CROP INSURANCE TO REDUCE RISK: USING A PAYOFF MATRIX TO AID IN THE PURCHASE DECISION

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Crop insurance provides a wheat grower the opportunity to assure himself at least some income in years when yields are low. Several types of crop insurance are available, the most common being Federal All-Risk Crop Insurance (FCI) and crop-hail insurance available from private insurance companies.

Federal All-Risk Crop Insurance

Our first example considers the use of Federal All-Risk Crop Insurance. The intent is not to tell you whether you should purchase such insurance, but to provide a framework which you can use to help make the decision for your wheat crop.

Federal Crop Insurance (FCI) insures against "all natural hazards beyond your control." It does not insure against poor farming practices.[1/] Our example illustrates the use of FCI for a particular situation.

FCI "does not guarantee full usual production, but only some part of the average over a representative period of years -- never over 75%, and usually less. The amount of the guarantee may not exceed the usual investment per acre in the crop in the area. Thus, the farmer bears the first part of the loss himself when the yield drops below average. The farmer bears the loss until the yield drops 25% or more below the average or usual production" (FCIC, 1972, p. 11-12).

1/ Details of the Federal Crop Insurance program are given in publications listed in references at the end of this publication. For further details contact your local or district Federal Crop Insurance office.

FCI establishes a "bushel per acre guarantee" for each area which may be a county or part of a county. This guarantee is 75% or less of the average or usual production per acre for the area. The grower usually can select one of three levels of coverage ($1.50, $2.00, or $2.50) per bushel. In our example, the usual production is 33 bushels per acre and the guarantee is 20.5 bushels plus additional guarantee of 1.5 bushels per acre if the crop is harvested. For the area from which our example is taken, the premiums for the 22 bushel guarantee are:

Coverage per bushel	Premium per acre
$1.50	$1.40
2.00	1.80
2.50	2.30

Premium reductions are available to growers with continuous insurance coverage and specific numbers of years without losses. Our example does not consider premium reduction.

Our example compares gross income and return over variable costs per acre with no insurance and with FCI at $2.50 per bushel for several yield levels which could occur in this wheat growing situation (Table 1). Not all possible yield levels are shown, but these yields can be considered representative of yields which might occur. Average or usual yield is 33 bushels. Possible yields of zero to 50 bushels in 5 bushel increments are considered in the example. Variable costs are $50 per acre plus $0.10 per bushel. Variable costs for a zero yield are $45 per acre (a $5 reduction because the crop is not harvested). Wheat price is $3.50 per bushel.

For the "no insurance" situation, gross income is simply yield times $3.50. Return over variable cost (ROVC) is computed by deducting variable costs.

For the FCI situation, gross income is wheat yield x 3.50 plus insurance payment. ROVC is gross income less variable costs and insurance premium. If yield exceeds the guarantee, there is no insurance payment. Example calculations for yields of zero and 5 bushels are shown.

Zero yield

Insurance payment = 20.5 bu. x $2.50 =	$51.25
Insurance premium	-2.30
Variable costs	-45.00
ROVC	$ 3.95

5 bu. yield

Guarantee = 20.5 + 1.5 = 22 bu.

Payment based on 22 bu. guarantee less 5 bu. harvested = 17 bu.

Insurance payment = 17 bu. x $2.50 =	$42.50
Wheat sale = 5 bu. x $3.50 =	17.50
Gross income	$60.00
Insurance premium	-2.30
Variable costs	-50.50
ROVC	$ 7.20

How would a grower use the information in Table 1 to help decide whether to purchase FCI? In comparing the ROVC with and without FCI, it is clear that insurance should not be purchased if the grower expected his yield never to be less than 25 bushels per acre. (Although not shown in the table, he would

not purchase FCI if he expected his yield never to fall below the guarantee of 22 bushels). At yields above the guarantee, he will not collect, but of course must pay the insurance premium.

The decision of whether to purchase FCI depends on the likelihood of the grower's wheat yield falling below the guarantee level. In our decision making framework, it really depends on the grower's subjective probability of his wheat yield falling below the guarantee level.

Let's consider a set of subjective probabilities of wheat yields, as shown in Table 2. At planting time, a grower's probability distribution of yields would be based on historical weather data, perhaps modified by soil moisture at planting time or long range weather forecasts. This grower (Case Ia) believes that there is no chance of a complete crop failure. He believes there is one chance in 100 (.01 probability) of a 5 bushel yield, a .02 probability of a 10 bushel yield and .03 probability of a 15 bushel yield. The remaining yield probabilities are shown in Table 2. The "expected yield" (the sum of the yields times the probabilities) is 33 bushels.

