Producer's Preference for a Cotton Farmer Owned Reserve: An Application of Simulation and Stochastic Dominance

James W. Richardson and Clair J. Nixon

The benefits to a typical High Plains cotton farmer from a cotton farmer owned reserve were estimated using a firm-level, income tax and farm policy simulation model. Eighteen farm programs were simulated including twelve variations of a farmer owned reserve using different entry prices and trigger prices. The after-tax net present value distributions for the different farm programs were compared using stochastic dominance. The results indicate that risk averse cotton producers should prefer the 1977 farm program to either a cotton farmer owned reserve or the farm program proposed by Secretary of Agriculture Block.

The Food and Agriculture Act of 1977 is scheduled to expire at the end of the 1981 crop year. This farm program has provided both price and income support for cotton producers in the form of loan rates and target prices. It has also provided disaster programs which aided cotton producers whose crop yields were adversely affected by the weather.

The U.S. Department of Agriculture recommended to Congress that the 1981 Farm Program eliminate target prices, deficiency payments, and disaster programs beginning with the 1982 crop year. The explanation for eliminating the target price and deficiency payment program is that it "was designed to protect producers before advent of the reserve program, and it has since lost most of its usefulness" [Block, p.11]. Despite the Secretary's efforts, target prices and deficiency payments for the major crops were retained in the 1981 Act.

In the case of wheat and feed grains, eliminating target prices and deficiency payments may not create a significant problem for producers since the Secretary proposed to increase the attractiveness of the farmer owned reserve for wheat and feed grains. Cotton producers, on the other hand, may suffer since they have no farmer owned reserve (FOR). Since the Secretary advocated the elimination of the target price program and a renewed emphasis on the FOR, the stage may be set for the creation of a cotton FOR. The purpose of this paper is to determine whether cotton producers on the Texas High Plains would likely prefer a cotton FOR to current and past farm programs.

The control variables for the wheat and feed grains FOR are (a) entry level price, (b) trigger price, (c) length of the reserve, (d) storage payment rate, (e) interest rate, and (f) waiver of interest charges. The entry level price is the loan rate if stocks enter the reserve indirectly (from the Commodity Credit Corporation [CCC] loan). The entry price for a direct entry FOR can be set, at the Secretary's discretion, above the loan rate to encourage greater participation in the re-

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serve. The trigger price is the price at which stocks may be withdrawn from the reserve, which is between 140% and 160% of the loan rate. The Secretary of Agriculture determines the length of the reserve (usually 3 years), the interest rate for CCC loans (14.5%), and the number of years that interest is to be waived (2 years for grains). The government's annual storage payment rate for grains in the reserve (26.5¢/bushel) is approximately equal to the cost of commercial storage for one year.

A cotton FOR would likely have most of the characteristics of a reserve for wheat and feed grains. The FOR would likely be a direct entry reserve with cotton entering at the national loan rate ($0.525/lb.) or a percentage of the loan rate. The trigger price would likely be set at 150% of the loan rate and the length of the reserve would be 3 years. The interest rate charged for stocks in the reserve would be about 14.5% for the first year and zero thereafter. The commercial storage cost for cotton is about $12/bale/year so the annual storage payment rate would likely equal this value.

Methodology

To determine whether or not producers would prefer a cotton FOR, a typical Texas High Plains cotton farm was simulated for 18 different farm programs. The simulation results are compared using stochastic dominance to determine preference by various risk groups. Kramer and Pope demonstrate that program participation or preference by farmers is influenced by the distribution of net returns rather than simply the expected net returns. Their work shows stochastic dominance to be superior to mean-variance in analyzing program preference, particularly when the distribution of net returns is skewed due to farm programs. (A detailed description of stochastic dominance is presented by Kramer and Pope and by King and Robison [1981a, 1981b]).

