EVALUATING THE PURCHASE OF FEDERAL ALL-RISK CROP INSURANCE

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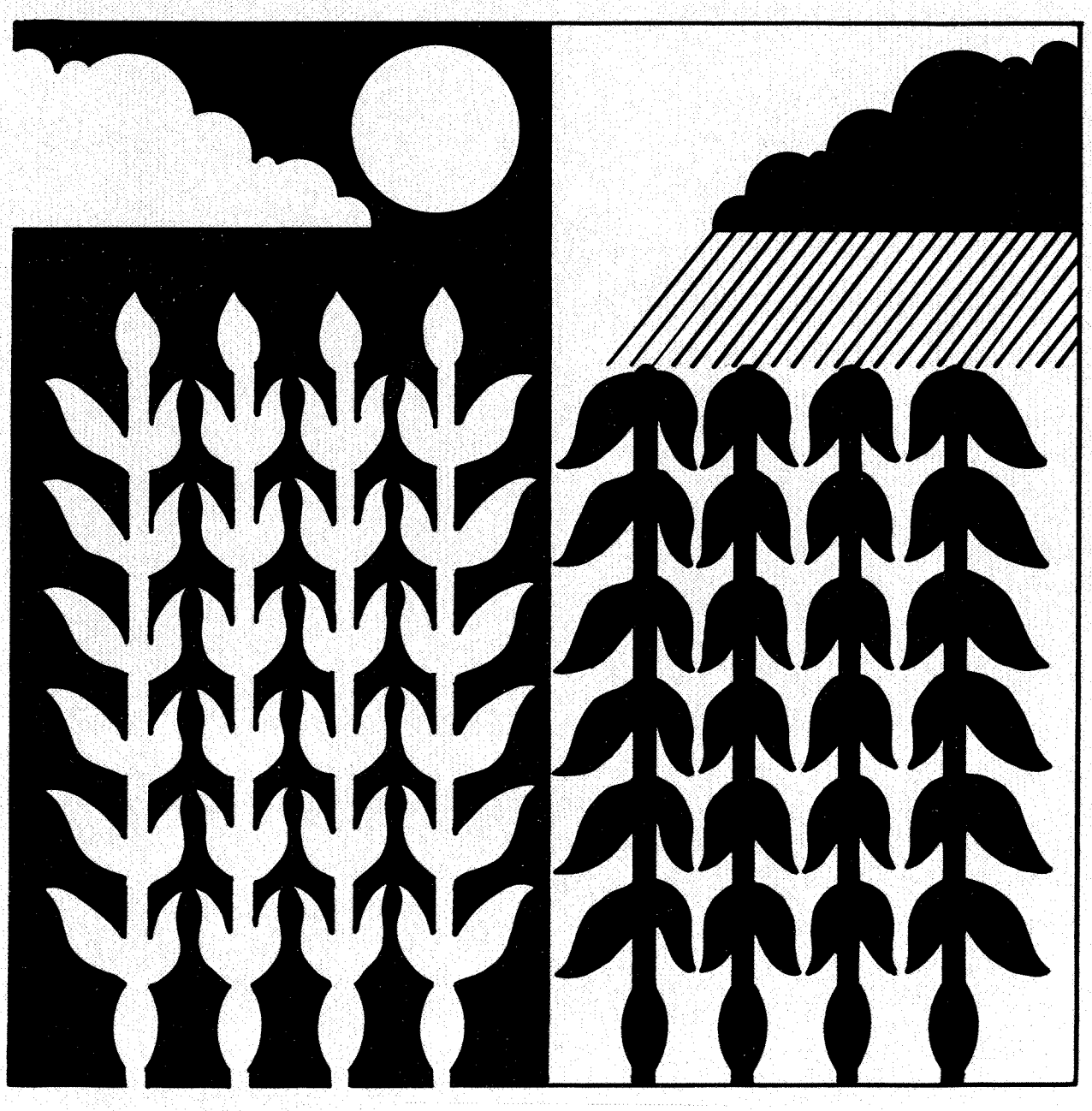

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EVALUATING THE PURCHASE OF FEDERAL ALL-RISK CROP INSURANCE

by

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Farming is risky business. Farmers' incomes are affected not only by the resource allocation decisions they make but also by a number of environmental and economic factors that they cannot control. Recognizing this, the federal government has, since the mid 1930s, provided some protection for agricultural producers from the adverse effects of yield and price variability. The role of government in agriculture is now being reevaluated, however, and a number of important program changes are being considered. One change that will have a significant impact on producers throughout Colorado is the elimination of the Disaster Assistance Program. To compensate, the federal All-Risk Crop Insurance Program has been expanded considerably, with coverage being extended to new crops and into over 250 new counties.

