Crop Insurance and Disaster Assistance Designs for Wheat and Grain Sorghum

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Jeff Williams
Kansas State University

Jayson Harper
Penn State Fruit Research and Extension Center

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Jeffery R. Williams, Gordon L. Carriker, G. Art Barnaby, and Jayson K. Harper

This study compares the effectiveness of two crop insurance and two disaster assistance program designs used in conjunction with a government commodity program and a linked crop insurance/government commodity program design. Stochastic dominance analysis of farm-level net return distributions is used to select the preferred design(s). The results indicate that the disaster assistance programs are preferred over the alternatives. The results also suggest that individual crop insurance is preferred to area crop insurance. A subsidy is required for risk-averse managers to prefer area crop insurance to individual crop insurance.

Key words: commodity program, crop insurance, disaster assistance, grain sorghum, stochastic dominance, wheat.

This study compares the effectiveness of two crop insurance designs, two disaster assistance designs, a linked crop insurance/government commodity program design, and a government commodity program for reducing net returns risk. These designs are evaluated using primary farm-level data for wheat and grain sorghum enterprises in a uniform production region in south-central Kansas and for wheat enterprises in a less uniform production region in northwest Kansas. Stochastic dominance analysis of the net returns distributions is employed to identify the preferred design(s) over several risk-preference intervals.

The Federal Crop Insurance Act of 1980 (U.S. Congress) expanded the availability of multiple peril crop insurance to replace the U.S. Department of Agriculture's (USDA) low-yield disaster assistance program. Although the 1980 act expanded the scope of crop insurance and made it more available, Congress continued to provide intermittent disaster assistance to farmers via emergency loans and direct payments because the number of acres covered by crop insurance remained below the 50% goal established for the program in 1980 (GAO).

Adverse selection and moral hazard are significant problems with the current crop insurance programs. Adverse selection occurs when farmers with higher relative yield-risk can buy insurance at the same cost as farmers who have lower relative yield-risk (Skees and Reed). As a likely result of adverse selection and rigid premiums, indemnities paid to farmers in each year from 1980–88 exceeded premiums collected (GAO). The loss ratio from 1981–88 was 1.56 and exceeded Congress's mandate of 1.0.[1] Moral hazard occurs when a farmer has incentive to alter production or harvest practices to increase the chance of collecting crop insurance. This can happen when indemnity payments are based on farm-specific measured losses and the market price is less than the price election used to calculate the indemnity payment.

The use of crop insurance as a risk management tool has been widely studied, with several studies focusing on the effects of crop insurance on farm-level income variability and financial

The authors are professor, assistant professor, and professor, Department of Agricultural Economics, Kansas State University; and assistant professor, Department of Agricultural Economics and Rural Sociology, The Pennsylvania State University. This study was partially funded under a special grant from the Federal Crop Insurance Corporation in cooperation with the Federal Extension Service. Senior authorship is shared by the authors.

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[1] The loss ratio is defined as the sum of all indemnity payments divided by the sum of all premiums collected.

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performance. Studies have also been conducted on the use of crop insurance in combination with, or as a substitute for, other government programs. For an overview of these studies refer to Williams, Harper and Barnaby. These studies examine crop insurance and government program designs that are either in place or that existed in the late 1970s and early 1980s. None of these studies examine alternatives designed to reduce adverse selection and moral hazard or use actuarially fair premiums to calculate premiums and subsidy costs.[2]

Alternative area crop insurance and disaster assistance designs have not received much attention in the literature. Yet during debate on the 1990 Farm Bill, several alternative crop disaster assistance proposals were put forth. In general, they differed only in how a disaster would be defined and how payments would be calculated—either at the individual-farm level or the county level (Carriker et al. 1991).

As early as 1949, Halcrow proposed an alternative all-risk (multiple peril) crop insurance based on area yields rather than expected farm yields. He believed voluntary individual all-risk crop insurance would not work satisfactorily, because of adverse selection. Recently, three analyses have evaluated the effectiveness of such a plan. Miranda analyzes Halcrow's alternative using farm-level data from 102 western Kentucky soybean farms. By comparing the reduction in variances of insured and uninsured yield distributions, he concludes that an area-yield design is capable of providing effective yield-loss coverage. However, Miranda's analysis does not include net returns or government program effects. In a second study by Carriker et al. (1990), two crop insurance designs (an individual farm-yield insurance and an area-yield insurance) are compared for effectiveness at reducing the variability in yield and income (gross income less actuarially fair insurance premiums with and without deficiency payments). They conclude that, although individual farm-level insurance is complex and suffers from moral hazard and adverse selection problems, it provides more farm income risk reduction than an area design. In a related study, Carriker et al. (1991) examine the effectiveness of several crop insurance and disaster assistance designs for reducing income and yield risk using primary yield data and second-degree stochastic dominance analysis. Their results indicate that risk-averse wheat producers and corn producers prefer an actuarially fair individual farm-yield insurance plan with a 100% coverage level to an area insurance plan with 100% coverage or the free disaster assistance designs with 65% coverage levels. None of these studies determine the preferred designs at alternative risk-preference levels or examine the effectiveness of such designs under equivalent government expenditures or alternative subsidy levels.