In the case of a multiple-year farm program, such as a cotton FOR, stochastic dominance requires the generation of the probability distribution for net returns over, say, a 10-year planning horizon. Net present value is used since it incorporates both the annual cash net returns and changes in net worth, over the planning horizon. Probability distributions of the net present value associated with different farm programs can be generated using a Monte Carlo farm simulation model.

Description of the Model

The model selected for this study is the Farm Level Income and Policy Simulation Model (FLIPSIM). FLIPSIM is designed to simulate the effects of alternative farm programs and income tax laws on the survival, growth, and success of typical farms (Richardson and Nixon). FLIPSIM is a recursive, farm-level, stochastic simulation model which simulates the annual production, farm policy, marketing, financial management, growth, and income tax aspects of a farm over a multiple-year planning horizon.

The model is stochastic in that for each iteration a different set of annual crop prices and yields are selected at random from user supplied probability distributions. The model is also recursive in that the financial position at the end of one year, is the beginning financial position for the following year. (A complete run consisted of 50 iterations of a 10-year planning horizon).

The organization of FLIPSIM is presented in Figure 1, in terms of the major subroutines in the model. At the start of each year, the crop mix is established, based on the user's predetermined mix of crops and the acreage set-aside requirements, if applicable (CROPMX). Stochastic prices and yields are drawn at random from multivariate triangular probability distributions provided by the user (STOCH). Total variable production costs and cash receipts are calculated based on crop acreages and stochastic prices and yields (VCOSTS and RECPTS). The farm policy options for the specific run are simulated and the necessary income adjustments are made (POLICY).

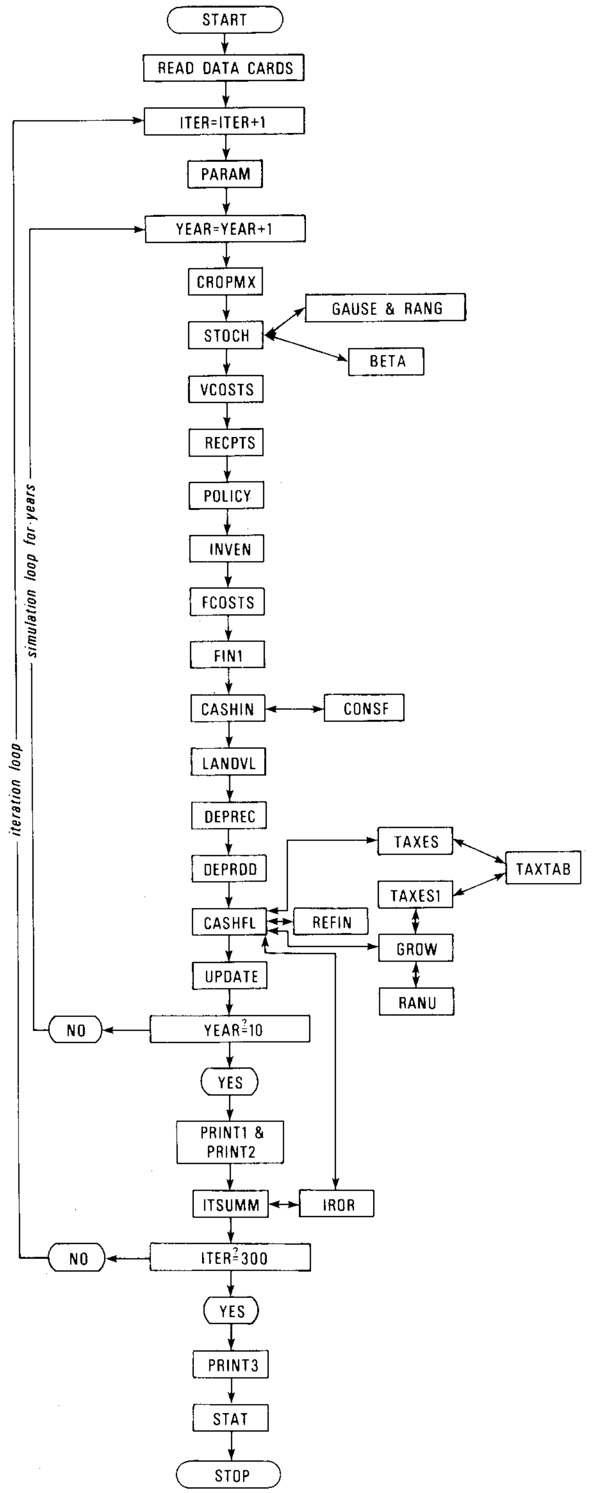

Figure 1. Schematic of the Farm Level Income and Policy Simulator (FLIPSIM).