A farmer's decision concerning the purchase of federal crop insurance will, in many cases, be both important and difficult. It will be important because the purchase of crop insurance may have a significant impact on the profitability and stability of his operation. It will be difficult because the crop insurance program itself is quite complex and because this type of decision requires that uncertainty be considered explicitly. To help farmers with this decision, the general structure of the crop insurance

program is described in this bulletin, and a worksheet for evaluating crop insurance alternatives is presented and explained.

The Crop Insurance Program

All-Risk Crop Insurance offers many coverage options to the producer considering its purchase. Yield and price guarantees are the distinguishing characteristics of the crop insurance program. They are the principal selling points of the program, and choosing appropriate guarantee levels is one of the more difficult decisions facing the farmer.

The operator can select a 50, 65, or 75 percent guarantee of the yield established for his area. He can also, for each guaranteed yield level, have the choice of three price guarantees--low, medium, and high. With the three yield guarantees and three price guarantees, a total of nine distinct alternative coverage levels are available.

There are other, less publicized, features of the crop insurance program. The farmer must decide to insure his crop before he plants (the deadlines for participation are well before customary planting times). Also, he must insure his entire crop, though he need not purchase insurance for each crop he grows. His yield guarantee will depend on the location of his farm within areas, or zones, inside his county. Each zone has a unique historical yield average on which guarantees are based. Finally, there is the option to exclude hail and fire protection--enabling the farmer to purchase this coverage from private sources.

Crop insurance premiums are based on coverage levels--the higher the price and yield guarantee, the higher the premium. With the elimination of Disaster Assistance, all premiums will be subsidized--30 percent of the base premium at the 50 and 65 percent yield guarantees and the dollar

amount of the 65 percent guarantee for insurance at the 75 percent yield level.

Indemnities are paid whenever the actual yield falls below the level of the yield guarantee. This difference between the two yields is multiplied by the guaranteed price and the number of acres insured. An example will help to illustrate this. Consider a wheat farmer who has experienced reduced yields due to drought. His yield per acre is only 13 bushels. His zone has a historical average of 26 bushels per acre. Had he insured at the 50 percent level, his guaranteed yield would have been 13 bushels--50 percent of 26 bushels. Since his actual yield does not fall below this guaranteed level, he would not receive a payment. At the 65 percent level, however, the yield guarantee is 17 bushels--65 percent of 26 bushels. Since his yield falls below this by four bushels per acre, he would receive a per acre payment of four times his guaranteed price. Had he chosen a price guarantee of $3.50 per bushel, this would result in a payment of $14 per acre--

4.0 bushel/acre deficit x $3.50 price guarantee = $14/acre payment.

His total payment, then, would be this per acre payment, $14, times the number of acres insured. Finally, at the 75 percent level, the yield guarantee is 19.5 bushels--75 percent of 26 bushels. His actual yield of 13 bushels falls 6.5 bushels short of this level. With a price guarantee of $3.50 per bushel, his payment is $22.75 per acre--

6.5 bushels/acre deficit x $3.50 price guarantee = $22.75/acre payment.

Evaluating the Alternatives

By its very nature, the decision concerning the purchase of crop insurance involves uncertainty. This makes the decision a difficult one. Consider two alternative farm plans, one yielding an income of $25,000 and the other one $20,000. If we are certain of attaining these income levels, it is obvious that the first plan would be preferred. In reality, though, because of price, yield, and institutional uncertainties, farmers cannot be certain of the results of the resource allocation decisions they make. Suppose, instead, that the outcomes of the two plans are realistically represented by the following two probability distributions:

Plan 1		Plan 2
-30,000		15,000
0		18,000
5,000		20,000
20,000		20,000
40,000		22,000
115,000		25,000
$ 25,000	Average	$20,000

In this case, each of the six outcomes has an equal chance, or probability, of being realized.