His ROVC's with and without FCI for this distribution of yields are shown in Table 2 for 500 acres of wheat. For this probability distribution of yields, the expected monetary value is greater for no insurance than for FCI. A risk neutral decision maker with this payoff matrix would not purchase FCI.

A risk averse decision maker would need to give further thought to the situation before making the decision for Case Ia. He might reason as follows: The probability of yield greater than the guarantee is 0.89 and, conversely, the probability of yield below the guarantee is only 0.11. Whenever the yield is above the guarantee, my ROVC will be $1150 lower (the cost of insurance for 500 acres @ $2.30 per acre) if I purchase FCI than if

I don't. This seems like quite a sacrifice. Yet if my yield is only 5 or 10 bushels, my ROVC will be much greater with than without FCI. While the ROVC's with FCI are not great, at least I'll cover my variable costs and have some money left to help with my fixed cash costs and living expenses. The purchase of FCI will then depend on his financial reserves, borrowing ability and how much he worries about a low income -- in other words on his willingness and ability to assume risks.

Suppose the decision-maker has a "safety first" utility function which says that he will not accept any action that includes more than a 5% chance of ROVC below $8,000. "No insurance" would be unacceptable because it has a 6% chance of an ROVC below $8,000. FCI would be acceptable because the chance of having ROVC below $8,000 is less than 5%.

A risk averter is likely to think in terms of some level of ROVC below which he prefers not to drop in any year. This level probably is related to his fixed cash costs (for items such as taxes), debt payments (mortgage, equipment, etc.) and cash living expenses. It may be the total of these items, or some percentage of this total. As an example, suppose fixed cash costs are $2500, debt payments are $3,500 and minimum cash living expenses are $8,000 for a total of $14,000. Our wheat grower with 500 acres could easily meet this objective with yields of 25 bushels or higher and $3.50 wheat. He could not meet this objective with yields of 20 bushels or less, regardless of whether he purchased FCI. Suppose his "safety first" criterion was less than 10% chance of ROVC below $14,000. Neither alternative (or action) will meet this criterion. The decision maker must change his criterion or give up wheat growing.

About now you're going to say "Modern decision theory is no good. It can't assure me of meeting my income objectives in an uncertain situation." Don't despair, utility is there. The payoff's (ROVC's) can be converted to utilities, using the utility function of the decision maker, and expected utility can be maximized. But perhaps you do not want to go through the process of deriving your utility function. What's left?

Specification of the events (yields), subjective probabilities, and payoffs (ROVC's) has forced the decision maker to think in more detail than he previously has about the consequences of the insurance-no insurance decision. If he conscientiously develops the payoff matrix for his own situation, he must consider the probabilities of occurrence of yields below the guarantee level. He must also consider the payoffs with and without FCI for these yield levels. And finally, even though FCI may not be able to guarantee the level of ROVC he would like to have, it will assure him of a higher level of income (or smaller loss) than no insurance. He can rather easily see how much closer he can come to attaining his objective with FCI than with no insurance.

The payoff matrix allows a decision maker to use what one might call a "reverse safety first" objective or criterion. Rather than setting a minimum level of income and probability of not falling below this minimum, the decision maker can use the payoff matrix to consider the probabilities of obtaining various (low) levels of income (or ROVC) with and without FCI. For example, the Case Ia decision maker can see that there is one chance in 100 of a negative $16,500 ROVC, 3 chances in 100 of -$8,000 ROVC, 6 chances in 100 of only $500 ROVC. He can then think about these probabilities in relation to his need for cash to pay his fixed cash expenses, debt payments and

mimimum cash living expenses. Perhaps he will decide that the chances of extremely low yields (such as zero or 5 or 10 bushels) are so small that he'll disregard the disastrous ROVC associated with such yields. But at least he has consciously considered such events and consequences. Before working through the payoff matrix he may not have really considered such outcomes.

FCI plus Disaster Payments

For 1978, disaster payments for low yields are available to wheat producers who participate in the set-aside program. The payment rate for low yields is $1.50 per bushel. Payments are made only if the growers yield drops below 60 percent of his established yield.

The next example (Case Ib) deals with a situation where disaster payments for low yields will be available to the grower. Otherwise, Case Ib is the same as Case Ia. We don't want to get bogged down in the details of compliance with all the provisions of the 1978 wheat program so we will assume that the grower with 500 acres of wheat is in compliance with provisions of the set-aside program.