[2] Actuarially fair crop insurance premiums assume that total premiums equal total indemnities for the actuarial period and do not include administrative costs. Using actuarially fair premiums allows comparisons of the risk reduction effectiveness of the designs without consideration of program administrative costs.

Program Alternatives

Brief descriptions of the six alternative designs considered in this study are presented here. The methods for calculating the per-acre net returns for each are presented in the appendix.

Government Commodity Program (GCP)

The current government commodity program does not provide for income replacement due to yield loss, but many farm managers consider the deficiency payment received when the market price falls below the target price to be important in reducing income risk. The use of the government commodity program may partially mitigate net return risk from local yield loss. If local crop losses represent a small portion of supply, market prices may not rise significantly and reduce the deficiency payment.

Individual Multiple Peril Crop Insurance (CI)

Under current Federal Crop Insurance Corporation (FCIC) procedures, each farm has an insurance yield (APH yield) based on historical farm-level production. The manager is reimbursed for any farm yield loss below the guaranteed yield (the insurance yield times the level of coverage). It does not provide protection from variable prices. The indemnity price election chosen by the manager in advance of a loss is used only to value the crop that is lost and does not reflect the dollars lost if market prices are above the indemnity price selected.

Area Multiple Peril Crop Insurance (ACI)

Under area multiple peril crop insurance, the adverse selection and moral hazard problems inherent in the current crop insurance program are reduced. Unlike the current FCIC program in which insurance premiums are based on a pool of insured farmers, area plan indemnities are based on an average area-yield loss (insured and uninsured farmers) with no individual loss calculation. The probability of collecting an indemnity payment is the same for all insured farmers in the area (no adverse selection). Moral hazard is prevented because individual farmers cannot influence the indemnity payment they receive by altering production and/or harvest practices. An additional advantage is that accurate farm-level yield data, which are difficult to obtain, are not needed to actuarially determine insurance premiums.

Halcrow proposes an area crop insurance in which the maximum liability level for each insured farm within the area is equal. The actual liability level, and therefore the indemnity payment, is a function only of the coverage level selected by the farm manager.

Under a method proposed by Barnaby and used in this study, the farmer is allowed to choose the level of dollar liability as well as the coverage level. Under this method, the farm manager has greater flexibility, compared to Halcrow's method, in tailoring the effective cost and coverage to meet the constraints of the individual farm.

Linked Deficiency Payment/Crop Insurance Program (LDC)

In a linked program, components of the current deficiency payment program and crop insurance program are combined. The per-acre deficiency payment is calculated using the actual yield with the program yield acting as a ceiling. The per-acre insurance indemnity payment is based on an insurance yield equal to the Agricultural Stabilization and Conservation Service (ASCS) program yield (or a percentage thereof) valued at the target price. Farmers who participate in the deficiency payment program are also required to purchase crop insurance. The commodity program component provides price risk protection only; the crop insurance program component provides yield risk protection. If the FCIC sets the insurance price election at or below the target price, the potential for moral hazard is greatly reduced, because there is an offsetting loss of deficiency payment for every bushel for which an indemnity is collected.[3] Additionally, because participation in the deficiency payment program is conditional on the purchase of crop insurance, a more diverse insurance pool of farmers is likely to exist, thereby reducing the potential for adverse selection; fewer farmers would opt out of the linked program compared to a stand-alone crop insurance program. Accurate farm-level yield data are, however, still required under this program.

Individual Disaster Assistance (DIS)

Producers are eligible for disaster assistance in the design presented here, which is equivalent to the 1988 disaster assistance program, if their harvested yield is less than or equal to 65% of their ASCS program yield. Individual disaster assistance functions similarly to an individual crop insurance yield guarantee of 65%, except that it is provided at no cost to the farmer, and the yield guarantee is based on the ASCS program yield and not the APH (actual production history) yield. Farms receiving disaster assistance for yield losses in excess of 65% of program yield (i.e., harvested yield is less than 35% of program yield) are required to purchase crop insurance for the following crop year. Additionally, the sum of disaster assistance plus any indemnity payment from crop insurance cannot exceed 100% of expected gross income per acre which is equal to the target price multiplied by the program yield.