Now the preferred farm plan is not so simple. Plan 1 has a higher average income, but Plan 2 has less variation around its average. At the time when a choice between the two plans must be made, we cannot be sure which set of conditions will hold.

When faced with the above choice of farm plans, a farmer should consider his beliefs about the distribution, or range, of incomes associated with each plan. He should also consider his ability to bear risk. For example, some operators are in a position to ride out one or two bad years in hopes of hitting a big pay-off. They might prefer Plan 1. Others

may have financial obligations and cannot afford a single bad year. They might prefer Plan 2.

The Pay-Off Matrix

The first, important step in analyzing a risky decision is the determination of the distribution of outcomes associated with each plan, or alternative, being considered. The end product of this process is called a "pay-off matrix." It consists of three components--alternative actions, events determining possible outcomes, and actual pay-offs.

Table 1 contains a pay-off matrix for a hypothetical dryland wheat farmer considering the purchase of crop insurance. He owns 2,000 acres. Summer fallowing permits him to farm 1,000 acres per year. The alternative actions are the nine coverage levels crop insurance offers, plus a tenth, uninsured alternative. These are listed along the top of the table. Included are the yield guarantee levels for his particular zone and the price guarantees.

Yields are the random variable, or event, that determine possible outcomes. Natural events, such as hail, drought, or killing frosts, are reflected in the yields. Our hypothetical wheat farmer's yields per planted acre for the last ten years are listed down the first column of the matrix. These are from his personal records and are used to establish a yield distribution. In a given year, he has an equal chance of getting any one of the yields included here.

Net cash revenues are the pay-offs and are shown for each action/event combination. The income distribution associated with each alternative can be seen in the column below each listed alternative. Average net cash revenues are summarized at the base of each column.

Table 1. Sample Pay-Off Matrix

	Yield/ Planted Acre	No Insurance	50% Yield Guarantee 13 bu/a (Low Price Guarantee) 2.50	50% Yield Guarantee 13 bu/a (Med Price Guarantee) 3.50	50% Yield Guarantee 13 bu/a (High Price Guarantee) 4.50	65% Yield Guarantee 17.0 bu/a (Low Price Guarantee) 2.50	65% Yield Guarantee 17.0 bu/a (Med Price Guarantee) 3.50	65% Yield Guarantee 17.0 bu/a (High Price Guarantee) 4.50	75% Yield Guarantee 19.5 bu/a (Low Price Guarantee) 2.50	75% Yield Guarantee 19.5 bu/a (Med Price Guarantee) 3.50	75% Yield Guarantee 19.5 bu/a (High Price Guarantee) 4.50
1.	29.0	$23,750	21,250	20,000	18,850	19,600	17,950	16,350	17,250	14,750	12,250
2.	24.5	6,880	4,380	3,130	1,980	2,730	1,080	-520	380	-2,120	-4,620
3.	17.0	-21,250	-23,750	-25,000	-26,150	-25,400	-27,050	-28,650	-21,500	-21,500	-21,500
4.	35.5	48,125	45,625	44,375	43,225	43,975	42,325	40,725	41,625	39,125	36,625
5.	13.0	-36,250	-38,750	-40,000	-41,150	-30,400	-28,050	-25,650	-26,500	-22,500	-18,500
6.	31.0	31,250	28,750	27,500	26,350	27,100	25,450	23,850	24,750	22,250	19,750
7.	29.0	23,750	21,250	20,000	18,850	19,600	17,950	16,350	17,250	14,750	12,250
8.	31.0	31,250	28,750	27,500	26,350	27,100	25,450	23,850	24,750	22,250	19,750
9.	21.0	-6,250	-8,750	-10,000	-11,150	-10,400	-12,050	-13,650	-12,750	-15,250	-17,750
10.	29.0	23,750	21,250	20,000	18,850	19,600	17,950	16,350	17,230	14,750	12,250
		12,500	10,000	8,750	7,600	9,350	8,100	6,900	8,250	6,650	5,050

By studying the distributions in each column, it is possible to get an idea of the range of incomes associated with each crop insurance alternative.