Gross income and ROVC's per acre with no insurance and with FCI at $2.50 per bushel are shown in Table 3. This table differs from Table 1 by the addition of disaster payments at $1.50 per bushel for yields below 20 bushels per acre (33 bushel established yield x 60 percent = 19.8 bushels). Example calculations for yields of zero and five bushels per acre are shown below:

	No insurance	FCI @ $2.50
Zero Yield		
Disaster payment = 20 bu. x $1.50 =	$30.00	$30.00
Insurance payment = 20.5 bu. x 2.50 =	--	51.25
Gross	$30.00	$81.25
Variable costs	45.00	47.30
ROVC	$-15.00	$33.95
5 bu. yield		
Disaster payment = 15 bu. x $1.50 =	$22.50	$22.50
Insurance payment = 17 bu. x 2.50 =	--	42.50
Wheat sale = 5 bu. x 3.50 =	17.50	17.50
Gross	$40.00	$82.50
Variable costs	50.50	52.80
ROVC	$-10.50	$29.70

The payoff matrix, in terms of ROVC's, for 500 acres of wheat is shown in Table 4. Several points are evident in comparison to Case Ia where disaster payments were not available. (1) The ROVC's with no insurance at yields below 20 bushels, while still low, are substantially higher. This may affect the the grower's decision to purchase FCI. (2) The combination of disaster payments and FCI at $2.50 per bushel indicates that if a grower's yield is below 20 bushels, he is better with even lower yields. This is because $1.50 disaster payment plus $2.50 per bushel insurance exceeds the $3.50 per bushel sale price for wheat. With FCI at $2.00 per bushel, the ROVC's for yields of 5, 10, and 15 bushels would all be about $10,000. (3) The purchase of insurance, coupled with the disaster payments, makes it possible to achieve an ROVC of at least $10,000.

In this case, a risk neutral decision maker would not purchase FCI because the expected monetary value (EMV) is higher with no insurance. A risk averter could use a safety first decision rule. Suppose the wheat grower decides that he will reject any action with more than a 10% chance of a payoff (ROVC) of less than $12,000. No insurance would be rejected. FCI at $2.50 per bushel has an 8% chance of an income below $12,000 so this action meets the objective.

Again the decision maker may want to consider the payoff matrix rather than rigidly adhering to a decision rule. A risk averter can clearly see that even with disaster payments there is a 6% chance of an income below $5,000 if he does not purchase insurance. With FCI at $2.50 he can be assured of at least $10,000 ROVC.

The grower may also want to consider alternative levels of FCI, that is $1.50 or $2.00 per bushel rather than $2.50. While not shown in Table 4, FCI at $2.00 per bushel will allow this grower to achieve an ROVC of about $10,000. Perhaps this would satisfy him. He would need to think about the tradeoff of an extra $250 premium vs. the additional ROVC (above about $10,000) that he would achieve with yields of 5, 10, or 15 bushels per acre. He also may want to consider saving another $2.00 per acre by purchasing FCI at $1.50 but receiving lower ROVC's at 5, 10, and 15 bushels per acre.

Table 1. Variable costs, gross income, and return over variable costs with no insurance and with Federal Crop Insurance, 22 bushel guarantee at $2.50 per bushel.

Yield	Variable costs	Income			
		No Insurance		FCI @ 2.50	
		Gross	ROVC	Gross	ROVC
0	$ 45.00	$ 0.00	$-45	$ 51.25	$ 3.95
5	50.50	17.50	-33	60.00	7.20
10	51.00	35.00	-16	65.00	11.70
15	51.50	52.50	1	70.00	16.20
20	52.00	70.00	18	75.00	20.70
25	52.50	87.50	35	87.50	32.70
30	53.00	105.00	52	105.00	49.70
35	53.50	122.50	69	122.50	66.70
40	54.00	140.00	86	140.00	83.70
45	54.50	157.50	103	157.50	100.70
50	55.00	175.00	120	175.00	117.70

Table 2. Payoff matrix for no insurance and for Federal Crop Insurance with 22 bushel guarantee at 2.50 per bushel, 500 acres (Case Ia).

Events Yields	Subjective probabilities of yields	Actions	
		No Insurance	FCI @ $2.50 and 22 bu.
		-------Payoffs (ROVC's)------	
5	.01	$-16,500	$ 3,600
10	.02	- 8,000	5,850
15	.03	500	8,100
20	.05	9,000	10,350
25	.10	17,500	16,350
30	.25	26,000	24,850
35	.25	34,500	33,350
40	.15	43,000	41,850
45	.10	51,500	50,350
50	.04	60,000	58,850
	1.00		
Expected monetary value =		$31,015	$30,765

Table 3. Variable costs, gross income, and return over variable costs with no insurance and with Federal Crop Insurance, 22 bushel guarantee at $2.50 per bushel. Eligible for disaster payments. Usual yield 33 bushels per acre.