Area Disaster Assistance (ADIS)

Disaster assistance using an area-yield measure functions similarly to area crop insurance, except that there is no premium charge. In an area disaster assistance program, disaster payments are based on the difference between the actual area yield and the expected area yield. Disaster assistance is received by all producers in any

[3] The linked deficiency payment/crop insurance design (LDC), as described in detail in the Appendix, may cause moral hazard to occur on flex acres. Under the 1985 farm program, deficiency payment acres and planted acres were equivalent. Under the 1991 commodity programs, 15% of the cropland base (flex acres) in addition to set-aside acres do not receive deficiency payments, although the program crop can be grown on the flex acres and insured. Under the LDC program, farmers would be reimbursed for losses valued at target price. If the target price is above market price, farmers have an incentive to reduce crop yields on flex acres to collect an indemnity. There is no off-setting loss of deficiency payments from the lower yield on flex acres as their is on eligible acres.

year in which the actual area yield falls below a prespecified disaster designation level (for instance, 65% or 75% of an area's historical mean yield).

Data and Procedures

It is unlikely that public policy will continue to support concurrent crop insurance and disaster assistance programs. A major argument for the replacement of Federal Crop Insurance with a standing disaster assistance program is the provision in recent years of ad hoc crop disaster program legislation when multiple peril crop insurance was available (USDA, pp. 63–65). Therefore, the alternatives considered here are limited to either a crop insurance or a disaster assistance program used with the government commodity program. Net returns (see the appendix for calculation formulas) under the alternative program designs are analyzed using stochastic dominance criteria to determine which would be preferred by agricultural producers with different risk attitudes. The six strategies examined are (*a*) Participation in the government commodity program only (GCP); (*b*) participation in the government commodity program and purchase of individual crop insurance (GCP+CI); (*c*) participation in the government commodity program and purchase of area crop insurance (GCP+ACI); (*d*) participation in a linked government deficiency payment/crop insurance program (LDC); (*e*) participation in the government commodity program and receipt of assistance under an individual disaster assistance program like the 1988 disaster relief bill (GCP+DIS); and (*f*) participation in the government commodity program and receipt of disaster assistance under an area disaster assistance program (GCP+ADIS).

Ten-year distributions of per-acre net returns, calculated as gross income minus all costs including labor, interest, and land costs, under strategies (*a*) through (*f*) are examined for southcentral Kansas wheat and sorghum, as separate enterprises and as a joint enterprise, and for northwest Kansas wheat. The 1991 loan rates, target prices, and acreage reduction provisions specified by the Food, Agriculture, Conservation, and Trade Act of 1990 are used to determine returns under the government commodity program. Wheat and sorghum price data for the 1978–87 period are converted to 1990 dollars using the USDA index of prices received by farmers (Kansas State Board of Agriculture).

Historical yield data for 45 southcentral Kansas farms with planted wheat and sorghum acreage and for 36 northwest Kansas farms with planted wheat acreage for the 1978–87 period are from the Kansas Farm Management Association data base. The commodity program yields are based on actual yields for 1980–84. Historical area yields used in the area insurance and area disaster assistance programs are the weighted average NASS county yields on planted acres for 1978–87. Production costs are from budgets developed for Kansas (Warmann and Schlender, 1990a, 1990b; Nelson and Langemeier). The typical ratio of wheat to grain sorghum acreage on southcentral Kansas farms is 3:1 (Langemeier and DeLano); therefore, the net returns from a joint wheat/grain sorghum enterprise is based on 75% of wheat net returns and 25% of grain sorghum net returns.