Constructing a Pay-Off Matrix

Farmers are encouraged to construct their own pay-off matrices for crops they may choose to insure. Although wheat and other dryland farmers are often thought of when discussing crop insurance, it is also a potentially valuable risk management tool for irrigators. Extended coverages and subsidized premiums combined with the loss of Disaster Assistance will make consideration of crop insurance worthwhile.

The construction of a pay-off matrix involves the completion of the worksheets on the following pages. The first two pages of the worksheet will aid in summarizing the data needed for the completion of the third page. Appendix A is an example of a worksheet a dryland wheat farmer may have filled out.

The farmer's records can supply much of the necessary data. From them, he first needs his yields per planted acre for the last ten years (or as far back as possible). These can serve as a yield distribution. The next figure needed is variable cost per acre. This should include purchased inputs (seed, fertilizer, chemicals, etc.), machinery operating costs (fuel, maintenance), interest on operating capital, and harvesting costs. A sample dryland wheat farmer's variable costs are illustrated in Table 2. Fixed costs are the next costs considered. These would include taxes and land and machinery payments. Fixed costs can be calculated on the whole farm context rather than on a per acre basis. If there is more than one crop enterprise, figure the fixed costs of the crop to be

WORKSHEET

Necessary data - from your records

1. Yields for the past ten years, or as far back as possible.

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

2. Variable costs per acre, including purchased inputs, machine variable costs, interest on operating loan, and harvest costs.

_____

3. Total fixed costs for the operation. If more than one crop is produced, the portion of the fixed costs dedicated to this crop.

_____

4. Acres farmed of crop.

_____

(The following data can be obtained from the local Crop Insurance office)

5. Average yield for your zone.

_____ bushels/acre

50 percent yield guarantee = _____ bushels/acre

65 percent yield guarantee = _____ bushels/acre

75 percent yield guarantee = _____ bushels/acre

6. Price guarantees for commodity.

low _____

medium _____

high _____

Worksheet
Page 2

7. Premium rates for crop.

@ 50 percent yield guarantee
- low price guarantee _____
- medium price guarantee _____
- high price guarantee _____

@ 65 percent yield guarantee
- low price guarantee _____
- medium price guarantee _____
- high price guarantee _____

@ 75 percent yield guarantee
- low price guarantee _____
- medium price guarantee _____
- high price guarantee _____

Other data

6. Anticipated price of commodity.

_____

Table 2. Variable Costs per Acre for Sample Dryland Wheat Operation

Field Operation	Machine Operating Costs		Purchased Inputs
One-way disc	$1.54		
Chisel	2.98		
Anhydrous application	.88		
Nitrogen			7.85
Broadcast spreader	.60		
P_2O_5			12.50
Rod weeder (fallow)	.48		
Rod weeder (fallow)	.48		
Combine (custom)		11.00	
Truck		4.63	
	$6.97		$20.35

1. Purchased inputs		20.35
2. Machinery variable costs		6.97
3. Interest on operating capital [(20.35 + 6.97) x .5 year x .15]		2.05
4. Harvesting costs		
Combine		11.00
Truck		4.63
Variable costs/acre		$45.00

insured as the portion of the total farm's fixed costs which are reasonably allocated to that crop. The sample dryland operator may pay $5,000 per year in real estate tax, $20,000 per year in land payments, and an additional $15,000 per year on machinery payments--a total of $40,000 (Table 3).

Table 3. Fixed Costs for Sample Dryland Wheat Operation

Taxes on land	$ 5,000/year
Land payments	20,000/year
Machinery payments	15,000/year
Fixed costs	$40,000/year

Finally, the farmer should include the number of acres under consideration for crop insurance.

The yield and price guarantee levels and the premium rates are available for each crop from the local crop insurance office. These are the data that should be recorded on the worksheet. Finally, a price expectation for the crop in question is needed. What price does the farmer think his crop will bring next year? The sample dryland operator has filled out his worksheet (Appendix A) and estimates his 1982 crop will bring $3.75 per bushel. It is helpful to take the time to develop this expectation fully, but it does not require one to be extremely accurate. The difference in incomes and income distributions associated with crop insurance are important, not the incomes themselves.