Yield	Variable costs	Income			
		No Insurance		FCI @ 2.50	
		Gross	ROVC	Gross	ROVC
0	$ 45.00	$ 30.00	$-15.00	$ 85.00	$ 33.95
5	50.50	40.00	-10.50	82.50	29.70
10	51.00	50.00	- 1.00	80.00	26.70
15	51.50	60.00	8.50	77.50	23.70
20	52.00	70.00	18	75.00	20.70
25	52.50	87.50	35	87.50	32.70
30	53.00	105.00	52	105.00	42.70
35	53.50	122.50	69	122.50	66.70
40	54.00	140.00	86	140.00	83.70
45	54.50	157.50	103	157.50	100.70
50	55.00	175.00	120	175.00	117.70

Table 4. Payoff matrix for no insurance and Federal Crop Insurance with 22 bushel guarantee at $2.50 per bushel, 500 acres (Case Ib). Eligible for disaster payments. Usual yield 33 bushels.

Events Yields	Subjective probabilities of yields	Actions	
		No Insurance	FCI @ $2.50 and 22 bu.
		----------Payoffs (ROVC's)-------	
5	.01	$ -5,250	$ 14,850
10	.02	- 500	13,350
15	.03	4,250	11,850
20	.05	9,000	10,350
25	.10	17,500	16,350
30	.25	26,000	24,850
35	.25	34,500	33,350
40	.15	43,000	41,850
45	.10	51,500	50,350
50	.04	60,000	58,850
	1.00		
Expected monetary value =		$31,390	$31,140

Crop-Hail Insurance

Unlike Federal All-Risk Crop Insurance which must be purchased before planting time, crop-hail insurance (CHI) can be purchased any time up to harvest. In practice, hail insurance normally would be purchased only a few weeks or months before harvest. At the time of hail insurance purchase, a wheat grower would usually have greater knowledge about the probability distribution of yields than at planting time. At planting time, his probability distribution of yields will be based on historical weather data, perhaps modified by soil moisture at planting time or long range weather forecasts. In contrast, when he contemplates purchase of CHI in the spring or early summer, he can see the standing crop and therefore has a reasonable idea of the yield he can expect. For example, the yield distribution before planting (FCI decision time) for Case Ia includes some probability of yields as high as 45 or 50 bushels, even though the average (or expected) yield is only 33 bushels. Assume that by spring this grower has experienced a better than "average" or "normal" growing year. At the time of the hail insurance decision his most likely yield is 40 bushels, assuming no hail. The probability of a yield of 50 bushels will be about nil. While the probability of something bad happening (hail, fire, insects, wind) may be quite high, the probability of something extremely good occurring is quite small. Therefore, the probability distribution of yields at the time of the CHI decision may be quite different than at the time of the FCI decision.

While FCI insures against all natural hazards beyond the farmer's control, hail insurance protects only against hail and wind. While the yield probabilities and payoffs in the FCI payoff matrix relate to yield variability due to any

natural cause, the payoff matrix for the CHI decision must be interpreted differently. Only losses from hail and wind will be paid. Losses are adjusted differently. With FCI, the yield deficit below the per acre guarantee for the entire farm unit is collected at the appropriate price per bushel. With CHI coverage may be purchased for individual acres or fields rather than the entire farm unit. Losses are paid based on the percent damage to the crop times the coverage purchased per acre rather than being based on actual yields.

CHI may be purchased for any dollar value up to the full value of the crop or a limit per acre allowed by the insurance company, whichever is less. A farmer may have double coverage, that is, FCI and CHI.

Crop-hail insurance premiums vary by area and are usually based on historical hail damage. Our example is based on the premiums for one township in Nebraska. The same type of analysis can be done using the rates for your location.

Our first CHI example (Case Ich) is based on Case Ia and considers purchase of insurance for the entire 500 acres. The best estimate of yield at CHI decision time is 40 bushels if no hail damage occurs. There is a 4% chance of a 45 bushel yield. Yields below 40 bushels are assumed to occur only if there is hail damage.

While several types of hail insurance policies are available, this example uses the "standard" policy. This policy pays the percent damage x coverage per acre with no deductible. The grower has purchased coverage on the entire 500 acres. The premium in his area is $20 per $100 coverage. Three levels of coverage $40, $80, and $120 per acre are considered.[1/] In this example, the grower does not have FCI coverage.

