many as 9 of the 12 years to be years of losses in the put option hedge relative to simple cash sale before the option hedge strategy would produce a lower average income than simple cash sale.

Options have a potential role in the marketing of cotton in Arizona as "a declining price insurance" when cotton markets return to relatively free market conditions similar to those existed during the 1973-84 period. Hedging by buying put options on cotton futures contracts may be a very valuable marketing tool when the prices are not obviously controlled by the government.

APPENDIX A

DEFLATED COTTON PRICES

APPENDIX A

DEFLATED COTTON PRICES

Table 1-A. Deflated Cotton Prices (1984=100=2.2343*1972)

crop year	cash		
	November	December	January+1
1973	14117	16473	15174
1974	6823	6236	6474
1975	8734	9448	9771
1976	12106	11688	11688
1977	7524	7493	8109
1978	9333	9463	8755
1979	8639	8980	10428
1980	10456	10093	9921
1981	6071	5998	6432
1982	6101	6190	6203
1983	7851	7727	7609
1984	5950	6151	5936

Source: U.S.D.A. Agricultural Marketing Service, Cotton Division. Daily Spot Cotton Quotations, Memphis.

Table 2-A. Deflated Cotton Prices (1984=100=2.2343*1972)

December futures			March+1 futures				
Dec-1	Mar	Nov	Dec-1	Mar	Nov	Dec	Jan+1
6291	7987	14731	6291	8028	14113	16672	16198
12928	11449	7486	12773	11507	7528	6973	7211
7750	8087	9360	7864	8222	9700	10248	10371
9726	9839	12917	9779	9992	13081	12548	12040
11016	11530	7933	11050	11567	8024	8188	8641
8720	9436	9657	8797	9561	10130	9729	9245
9321	9132	9172	9442	9324	9386	9741	10655
9726	9703	10738	9945	9757	10945	11094	10670
10158	9741	6895	10229	9816	7201	6978	7218
7618	7776	6726	7745	7963	6992	6981	6942
7210	7365	8130	7322	7491	8317	7993	7762
7511	7576	6347	7615	7669	6522	6570	6489

Source: U.S.D.A. Agricultural Marketing Service, Cotton Division. Cotton Price Statistics.

APPENDIX B

THE DIFFERENTIAL EQUATIONS THAT ARE USED IN THE BLACK MODEL TO ESTIMATE THE VALUE OF COMMODITY OPTION

APPENDIX B

The differential equations that are used in the Black Model to estimate the value of commodity option are as follows:

$$w(x, t) = e^{r(t-t^*)}[xN(d_1) - c^*N(d_2)],$$

$$d_1 = \left[\ln\frac{x}{c^*} + \frac{s^2}{2}(t^* - t)\right] \Big/ s\sqrt{(t^* - t)},$$

$$d_2 = \left[\ln\frac{x}{c^*} - \frac{s^2}{2}(t^* - t)\right] \Big/ s\sqrt{(t^* - t)}.$$

where:

w(X,t) = The value of the commodity option.

c* = The exercise price.

X = Futures price

(t*-t) = The days to maturity.

N(d) = the cumulative normal density function.

$xe^{n(t-t^*)}$ = The same as the value of an option on a security (Black and Schoales, 1973) that pays a continuous dividend at rate equal to stock price times the interest rate when the option can only be exercised at maturity.

r = interest rate (constant through time)

S^2 = The variance rate (constant through time)

Tax and transaction cost = zero

Note:
The computer program that was used in this study to compute option premiums using the Black Model was purchased. It may be available in the public demand.

REFERENCES CITED

Anderson, Carl G. "A review and evaluation of cotton futures options trading," Beltwide Cotton Production Research Conferences, 1985 Proceedings. (January, 1985), 259-261.

Bailey, DeeVon and Richardson, J.W. "Analysis of selected marketing strategies: A whole-farm simulation approach," Amer. J. Agr. Econ. 57(1985):813-820.

Black, Fischer "The pricing of commodity contracts," Journal of Financial Economics, Vol. 3, 1976, 167-179.

Black, Fischer and Scholes, Myron "The Pricing of Options and Corporate Liabilities," Journal of Political Economy 81, May/June, 1973, 637-654.

C. Curtis Cable, Jr. "Pricing and marketing alternatives for cotton producers," The University of Arizona Cooperative Extension Service. A-89. Sep. 1979.

Ethridge, M. Dean and Caillavet, DeWitt, F. "Effectiveness of the Loan Program for Increasing Net Price to Cotton Farmers," Beltwide Cotton Production Research Conferences, 1985 Proceedings. (January 1985), 226-231.

Firch, Robert S. "Forward contracting of cotton in Arizona 1974-79," Beltwide Cotton Production Research Conferences, 1982 Proceedings. (January, 1982), 300-302.

Firch, Robert S. "Commodity Policy Options: Cotton," Presented at conference entitled Alternative Agricultural and Food Policies and the 1985 Farm Bill, University of California, Berkeley, June 11-12, 1984.

Kenyon, David E. "Farmers' guide to trading agricultural commodity options," U.S.D.A. Econ. Res. Service. Agr. Infor. Bull. No. 463, April, 1984.

Sandmo, Agnar "On the theory of competitive firm under price uncertainty," American Economics Review, Vol. 61(1), March, 1971, 65-73.

Thompson, Cynthia V. and Hudson, James F. "Cotton marketing alternative, Louisiana, 1979-1981," D.A.E. Research Report, Louisiana Agr. Exp. Sta. (1983), No. 616.

REFERENCES CITED--Continued

U.S.D.A. Agricultural Marketing Service, Cotton Division. Daily Spot Cotton Quotations, Memphis.

U.S.D.A. Agricultural Marketing Service, Cotton Divison. Coton Price Statistics.