Page 3 of the worksheet is a blank matrix. Like the sample matrix, the yields should be listed down the first column. Then include the actual

WORKSHEET

Yield	No Insurance	(50% Yield Guarantee) (low, med, and high price guarantees)			(65% Yield Guarantee) (low, med, and high price guarantees)			(75% Yield Guarantee) (low, med, and high price guarantees)		
1. _____										
2. _____										
3. _____										
4. _____										
5. _____										
6. _____										
7. _____										
8. _____										
9. _____										
10. _____										

yield and price guarantee alternatives across the top. The final step is to compute net cash revenues for each crop insurance alternative.

Net cash revenue is simply the total revenue minus the total costs, as seen in equation 1.

1. Total revenue - total cost = net cash revenue.

Total revenue is crop receipts plus any indemnity received. For review, indemnities are the yield deficit (guaranteed yield minus actual yield) times the price guarantee chosen times the insured acreage:

2. (Guaranteed yield - actual yield) x price guarantee
   x insured acres = indemnity.

Indemnities are added to the crop receipts, which are equal to actual yield times anticipated price times the number of acres insured:

3. Actual yield x anticipated price x insured acres = crop receipts.

Summing the indemnities and crop receipts, equations 2 and 3, result in the total revenue, equation 4:

4. Insurance indemnity + crop receipts = <u>total revenue</u>.

Total costs are variable costs times insured acres plus fixed costs plus premium costs times insured acres, equation 5:

5. (Variable cost/acre x insured acres) + fixed costs
   + (Premium costs/acre x insured acres) = <u>total costs</u>.

Not all alternatives include crop insurance. When figuring costs, it may be helpful to sum the variable and fixed costs for the operation and

write it down somewhere. Then the additional costs, premiums, can be added to these costs that remain constant.

Let us look at our wheat farmer example once again. Assume he is insured for $3.50 per bushel at the 65 percent yield guarantee. This year he gets only a yield of 13.0 bushels per acre. His zone's historical average is 26.0 bushels per acre. First, he summarizes the relevant data needed to figure his net cash revenue:

1. Actual yield 13.0 bu/acre
2. Yield guarantee 17.0 bu/acre
3. Anticipated price $3.75/bu
4. Insured acres 1,000
5. Variable costs $45.00/acre
6. Fixed costs $40,000
7. Premium $5.80/acre
8. Price guarantee $3.50/acre

In this case, the guaranteed yield, 17.0 bushels, is greater than the actual yield, 13.0 bushels, so there will be an indemnity (equation 2):

17 bushels (yield guarantee) - 13.0 (actual yield) = 4 bushels (deficit)

4 bushels x 3.50 (price guarantee) x 1,000 (insured acres) = $14,000 indemnity

Adding this $14,000 payment to his crop receipts (equation 3) results in total revenue (equation 4):

13.0 (actual yield) x 3.75 (anticipated price) x 1,000 (acres) = $48,750 crop receipts

14,000 (indemnity) + 48,750 (crop receipts) = 62,750 total revenue.

Subtract total costs (equation 5) from total revenues to get net cash revenue (equation 1):

(45.00 variable costs/acre x 1,000 acres) + 40,000 (fixed costs) + (5.80 premium/acre x 1,000) = $90,800 total costs.

then

$62,750 (total revenue) - 90,800 (total costs) = -$28,050 net cash revenue.

In summary:

Net cash revenue (equation 1) = total revenue (equation 4) - total costs (equation 5),

and

total revenue (equation 4) = indemnity (equation 2) + crop receipts (equation 3).

The pay-off matrix summarizes the decision variables but does not make the decision. This must be made by the farmer, based on his attitudes towards risk. Each individual will have his own decision making criteria which are unique to his operation. In the case of crop insurance, he must decide if he can survive a big loss in order to get higher profits in the good years, or if he should insure (and sacrifice these higher profits) and keep the big losses to a minimum.

Decision-Making Guidelines

There are several decision-making guidelines that can aid in selecting the best alternative given one's attitude towards bearing risk. These are by no means strict procedures, but they are helpful in selecting an alternative that is consistent with one's degree of risk aversion.