The payoffs for no insurance are yield x $3.50 (Table 5). Payoffs from CHI are calculated as illustrated below for $40 coverage ($8 premium) and zero and 5 bushel yields:

[1/] The insurance company may not allow the higher levels

Yield	% damage	Coverage	Payment	Wheat sale	Total income	Variable costs plus insurance premium	ROVC per acre
0	100	$40	$40	$ 0	$40.00	$53.00	$-13.00
5	87.5	40	35	17.50	52.50	58.50	- 6.00

The decision. In this situation, a risk neutral decision maker would not purchase CHI at any of the three levels because the expected monetary value (EMV) is highest with no insurance.

A risk averter would need to carefully consider his degree of risk aversion. The $40 CHI coverage has an EMV of $1,000 less than the EMV of no insurance. Each successive higher level of insurance coverage reduces EMV by $1,000. He needs to think about the tradeoff of lower EMV's if he insures with the possibilities of low or negative incomes if he doesn't insure.

The grower could think in terms of a minimum income objective and the probability of falling below this minimum. For example, suppose this grower wants to avoid a negative ROVC. More specifically, he would like to avoid any action with more than 5% chance of a negative return over variable costs. No insurance would not meet this objective (it has a 6% chance of a negative income) but CHI at $40, $80, or $120 per acre would meet the objective. CHI at $40 would meet the objective and yet has a higher EMV than insurance at the higher levels. Therefore, to meet his objective, there is no reason to purchase more than $40 per acre CHI. However, by purchasing higher coverage he can assure himself of higher minimum incomes if there is heavy hail loss.

Suppose our decision maker needs a minimum of $14,000 ROVC from his 500 acres of wheat to cover his fixed cash costs, debt payments, and living expenses. He has decided that his "safety first" criterion is no more than a 5% chance of an ROVC below $14,000. CHI at $40 would not meet this objective but CHI at $80 per acre would meet it.

Even if the decision maker has not formulated a specific safety first objective, the payoff matrix can still be useful. The tradeoff between lower EMV but higher minimum incomes as the amount of insurance is increased is quite clear and should help him decide whether and how much insurance to purchase.

Table 5. Payoff matrix for no insurance and crop-hail insurance at three levels of coverage per acre, 500 acres of wheat (Case Ich 1).

Events			Actions			
	Percent yield loss due to	Subjective probabilities	No	Crop-hail Insurance		
Yields	hail	of yields	insurance	$40	$80	$120
0	100%	.01	$-22,500	$- 6,500	$ 9,500	$25,500
5	87.5	.02	-16,500	- 3,000	10,500	24,000
10	75	.03	- 8,000	3,000	14,000	25,000
15	62.5	.04	500	9,000	17,500	26,000
20	50	.05	9,000	15,000	21,000	27,000
25	37.5	.06	17,500	21,000	24,500	28,000
30	25	.07	26,000	27,000	28,000	29,000
35	12.5	.08	34,500	33,000	31,500	30,000
40	0	.60	43,000	39,000	35,000	31,000
45	0	.04	51,000	47,500	43,000	39,500
		1.0				
EMV			$33,165	$32,165	$31,165	$30,165

Crop-Hail and Federal All-Risk Insurance

It is possible for a grower to purchase and collect from both FCI and CHI on the same field. FCI must be purchased for an entire farm unit as defined by the Federal Crop Insurance Corporation. The farmer with FCI could subsequently purchase CHI on part or all of the acreage in the farm unit. An example will illustrate the decision to purchase CHI when the grower has FCI coverage.

FCI coverage is limited to a maximum of 75% (and usually less) of the usual yield. It also has an upper limit in coverage per bushel, currently $2.50. The intent is to help a farmer recover his production costs. CHI allows a farmer to achieve greater insurance protection. Hence a grower might want to purchase hail protection above that available with FCI, particularly in years when in the period a few weeks before harvest the wheat yield appears to be particularly good, assuming no hail damage.

The FCI-CHI example is based on the previous CHI example (Case Ich in Table 5). At the time of the CHI decision, the grower expects that the yield will be 40 bushels per acre if there is no hail damage. There is a slight chance of a higher yield. Yields below 40 bushels are related to the probability of hail damage (Table 6). The probability distribution is the same as in Table 5. The payoffs (ROVC's) in Table 6 are for FCI alone (which has already been purchased) and for FCI plus CHI at $40 and $80 per acre.

The decision: The EMV is higher for FCI alone than for FCI plus CHI at either $40 or $80 per acre. Faced with this situation, a risk neutral decision maker (or EMV'er) would not purchase CHI.