The model calculates the standard financial activities of a farm, such as paying fixed and variable costs, making loan payments, withdrawing family living expenses,[1] depreciating machinery, and paying income taxes.[2] The market value of farmland is calculated annually as a function of a moving average for the rate of return to production assets (LANDVL). This allows the value of cropland to adjust over time to the changing profitability of typical farms in the region. When the farm has an ending-year cash flow deficit (i.e., there is not sufficient income to fully repay the operating loan) a second mortgage on farmland and/or intermediate assets is obtained. If a second mortgage cannot be obtained due to excessive debts, the farm is permitted to sell a portion of the farmland to cover ending-year cash flow deficits (REFIN). The maximum debt asset ratio the farm is permitted to carry is 20% on long-term assets and 30% on intermediate assets. If adequate cash is available at year end, the farm may grow by leasing or purchasing 160 acres of cropland in odd years, i.e., 1981, 1983, ..., 1989 (GROW). To grow, the farm must have sufficient cash reserves to pay a 40% downpayment for cropland and a 25% downpayment for any additional equipment required.

When machinery is fully depreciated, it is either sold and replaced, kept,or kept and replaced, depending upon its expected useful life. The market value of used machinery is updated annually using the beginning value for each machine and an inflation rate for used equipment provided by the user. Additional farm machinery is purchased in discrete units when the farm grows to the point where its present complement is inadequate. Budgets for the individual crop enterprises are adjusted as the farm grows, thus accounting for any economies or diseconomies of size.

Typical Farm

The typical farm selected for this study is a 1,100 acre cotton-sorghum farm on the Texas Southern High Plains. Data to describe the typical farm were obtained from a stratified random sample of producers on the High Plains. The farm consists of 385 cropland acres owned and 715 acres leased on a crop-share basis. Approximately one-third of the farm is irrigated. Crops that can be produced on the farm are irrigated cotton, dryland cotton, irrigated sorghum, and dryland sorghum.

Enterprise budgets for these crops [McGrann, et al.] provide the projected production costs and labor requirements for 1981, which is the first year simulated. To calculate production costs over the remainder of the 10-year planning horizon, the 1981 per acre costs of production are inflated 10% annually.

Prices of cotton lint, cotton seed, and sorghum were inflated at 7 percent per year from their assumed 1981 modal values of \$.65/lb., \$100/ton, and \$5.00/cwt., respectively. Crop yields were assumed to increase 1 percent per year. The modal crop yields/acre for irrigated cotton, dryland cotton, irrigated sorghum, and dryland sorghum in 1981

[1]Annual family living expenses are calculated using the following consumption function:

$$\text{Consumption Expense \$} = 3.2315\, FFS^{0.3765}\, ADI^{0.6283}\, CPI^{0.3716}$$

where FFS is family size, ADI is disposable income, and CPI is the Consumer Price Index for all commodities and services (1967 = 100). The CPI is included to make consumption homogeneous of degree one in income and prices. The function for farmers on the Southern Plains was estimated using the SRS "Farm Operator Family Living Expenditure Survey for 1973." The average and marginal propensities to consume, calculated at the mean, are 0.89 and 0.56, respectively.