Target prices are used as the indemnity prices in the individual and area crop insurance programs, area disaster assistance program, and the linked deficiency payment/crop insurance program. Net returns for the area insurance and area disaster assistance designs are estimated with the liability level equivalent to the program yield valued at the indemnity price. The indemnity price and coverage level provisions of the 1988 disaster assistance program are reflected in the individual disaster assistance program description (equation A6). The coverage level (CL) in the individual crop insurance program is set at 65%. The CLs in the area crop insurance program, linked program, and area disaster assistance program are set so that the total government liability (deficiency payments plus insurance indemnities or disaster payments) to all farms under each program is equal to that for all farms under the individual crop insurance strategy. This results in CLs for the area insurance and disaster assistance programs of 73.45 and 73.85% for southcentral Kansas wheat and grain sorghum, respectively, and 75.85% for northwest Kansas wheat. Under the linked program, the resulting CLs are 79.20 and 74.00% for southcentral Kansas wheat and grain sorghum, respectively, and 75.78% for northwest Kansas wheat. When the wheat/grain sorghum enterprise is considered, the CLs are 73.66% for the area insurance and area disaster assistance programs, and 77.10% for the linked program. For all crop insurance programs, actuarially fair premiums are used.

Stochastic dominance with respect to a function (SDRF) criteria are used to choose efficient strategies from among a set of alternatives by comparing the distribution of net returns for each. It is a useful technique when risk management options alter net return distributions. A review of the conceptual impact of insurance on cumulative probability density functions can be found in Robison and Barry. An example can be found in Williams. The risk preference categories used here are whole-farm risk aversion coefficients adjusted to evaluate per-acre net returns for southcentral and northwest Kansas farms using a method suggested by Raskin and Cochran. The SDRF analysis is conducted using a program developed by Cochran and Raskin.

A series of SDRF analyses are performed. First, SDRF is applied to all six strategies for six risk preference categories. In a five-step process, the least dominated of the six strategies is identified in set #1. Dropping that strategy from consideration, leaving five strategies (set #2), the next least dominated strategy is identified. This process continues until only two strategies are left. The results provide a ranking of the strategies based on SDRF criteria. However, the results do not indicate the frequency that a specific strategy is preferred over another. The second SDRF analysis makes pair-wise comparisons of the six strategies for the moderately risk-averse category. The results of this stage of the analysis identify the frequency that a particular strategy is preferred over another strategy. The final SDRF analysis compares the individual crop insurance program to the area crop insurance program with various premium subsidies to determine the subsidy level needed for farmers to prefer area crop insurance over individual crop insurance.

Results

Descriptive statistics of the net return distributions for each of the six strategies are presented in table 1. The stochastic dominance analysis results are presented in tables 2, 3, and 4.

Net Returns, Variability, and Liabilities

The mean average net returns for each strategy are presented in table 1. For the GCP + CI and GCP + ACI programs, actuarially fair premiums result in the same mean average net returns as the GCP strategy. Under the disaster assistance programs (GCP + DIS and GCP + ADIS),

Table 1. Descriptive Statistics and Liability Outlays for Alternative Strategies

	Strategy[a]					
Statistic	GCP	GCP +CI	GCP +ACI	LDC	GCP +DIS	GCP +ADIS
	1990 Dollars acre					
	Southcentral wheat					
Mean Average Net Returns[b]	23.15	23.15	23.15	21.59	23.53	23.45
	(0.80)	(0.77)	(0.79)	(0.80)	(0.76)	(0.78)
Liabilities[c]	17.51	17.81	17.81	17.81	17.89	17.81
	Southcentral grain sorghum					
Mean Average Net Returns[b]	4.79	4.79	4.79	3.29	6.64	9.10
	(7.90)	(6.59)	(7.26)	(9.59)	(5.72)	(3.82)
Liabilities[c]	16.07	20.37	20.37	20.37	18.05	20.37
	Southcentral wheat and grain sorghum					
Mean Average Net Returns[b]	18.56	18.56	18.56	17.01	19.31	19.86
	(0.92)	(0.84)	(0.88)	(0.90)	(0.84)	(0.83)
Liabilities[c]	17.15	18.45	18.45	18.45	17.93	18.45
	Northwest wheat					
Mean Average Net Returns[b]	29.74	29.74	29.74	26.75	31.52	33.45
	(1.03)	(0.78)	(0.85)	(0.85)	(0.86)	(0.76)
Liabilities[c]	24.81	28.52	28.52	28.52	26.74	28.52

[a] For complete definitions of the strategies, refer to the procedures section of the text.
[b] Coefficient of variation, in parenthesis, calculated from the mean average and mean standard deviation.
[c] Equals the sum of deficiency payments and insurance indemnities or disaster assistance payments in dollars/acre/year.