A risk averter would faced with the decision of whether to stick with FCI alone or to purchase CHI at either $40 or $80 per acre. Suppose our

decision maker's safety first objective is no more than a 10% chance of a payoff below $14,000, the amount he needs to cover fixed cash costs, debt payments and minimum cash living expenses. FCI alone does not meet the objective because it has a 15% chance of ROVC below $14,000. FCI plus CHI at $40 per acre meets the objective. In fact, there is no chance of a payoff below $14,000. With this objective, there is no reason to purchase $80 per acre CHI. He could probably purchase less than $40 CHI and yet meet his objective.

The $80 per acre CHI leads to a situation where the grower, if there is any hail damage, is better off with more damage. In fact, he is slightly better off with 100% damage than with 40 bushels, the most likely yield without hail damage. Some growers might want to purchase $80 rather than $40 coverage per acre because of the higher incomes at the lower yield levels. However, one must recognize that if there is little or no hail damage, ROVC will be lower with $80 coverage.

Alternative Crop-Hail Policies

Crop hail insurance is available in many states in forms other than the standard policy used above. Many of these forms include some type of a deductible feature (Delvo and Greer, Fessler, CHIAA). While not shown here, a payoff matrix with alternative crop-hail policies as the actions could be used to help make the decision of which form of policy to purchase.

Table 6. Payoff matrix comparing Federal Crop Insurance with FCI at $2.50 per bushel plus crop-hail insurance at two levels of coverage per acre, 500 acres of wheat.

Events			Actions		
				FCI @ $2.50 plus CHI	
Yields	Percent yield loss due to hail	Subjective probabilities of yields	FCI	$40	$80
			--------Payoffs (ROVC's)--------		
0	100	.01	$ 1,975	$17,975	$33,975
5	87.5	.02	3,600	17,100	30,600
10	75	.03	5,850	16,850	27,850
15	62.5	.04	8,100	16,600	25,100
20	50	.05	10,350	16,350	22,350
25	37.5	.06	16,350	19,850	23,350
30	25	.07	24,850	25,850	26,850
35	12.5	.08	33,350	31,850	30,350
40	0	.60	41,850	37,850	33,850
45	0	.04	50,350	46,350	42,350
		1.0			
EMV			$33,621	$32,621	$31,621

Crop Hail Insurance plus Disaster Payments

Table 7 is a payoff matrix for considering purchase of CHI at $40 and $80 per acre in a situation where disaster payments for low yields are available. The probability distribution of yields is the same as in Table 5. The only difference is that disaster payments at $1.50 per bushel will be paid to the grower on shortfalls below yields of 20 bushels per acre.

The decision: Suppose our grower still has a safety first objective of no more than 10% chance of a payoff less than $14,000. This objective can be attained with CHI at $40 per acre along with disaster payments.

Purchase of CHI at $80 per acre coverage would allow a minimum payoff of over $20,000 to be obtained. Of course, this would be done at a sacrifice of about $4,000 in ROVC if there is no hail damage and a sacrifice of $1,000 in EMV.

Table 7. Payoff matrix for no insurance and crop-hail insurance with eligibility for disaster payments. Established yield 33 bushels per acre. 500 acres of wheat.

Events			Actions		
	Percent yield loss due to hail	Subjective probabilities of yields	No insurance	Crop-Hail Insurance	
Yield				$40	$80
			----------Payoffs (ROVC's)--------		
0	100	.01	$- 7,500	$ 8,500	$24,500
5	87.5	.02	- 5,250	8,250	21,750
10	75	.03	- 500	10,500	21,500
15	62.5	.04	4,250	12,750	21,250
20	50	.05	9,000	15,000	21,000
25	37.5	.06	17,500	21,000	24,500
30	25	.07	26,000	27,000	28,000
35	12.5	.08	34,500	33,000	31,500
40	0	.60	43,000	39,000	35,000
45	0	.04	51,500	47,500	43,500
		1.0			
EMV			$33,915	$32,915	$31,915

Worksheets for Considering FCI for your Situation

To use our decision making format to make the FCI purchase decision, you need several pieces of information. The worksheets below are designed to help you gather and process this information.

Information needed

1. FCI information
   a) Yield guarantee for your area
   b) FCI premiums for the prices per bushel available in your area
2. Your variable production costs per acre at various yield levels.
3. Expected wheat price at harvest or usual sale time.
4. Your subjective probability distribution of yields.

Some of this information is much easier to collect than other pieces. The FCI information is available from your FCI agent or local FCI office. Variable production costs for items such as seed, fertilizer, chemicals, fuel, and equipment repairs may be somewhat more difficult to obtain but can be rather easily estimated. Expected wheat price at harvest or usual sale time is not so easy to estimate. It, like yield, has a probability distribution. As a first approximation, use your best guess of the wheat price; that is, a point estimate. Later you may want to repeat the payoff matrix with other wheat prices. The probability distribution of yields may be the most difficult information to gather or estimate.