[2]The model computes the farm operator's annual income tax using the lesser of the regular tax computation or income averaging. A farm operator is assumed to be married, filing a joint income tax return, and itemizing personal deductions. Schedule Y of the 1980 tax code is used to calculate income taxes. All sources of income, both farm and non-farm, are accounted for, including capital gain income and depreciation recapture (when applicable).

were 450 lbs., 225 lbs., 32.5 cwts., and 4.07 cwts., respectively. Annual crop prices and yields were drawn at random each year of the planning horizon from multivariate triangular probability distributions.[3] The typical crop mix observed for the area during the 1977-1980 period was held constant over the 10-year planning horizon.

Items in the machinery complement for the typical farm (2 sets of 8-row equipment) were identified from the farm survey. Each item was assigned an age equal to the modal age observed for that particular type of machine or implement. The machinery complement for the 1,100 acre farm is considered to be adequate to farm up to 1,750 acres [Beach]. When a farm grows past this threshold, the operator must buy a full complement of 8-row equipment at prevailing market prices. It was assumed that the market value of new farm machinery would increase 10% per year while the nominal market value of used machinery would increase 1% per year.

Per acre costs of production for cotton and sorghum are reduced appropriately once the farm grows past the 1,750 acre level. These adjustments are based on cost estimates obtained from the farm survey. Crop yields were also adjusted downward slightly once the farm grew beyond, 1,750 acres.

The farm's beginning debt asset ratio is 40%, the average observed from the farm survey. Interest rates for existing long- and intermediate-term debts are reported to be about 7.5% and 10%, respectively. It is assumed that interest rates for new land and machinery loans are 8% and 12%, respectively, and that the interest rate on operating capital is 13%. Interest rates charged on second mortgages are assumed to be one-half of a percentage point higher than for comparable new loans. In addition a 1% loan origination fee is charged for refinancing ending-year cash flow deficits.

A minimum family living expense is set at $14,800 in 1981 and inflated annually at 10%. The inflated minimum is used if it exceeds the value calculated by the consumption function. Family size is assumed to be 3 members and off-farm income from all sources is assumed to be $2,800 per year.

Farm Programs Analyzed

The typical farm was simulated once for each farm program listed in Table 1. Scenario A assumes the typical farm does not participate in any farm program. Two versions of the 1977 Farm Program were simulated, one with the low yield disaster provision (B1) and one without (B2). Three versions of Secretary Block's proposed farm program were simulated (C1, C2, and C3) using different loan rates for Texas High Plains cotton $.43, $.50 and $.525/lb., respectively.

Twelve cotton FOR programs were simulated using three entry prices, two release prices, and two assumptions regarding interest waiver (programs D-0 in Table 1). Entry prices for the cotton FOR, $.50, $.525, and $.578/lb., equal 115% of the 1981 Texas High Plains cotton loan rate, the 1981 national loan rate for cotton, and 110% of the 1981 national loan rate, respectively. The absolute difference between the 1981 modal price and the entry price was held constant as the modal price increased. Two trigger prices, 135% and 150% of the national loan rate, are used to determine the effect of the trigger price on farmer participation in a FOR. The interest rate charged for FOR loans is 10% per year. It is assumed that interest will be either waived in the last 2 years or waived for all 3 years of the reserve.

The model further assumes that the farm operator will place the entire crop in the

[3]The 1981 distributions for prices are distributed triangularly as follows: cotton, $/lb. ~(0.40, 0.65, 0.80), sorghum, $/cwt. ~(4.17, 5.00, 5.80), and cotton seed, $/ton ~(90, 100, 125). The 1981 distributions for yields are distributed triangularly as follows: irrigated cotton, lbs./acre ~(420, 450, 800), dryland cotton, lb./acre ~(0,225, 360), irrigated sorghum, cwt./acre ~(28.7, 34.5, 39.6), and dryland sorghum, cwt./acre ~(0, 14.1, 19.2). The minimum and maximum values are updated for years 1982-1990 as the modal values are inflated thus maintaining the same range of values as shown for the 1981 distributions.