A decision maker may be very risk averse--one big loss may bankrupt him. He would likely select the alternative resulting in the least losses. The operator selects the worst outcome from each alternative in the pay-off matrix. He then selects the alternative that yields him the least loss. In our illustrative pay-off matrix, the crop insurance would have been purchased at the highest price and yield guarantees. It has the least loss in its worst outcome--(-$18,500).

A second decision maker may be risk loving. He might do the opposite of the risk averter--rather than choose the highest of the low outcomes, he would choose the highest of the high. The alternative that contains the outcome with the greatest monetary value is chosen. In the example, this decision maker would choose not to insure at all.

Finally, there is the farmer who maximizes his expected monetary value. Simply stated, he would choose the alternative that has the highest average net cash revenue. The uninsured alternative would have been chosen if our wheat farmer followed this criteria. Its net cash revenue, $12,500, has an average $2,500 higher than the next best insured alternative.

Conclusions

An explanation of the new All-Risk Crop Insurance Program has been presented, and a pay-off matrix was introduced as a way of evaluating the

purchase of insurance. The decision whether to buy it or not is up to the individual, his goals and risk preferences.

Possibly, more important than the actual decision of purchasing insurance, is the effort spent evaluating the alternatives and their resulting income distributions. This is the most important aspect of making a decision under uncertainty. The probability of making a wise decision is greatly increased when all alternative actions are thoroughly considered. This kind of analysis is by no means limited to the purchase of crop insurance. It can apply to nearly any farm decision. Pay-off matrices can be constructed for evaluating the purchase of additional land, machinery, storage, or any other resource whose benefits and costs to the operation are not immediately clear.

Appendix A. Crop Insurance Worksheet

Necessary data - from your records

1. Yields for the past 10 years, or as far back as possible

29.0	31.0
24.5	29.0
17.0	31.0
13.0	29.0

2. Variable costs per acre, including purchased inputs, machine variable costs, interest on operating loan, and harvest costs

   $45,000

3. Total fixed costs for the operation. If more than one crop is produced, the portion of the fixed costs dedicated to this crop

   $40,000

4. Acres farmed of crop

   1,000

5. Average yield for your zone

   26.0 bushels/acre

   50 percent yield guarantee = 13.0 bushels/acre

   65 percent yield guarantee = 17.0 bushels/acre

   75 percent yield guarantee = 19.5 bushels/acre

6. Price guarantee for commodity:

low	2.50
medium	3.50
high	4.50

7. Premium rates for crop

   @ 50 percent yield guarantee

low price guarantee	2.50
medium price guarantee	3.75
high price guarantee	4.90

   @ 65 percent yield guarantee

low price guarantee	4.15
medium price guarantee	5.80
high price guarantee	7.40

Appendix A. Crop Insurance Worksheet (continued)

@ 75 percent yield guarantee

low price guarantee	6.50
medium price guarantee	9.00
high price guarantee	11.50

Other data

6. Anticipated price of commodity

$3.75

Appendix B. Use of Programmable Calculator

A short program for a Texas Instrument (TI) 58, or 59, programmable calculator can quickly calculate net cash revenues for the pay-off matrix.

Using the program involves first storing data in the calculator's memory registers and then entering the actual program. The memory register number and its respective data requirements are shown below.