Worksheet 1. FCI information

Bushel guarantee per acre	Available prices per bushel		
	$_____	$_____	$_____
	Premium rates per acre		
_____ bu.	$_____	$_____	$_____

Worksheet 2. Variable production costs

Seed	$_____
Fertilizer	_____
Pesticides	_____
Fuel	_____
Equipment repairs	_____
Custom hire	_____
Labor	_____
Total variable costs per acre	$_____

Change in production and harvest costs per bushel of yield: $_____

Worksheet 3. Expected Wheat Price

Most likely wheat price at harvest or usual time of sale: $_____per bu.

Highest price you are likely to receive: $_____per bu.

Lowest price you are likely to receive: $_____per bu.

Worksheet 4. Yield Distribution

Yield range (1)	Midpoint of range (2)	Your conviction that the yield will be within the range (3)	Subjective probabilities of yields (4)
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
	Total	_____	1.0

Suggestions for Completion of Worksheet 4:

1. Use not more than 10 yield ranges.
2. Think first of the highest, lowest and most likely yield youare likely to produce.
3. Choose yield ranges that will adequately describe the probability distribution.
4. These ranges should give midpoints that will be relatively easy to work with. For example, if you use 5 bushel ranges, ranges such as 12.5 to 17.5, with a midpoint of 15 may be easier to handle than a range of 15 to 20 with a midpoint of 17.5.
5. Enter on each line in the third column a number between 0 and 100 to indicate your conviction that the actual yield will fall within the given range. Assign 100 to the range you believe most likely to occur and 0 to those you believe will not occur. Then enter numbers closer to 100 in ranges for which you believe there is a greater chance of the yield falling and numbers closer to 0 in the ranges where you believe the yield has a smaller chance of falling.
6. Add the numbers in column three. Divide the total into each number in the column and enter the result in column 4 under subjective probabilities of yields. You now have the probability distribution of yields. It should add to 1.0.
7. Inspect the probability distribution. If it seems reasonable, use it. If not, you may want to make adjustments. You may also want to do some rounding of the probabilities. If so, make sure the distribution still adds to 1.0.

Worksheet 5. Yields, variable costs, gross income and ROVC's per acre with and without FCI

Yields	Variable costs[1]	Income			
		No insurance		FCI	
		Gross[2]	ROVC[3]	Gross[4]	ROVC[5]

[1] From worksheet 2.

[2] Yield times price

[3] Column 3 less column 2

[4] Insurance income plus wheat sale, worksheet 5a.

[5] Column 5 less column 2 and insurance premium, from worksheet 5a.

Worksheet 5a. Computation of ROVC's for FCI

	bu.	bu.	bu.	bu.	bu.
Yield guarantee					
+1.5 bu. if harvested					
Total guarantee					
Less: actual yield					
Loss of yield					
Price per bu.	$	$	$	$	$
Insurance payment					
Plus: wheat sale income (yield x price/bu.)					
Gross income/acre					
Less: insurance premium plus variable costs					
Return over variable costs (Transfer to worksheet 5)	$	$	$	$	$
If disaster payments are available add:					
60% established yield minus actual yield times $1.50 per bushel					
ROVC including disaster payment	$	$	$	$	$

NOTE: Remember that the disaster payment must also be added to ROVC without FCI.

Worksheet 6. Payoff matrix. Acres = _____

Events yields	Subjective probabilities of yields	Actions	
		No insurance	FCI
		-----Payoffs (ROVC's)[1/]-------	
_____	_____	$_____	$_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
Expected monetary value		$_____	$_____

[1/] Values from worksheet 5 for each yield times acres of wheat.

Worksheets for Your Situation for Considering CHI

These worksheets are designed to help you gather and process the information needed to make the decision of whether to purchase Crop-Hail Insurance.

Information Needed

1. CHI information on coverage available and premiums for alternative policy forms.
2. Your variable production costs per acre at various yield levels.
3. Expected price at the time of harvest or usual sale.
4. The yield expected if there is no hail damage.
5. Your subjective probability distribution of the percent damage due to hail.

Worksheet 1. CHI Information

Policy form	Premium per $100	Premium per acre for coverage $____/A	$____/A	$____/A

Worksheet 2. Variable Production Costs Per Acre

Seed	$_____
Fertilizer	_____
Pesticides	_____
Fuel	_____
Equipment repairs	_____
Custom hire	_____
Labor	_____
Total variable costs per acre	$_____

Change in production and harvest costs per bushel of yield: $_____

Worksheet 3. Expected Wheat Price and Expected Yield

Most likely wheat price at harvest or usual time of sale: $_____per bu.