TABLE 1. Farm Programs Selected for Analysis

A.	Non-participation in any farm program provisions.
B1.	Food and Agriculture Act of 1977 — price support, target price, disaster provision, entry and trigger price for the sorghum FOR, and payment limitations announced for 1981 are increased annually to maintain the relationship to their respective 1981 modal crop prices and yields
B2.	Food and Agriculture Act of 1977 — program B1 but without the disaster provisions.
C1.	Block's Proposal — program B2 with no target prices after the 1981 crop year. The 1981 loan rate for High Plains cotton is about $0.43/lb.
C2.	Block's Proposal — program C1 assuming the 1981 loan rate for High Plains cotton is $0.50/lb.
C3.	Block's Proposal — program C1 assuming the 1981 loan rate for High Plains cotton is $0.525/lb.
D.	Cotton FOR — $0.50/lb. entry price, $0.78/lb. trigger price, and waiver of the last two years interest.
E.	Cotton FOR — $0.525/lb. entry price, $0.78/lb. trigger price, and waiver of the last two years interest.
F.	Cotton FOR — $0.58/lb. entry price, $0.78/lb. trigger price, and waiver of the last two years interest.
G.	Cotton FOR — $0.50/lb. entry price, $0.78/lb. trigger price, and waiver of all interest.
H.	Cotton FOR — $0.525/lb. entry price, $0.78/lb. trigger price, and waiver of all interest.
I.	Cotton FOR — $0.58/lb. entry price, $0.78/lb. trigger price, and waiver of all interest.
J.	Cotton FOR — $0.50/lb. entry price, $0.70/lb. trigger price, and waiver of last two years interest.
K.	Cotton FOR — $0.525/lb. entry price, $0.70/lb. trigger price, and waiver of last two years interest.
L.	Cotton FOR — $0.58/lb. entry price, $0.70/lb. trigger price, and waiver of last two years interest.
M.	Cotton FOR — $0.50/lb. entry price, $0.70/lb. trigger price, and waiver of all interest.
N.	Cotton FOR — $0.525/lb. entry price, $0.70/lb. trigger price, and waiver of all interest.
O.	Cotton FOR — $0.58/lb. entry price, $0.70/lb. trigger price, and waiver of all interest.

[a]Loan rates, target prices, trigger prices and proven yields for 1982-1990 are obtained by increasing their 1981 announced values to maintain the relationships to their respective 1981 modal crop prices and yields.

FOR (or CCC loan) if it is more profitable than selling the crop on the spot market. Stocks enter the reserve if the local cash price is less than the effective entry price for the reserve. The effective entry price equals the announced entry price minus one year's interest and any additional costs not covered by the government storage payment. (It is assumed that government storage payments cover the full cost of commercial storage.) Stocks are placed in a CCC loan if the spot price is less than the loan rate minus the commercial storage costs for 9 months. Stocks in the FOR are released if the spot price over the next 3 years exceeds the trigger price. Stocks in the CCC loan are released if the following year's spot price exceeds the loan price plus interest charges for 9 months. The spot price used in this case is the stochastic price for cotton, drawn from a probability distribution of annual average prices. As a result, the model compared the trigger price to a spot price only once a year.

Results

The farm programs in Table 1 were simulated for the typical High Plains cotton farm over the 1981-1990 time period. The after-tax net present value distribution and the probability of survival for each farm program is summarized in Table 2. As expected, the Food and Agriculture Act of 1977 (B1) has the highest mean ($203,525) and the lowest standard deviation ($255,830) for net present value. This program also offers the highest probability of the farm remaining solvent for 10 years (86%). In contrast, non-participation in a farm program (scenario A) results in the lowest probability of survival (58%) and the lowest mean net present value ($65,915). The skewness statistics in Table 2 indicate that

TABLE 2. Summary of the Net Present Value Probability Distributions and the Farm's Probability of Survival for Selected Programs.