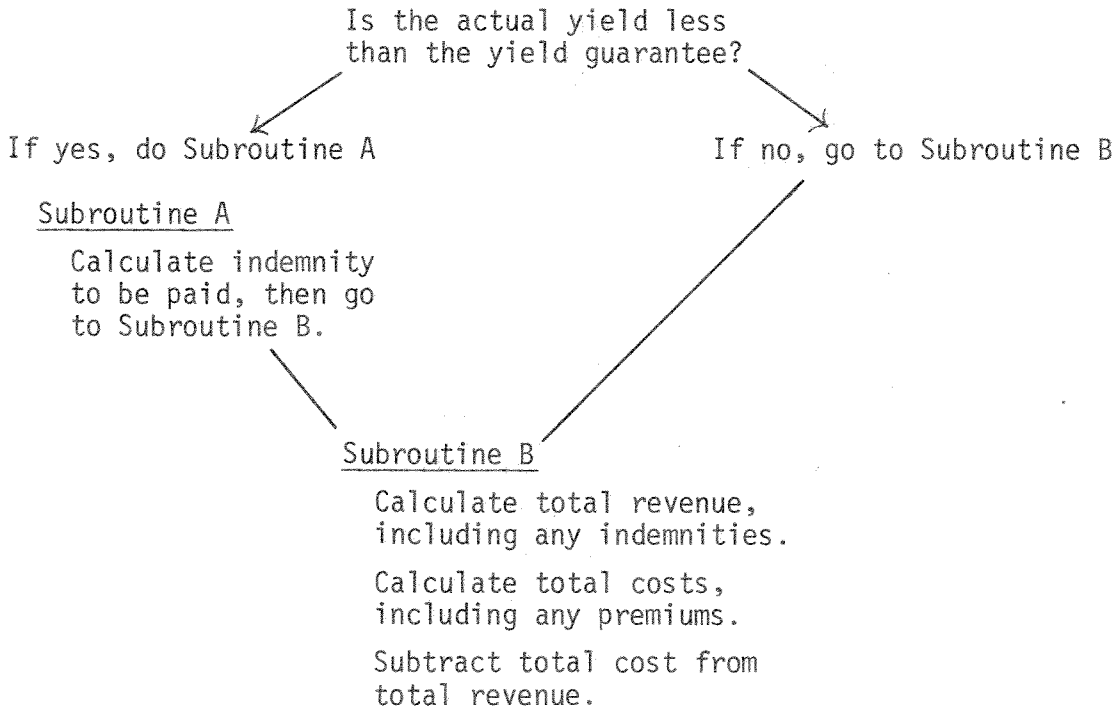
Memory number	Data
00	Yield/acre
01	Anticipated price/bu.
02	Acres insured
03	Variable costs/acre
04	Fixed costs
05	Premium/acre
06	Price guarantee/bu.
t-register	Yield guarantee

The t-register ($X \leq t$) stores the yield guarantee and "tests" it to see if it is greater than the actual yield.

Conceptually, the program tests to see if the farmer's actual yield is below his yield guarantee. If it is, the insurance indemnity is calculated and added to the operation's total revenue. Total costs, including any premiums, are then substracted. A diagram can aid in illustrating this:

→

Appendix B. Use of Programmable Calculator (continued)



When the data is sorted, the actual program should be entered. The calculator must be put in the learn mode (LRN). A five-digit display of zeros should appear when the LRN key is pushed. At this point, the program can be entered by strictly following the third column of the program listing on the next page.

When this is complete, the calculator should be exited from the learn mode by using the LRN key again. At this point, a single zero should be displayed. To run the program, the reset key, RST, should be pushed for assurance that the program will start from the beginning. Then use the run/stop function, R/S, to actually start the program. The net cash revenue should appear momentarily.

Each net cash revenue can be calculated by simply changing the relevant data in the memories. For example, if a column in the pay-off

Appendix B. Use of Programmable Calculator (continued)

000	43	RCL
001	00	00
002	22	INV
003	77	GE(X≤t)
004	11	A
005	85	+
006	12	B
007	95	=
008	91	R/S
009	76	LBL
010	11	A
011	32	X≤T
012	75	-
013	43	RCL
014	00	00
015	95	=
016	65	X
017	43	RCL
018	06	06
019	65	X
020	43	RCL
021	02	02
022	85	+
023	12	B
024	95	=
025	91	R/S
026	76	LBL
027	12	B
028	43	RCL
029	00	00
030	65	X
031	43	RCL
032	01	01
033	65	X
034	43	RCL
035	02	02
036	75	-
037	43	RCL
038	03	03
039	65	X
040	43	RCL
041	02	02
042	75	-
043	43	RCL
044	04	04
045	75	-
046	43	RCL
047	05	05
048	65	X
049	43	RCL
050	02	02
051	95	=
052	91	R/X

Appendix B. Use of Programmable Calculator (continued)

matrix is being completed, one would only have to change the actual yield in memory register 00 to quickly calculate each value in the column. The remainder of the stored data will not be affected.