Highest price you are likely to receive: $_____per bu.

Lowest price you are likely to receive: $_____per bu.

Most likely wheat yield if no hail damage _____bu.

Worksheet 4. Subjective Probability Distribution of Hail Damage

Percent damage	Subjective probability
Total	1.0

Worksheet 5. Percent Hail Damage, Yields, Variable Costs and ROVC's Per Acre with no Insurance and with Alternative Amounts or forms of Crop Hail Insurance.

Yields	Percent yield loss due to hail	Subjective probabilities of yields or losses	Coverage or form of CHI			
			None			
			ROVC per acre			

Worksheet 5a. Computation of ROVC's for CHI

Coverage per acre $_____ Policy form _____

% loss	_____	_____	_____	_____	_____
Insurance payment	$_____	$_____	$_____	$_____	$_____
Plus: wheat sale income	_____	_____	_____	_____	_____
Gross income/acre	_____	_____	_____	_____	_____
Less: insurance premium plus variable costs	_____	_____	_____	_____	_____
ROVC	$_____	$_____	$_____	$_____	$_____

(Transfer to worksheet 5)

Worksheet 6. Payoff matrix. Acres = _____

States of nature			Actions			
			Coverage or form of CHI			
Yields	Percent yield loss due to hail	Subjective probabilities of yields	None	_____	_____	_____
				_____	_____	_____
			----------Payoffs (ROVC's)----------			
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
EMV of ROVC			_____	_____	_____	_____

Worksheets for Considering CHI in Addition to FCI

These worksheets are designed to help you gather and process the information needed to make the CHI purchase decision when you already have FCI coverage.

You will need the same information as listed on the CHI worksheets plus some information from your FCI coverage. Worksheets 1 through 4 from the CHI set can be used as is and are not repeated here. Worksheets 5 and 6 can be used by replacing the "None" column with FCI. The only new worksheet required is 5a which is shown below.

Worksheet 5a. Computation of ROVC's for FCI plus CHI

	Bushels/Acre				
FCI yield guarantee	_____	_____	_____	_____	_____
+ 1.5 bu. if harvested	_____	_____	_____	_____	_____
Total FCI guarantee	_____	_____	_____	_____	_____
Less actual yield/A.	_____	_____	_____	_____	_____
Loss of yield (bu.)	_____	_____	_____	_____	_____
Price per bu.	$_____	$_____	$_____	$_____	$_____
FCI payment	_____	_____	_____	_____	_____
CHI payment	_____	_____	_____	_____	_____
Wheat sale income	_____	_____	_____	_____	_____
Gross income per acre	_____	_____	_____	_____	_____
Less: insurance premium plus variable costs	_____	_____	_____	_____	_____
ROVC/Acre	$_____	$_____	$_____	$_____	$_____

References

Federal All-Risk Crop Insurance

1. Myrick, Dana H., All Risk Crop Insurance: Principles, Problems, Potentials, Montana Agr. Exp. Sta. Bul. 640, Sept. 1970.

2. Myrick, Dana, Laurel Loftsgard and Layton Thompson, eds., Crop Insurance in the Great Plains, Montana Agr. Exp. Sta. Bul. 617, July 1967. (Great Plains Ag. Econ. Pub. No. 28).

The following publications are available from the Federal Crop Insurance Corporation (FCIC), USDA and from local FCIC offices:

1. FCIC, All Risk Crop Insurance: Facts to Help you Decide; Questions and Answers plus a Worksheet for Your Farm.

2. FCIC, Federal Crop Insurance, A description, PA 408, January 1972.

3. FCIC, Risk: How to Measure It and How to Manage It.

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1. Delvo, Herman W. and James D. Greer, Hail Insurance: An Analysis of Policy Forms in Nebraska, 1969. Dept. of Ag. Econ. Rep. No. 51, University of Nebraska, 1969.

2. Fessler, Max E., Hail Insurance on Kansas Wheat, Bureau of Business Research, School of Business, Univ. of Kansas, 1958.

The following publications are available from the Crop Hail Insurance Actuarial Association (CHIAA), 209 West Jackson Blvd., Chicago:

1. CHIAA, Crop Hail Insurance Statistics: Direct Writings, Nebraska 1975, 1976.

2. CHIAA, Rates and Rules for Crop-Hail Insurance: Nebraska, 1974.

3. CHIAA, Summary of Rate Analysis Procedures for Crop-Hail Insurance, 1974 Filings, Nebraska, 1974.

(Similar publications are available for other states).