Program[a]	Net Present Value Distribution[b] Mean	Standard Deviation	Skewness	Farm's Probability of Survival[c]
	($)	($)		(%)
A	65,915	275,918	0.743	58
B1	203,525	255,830	0.545	86
B2	155,986	267,121	0.522	80
C1	75,792	271,377	0.721	64
C2	88,809	280,755	0.729	64
C3	104,993	279,094	0.583	64
D	73,200	275,864	0.807	62
E	75,107	278,581	0.812	62
F	90,813	281,940	0.819	64
G	80,533	276,958	0.742	62
H	85,002	280,798	0.742	64
I	125,679	294,548	0.661	70
J	76,202	283,482	0.905	62
K	84,188	297,370	0.980	62
L	97,720	267,003	0.840	72
M	95,894	285,748	0.656	62
N	103,739	298,971	0.844	64
O	193,644	338,732	0.681	70

[a]Provisions for the individual programs are described in Table 1.

[b]Statistics for the distribution were calculated using both observed and "unobserved" values for the distribution. Since the model stops simulating a farm once it is declared insolvent, the net present value for an insolvent iteration is unobserved. All unobserved values for the distribution were assumed to be equal − 186,000, the most negative net present value observed for any of the 18 scenarios simulated. This practice normalizes all 18 distributions to a common base point and permits their comparison using Meyer's stochastic dominance program.

[c]Survival is defined as remaining solvent through 1990.

the net present value distributions are skewed differently so mean-variance analysis should not be used to predict program preference. In general, skewness increases as the probability of survival decreases. This is, in part, due to a greater number of negative net present value figures being observed for the less profitable scenarios.

Meyer's stochastic dominance program was used to make pair-wise comparisons of the net present value probability distributions. The program requires specification of lower, $r_1(x)$, and upper, $r_2(x)$, boundary risk aversion coefficients. A risk aversion coefficient indicates the amount that a given probability must be altered for an individual to accept an actuarily fair bet. Three risk aversion intervals, (−.00001,0), (0, .00001), and (−.00001, .00001), were used rather than eliciting risk aversion coefficients from individual cotton producers. These levels represent risk aversion coefficients for three different groups of cotton producers, ranging from risk lovers to risk avoiders and are based on values suggested by previous research (King and Robison, 1981b).

The results of the stochastic dominance analysis are summarized in Table 3. The efficient set for a risk averse producer contains only farm program B1, the Food and Agriculture Act of 1977. If a risk averse producer is not allowed to participate in program B1, the producer's next most preferred efficient set contains farm programs B2 and 0, the 1977 Act without the disaster provisions and the cotton FOR with a high entry price

TABLE 3. Predicted Preference of High Plains Cotton Producers for Selected Farm Programs.

Efficient Sets	Utility Group[1] Risk Preferred	Risk Neutral (programs)[2]	Risk Averse
Most preferred set	B1,0	B1,0	B1
Second most preferred set	B2,I,N	B2,F,I,L,N	B2,0
Third most preferred set	F,K,L	C3,H,K,M	I,L
Fourth most preferred set	C3,J,M	C2,E,G,J	C3
Fifth most preferred set	C2,H	C1,D	N
Sixth most preferred set	G,E	A	C2,F,M
Seventh most preferred set	C1,D		C1,G,H,K
Eighth most preferred set	A		E,J
Ninth most preferred set			D
Tenth most preferred set			A

[1]The utility groups are associated with the following risk aversion intervals: (−.0001,0), (−.00001, .00001), and (0, .00001).
[2]Provisions for the farm programs are described in Table 1.

(58¢/lb.), low trigger price (70¢/lb.) and no interest charges, respectively. Farm program B1 would obviously be preferred to B2 since the former provides for low yield disaster payments that are excluded in B2. Farm program B1 is preferred to program 0 for the same reason.