Table 2. Stochastic Dominance with Respect to a Function, Results

Pratt-Arrow Risk Aversion Coefficient[a]	Strategy[b]	Southcentral wheat[c] (Set #) 1	2	3	4	5	Southcentral grain sorghum[c] (Set #) 1	2	3	4	5	Southcentral wheat and G. sorghum[c] (Set #) 1	2	3	4	5	Northwest wheat[d] (Set #) 1	2	3	4	5
−0.0105 to 0.0	GCP	45	35	0	—	—	45	45	1	—	—	45	45	4	—	—	36	36	1	—	—
	GCP + CI	45	36	9	4	—	45	45	29	15	0	45	45	20	6	0	36	36	24	4	—
	GCP + ACI	45	35	18	10	0	45	42	11	1	—	45	44	19	4	—	36	35	22	6	0
	LDC	45	45	45	45	45	45	45	45	43	43	45	45	45	45	45	36	36	36	36	36
	GCP + DIS	21	—	—	—	—	41	0	—	—	—	38	0	—	—	—	30	0	—	—	—
	GCP + ADIS	24	0	—	—	—	3	—	—	—	—	5	—	—	—	—	4	—	—	—	—
−0.0105 to +0.0105	GCP	45	35	0	0	0	45	45	0	0	0	45	45	0	0	0	36	36	0	—	—
	GCP + CI	45	32	0	—	—	44	30	0	—	—	45	45	0	—	—	36	29	0	0	—
	GCP + ACI	45	35	0	0	—	45	31	0	0	—	45	42	0	0	—	36	26	0	0	0
	LDC	45	45	45	43	43	45	45	43	28	18	45	45	45	44	43	36	36	36	36	34
	GCP + DIS	21	—	—	—	—	39	0	—	—	—	38	0	—	—	—	27	0	—	—	—
	GCP + ADIS	24	0	—	—	—	4	—	—	—	—	5	—	—	—	—	4	—	—	—	—
0.0 to +0.105	GCP	45	35	3	1	0	45	45	28	13	0	45	45	11	3	0	36	35	1	—	—
	GCP + CI	36	24	0	—	—	17	7	5	—	—	33	23	0	—	—	20	15	4	4	—
	GCP + ACI	45	35	6	0	—	45	22	7	0	—	45	32	8	0	—	36	12	10	10	0
	LDC	27	27	26	25	23	35	33	33	12	6	35	34	32	24	20	27	27	27	27	17
	GCP + DIS	16	—	—	—	—	28	0	—	—	—	29	0	—	—	—	24	0	—	—	—
	GCP + ADIS	23	0	—	—	—	4	—	—	—	—	6	—	—	—	—	5	—	—	—	—

0.0	GCP	45	35	1	0	0	45	45	23	9	0	45	45	7	2	0	36	36	1	—	—
to	GCP + CI	45	32	0	—	—	44	30	1	—	—	45	45	0	—	—	36	31	2	2	—
+0.0105	GCP + ACI	45	35	3	0	—	45	35	4	0	—	45	43	5	0	—	36	27	5	5	0
	LDC	45	45	45	43	43	45	45	43	28	18	45	45	45	44	43	36	36	36	36	34
	GCP + DIS	21	—	—	—	—	39	0	—	—	—	38	0	—	—	—	27	0	—	—	—
	GCP + ADIS	24	0	—	—	—	4	—	—	—	—	7	—	—	—	—	5	—	—	—	—
+0.0105	GCP	45	36	28	13	2	45	45	45	42	38	45	45	39	31	2	36	36	32	29	14
to	GCP + CI	38	26	16	0	—	23	11	—	—	—	40	32	8	—	—	21	19	13	—	—
+0.052	GCP + ACI	45	36	15	—	—	45	35	24	18	2	45	38	23	5	—	36	22	17	5	—
	LDC	38	36	34	34	30	39	37	16	13	—	42	41	40	33	28	31	31	29	18	7
	GCP + DIS	18	—	—	—	—	34	18	10	—	—	32	2	—	—	—	25	12	—	—	—
	GCP + ADIS	23	4	—	—	—	7	—	—	—	—	6	—	—	—	—	9	—	—	—	—
+0.052	GCP	45	37	30	17	15	45	45	45	45	39	45	45	39	33	17	36	36	36	36	36
to	GCP + CI	40	31	24	11	—	21	—	—	—	—	36	30	19	—	—	24	23[e]	—	—	—
+0.105	GCP + ACI	45	37	21	—	—	45	45	45	25	3	45	39	30	21	—	36	23	22	16	—
	LDC	27	27	26	24	23	35	17	—	—	—	35	34	32	24	20	27	27	17	—	—
	GCP + DIS	27	—	—	—	—	44	43	28	16	—	36	19	—	—	—	35	29	28	18	0
	GCP + ADIS	27	13	—	—	—	26	24	15	—	—	14	—	—	—	—	17	—	—	—	—

[a] The risk aversion coefficients correspond to approximate risk attitudes of Slightly Risk Preferring, Risk Neutral, Generally Risk Neutral and Risk Averse, Slightly Risk Averse, Moderately Risk Averse, and Strongly Risk Averse, respectively.
[b] For complete definitions of the strategies, refer to the procedures section of the text.
[c] 45 farms in analysis.
[d] 36 farms in analysis.
[e] A slightly greater risk-aversion interval was used to select which strategy to eliminate from the next set.