Given a choice among the farm programs in Table 1, excluding B1, B2, and 0, a risk averse producer should prefer cotton FOR programs I and L. A producer should be indifferent between either of these two programs. Since farm program 0 dominates program I, risk averse cotton producers should prefer a low trigger price (70¢/lb.) to the high trigger price (78¢/lb.). The reason being that the lower the trigger price, the greater the probability stocks will be released. Comparing farm program L to 0 indicates risk averse producers are rational in that they should prefer no interest charges for a reserve to paying one year's interest. Since risk averse producers should be indifferent between I and L, an equal trade-off appears to exist between I which has no interest and a high trigger price and L which has no interest for two years and the lower trigger price.

Farm program C3 is the only program in the fourth efficient set for a risk averse producer. Thus farmers should prefer high loan rate programs to all cotton FOR programs with the exception of I, L, and 0; even though the former does not include target prices and deficiency payments. Decreasing the cotton loan rate by 2.5¢/lb. (C2) should reduce the typical producer's preference for the Secretary's program to the sixth most efficient set.

For producers who prefer risk, the most preferred efficient set contains programs B1 and 0. The second most preferred efficient set contains programs B2, I and N. Despite a preference for risk, the producer should prefer the Food and Agriculture Act of 1977 (B1) to a similar farm program that excludes disaster provisions (B2). Risk loving producers, like their risk adverse counterparts, should prefer a higher entry price (program 0 vs. N) and a lower trigger price (program 0 vs. I) for the cotton FOR.

Producers who are risk neutral should prefer programs B1 and 0 to the other 16 programs described in Table 1. If these most preferred programs are not available, risk neutral producers should prefer program B2, F, I, L and N. By classifying these five programs in the second most preferred efficient set, one can conclude that if offered a cotton FOR, risk neutral producers should be indifferent between a high entry price and a low entry price, if the former is associated with lower total interest costs and both have the same trigger price (program N vs. L).

Irrespective of the utility group, nonparticipation in a farm program (A) is the least preferred option. The reason being that this option offers no protection from price variability.

Summary and Conclusions

With the proposed elimination of target prices and a renewed emphasis on the grain FOR, a cotton FOR may be a possibility for the 1980's. The consequences of participating in a cotton FOR were analyzed for a typical Texas High Plains cotton farm using a Monte Carlo farm simulation model. Twelve cotton FOR programs were analyzed using alternative entry prices ($.50, $.525, and $.58/lb.), trigger prices ($.70 and $.78/lb.), and interest costs (waived in 2 or 3 years). The cotton FOR programs were compared to a continuation of the 1977 Act and to a program proposed by Secretary Block in early 1981.

Stochastic dominance with respect to a function was used to make normative forecasts of producer's preference for a cotton FOR as well as other farm programs. An after-tax net present value distribution for each farm program was estimated using a firm level simulation model, FLIPSIM. The distributions were compared for three utility groups using Meyer's stochastic dominance program.

The results indicate that risk averse High Plains cotton producers should prefer a continuation of the Food and Agriculture Act of 1977 to a cotton FOR. However, if the disaster provisions in the 1977 Act were eliminated, this group of producers should be indifferent between the resulting farm program and a cotton FOR which has a 58¢/lb. entry price, 70¢/lb. trigger price and interest waived in all years. If offered a cotton FOR, risk neutral High Plains cotton producers should prefer a high entry price to a low one, waiver of all interest, and a low trigger price to a high trigger price. This preference for cotton FOR control variables should hold for cotton producers, irrespective of their risk aversion classification.

Ten of the eighteen farm programs were preferred by risk averters to Secretary of Agriculture Block's proposed farm program of no target prices and low loan rates for High Plains cotton (43¢/lb.). Producers who are either risk neutral or risk lovers preferred the Secretary's program over only one option, namely, not participating in any farm program.

In conclusion, High Plains cotton producers should prefer a continuation of the 1977 farm programs to any of the cotton FOR programs analyzed. However, given a choice between Secretary Block's proposed program and a cotton FOR, most farmers should prefer a FOR. The CCC loan rate for High Plains cotton would have to be increased to about 52.5¢/lb. to make Secretary Block's proposed program more attractive than the majority of the cotton FOR programs.

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