Table 3. Stochastic Dominance Comparison of Individual Strategies for Moderately Risk-Averse Managers

Strategy[a]	GCP	GCP +CI	GCP +ACI	LDC	GCP +DIS	GCP +ADIS
	# of times a strategy is dominated					
	Southcentral wheat[b]					
GCP	—	13	25	2	45	35
GCP + CI	0	—	16	0	38	26
GCP + ACI	3	15	—	2	34	35
LDC	40	34	30	—	37	34
GCP + DIS	0	0	4	0	—	18
GCP + ADIS	0	4	0	1	23	—
	Southcentral grain sorghum[b]					
GCP	—	45	38	27	45	45
GCP + CI	0	—	7	2	3	19
GCP + ACI	2	35	—	18	23	45
LDC	7	37	13	—	13	21
GCP + DIS	0	15	10	0	—	31
GCP + ADIS	0	2	0	0	6	—
	Southcentral wheat and grain sorghum[b]					
GCP	—	38	31	2	45	45
GCP + CI	0	—	8	0	29	26
GCP + ACI	4	23	—	1	36	41
LDC	28	40	32	—	39	35
GCP + DIS	0	0	2	0	—	17
GCP + ADIS	0	3	0	0	19	—
	Northwest wheat[c]					
GCP	—	28	27	14	36	36
GCP + CI	0	—	13	0	11	20
GCP + ACI	4	17	—	2	17	36
LDC	7	28	18	—	12	21
GCP + DIS	0	7	9	0	—	25
GCP + ADIS	0	5	0	1	9	—

[a] For complete definitions of the strategies, refer to the procedures section of the text. The numbers indicate the number of farms, out of possible 45 or 36, for which the strategy indicated by the column label dominates the strategy indicated by the row label.
[b] 45 farms in analysis.
[c] 36 farms in analysis.

free coverage results in higher mean net returns. Due to the limitations of the LDC program, mean net returns are lower for this strategy. For three of the four enterprises, the relative variability of net returns, as measured by the coefficient of variation (CV), are lowest for the GCP + ADIS strategy; however, for southcentral wheat, the relative variability in net returns is lowest for the GCP + CI strategy. The relative variabilities of the net return distributions for most of the farms are generally lower than those under the GCP strategy alone.

Average per-acre liabilities resulting from the alternative strategies are also indicated in table 1. The difference between the liability under the GCP strategy and the GCP + CI strategy measures the average cost to producers of the additional risk reduction provided by this strategy.[4] Because the liability levels are restricted to be equal between the GCP + CI strategy and the other crop insurance alternatives, a direct evaluation of the risk reduction available for the same cost can be made. Under the disaster assistance programs (GCP + DIS and GCP + ADIS), the annual per-acre liabilities are paid by the government.

Stochastic Dominance Analysis

Results of the first stochastic dominance analysis are reported in table 2. The numbers in the

[4] For example, the GCP + CI strategy for southcentral wheat costs an average of $0.30 per acre per year ($17.81–$17.51). The average annual per-acre cost is the average over all farms. The actual cost would vary from farm to farm because of different ASCS program yields for each farm.

Table 4. Stochastic Dominance Analysis of Individual Crop Insurance and Area Crop Insurance under Alternative Subsidization Rates

		Southcentral[b] wheat				Southcentral[b] grain sorghum				Southcentral[b] wheat and grain sorghum				Northwest[c] wheat			
	Strategy[a]	0%	10%	20%	30%	0%	10%	20%	30%	0%	10%	20%	30%	0%	10%	20%	30%
Mean average	GCP + CI	23.15	23.15	23.15	23.15	4.79	4.79	4.79	4.79	18.56	18.56	18.56	18.56	29.74	29.74	29.74	29.74
net returns[d]	GCP + ACI	23.15	23.18	23.21	23.24	4.79	5.22	5.65	6.08	18.56	18.69	18.82	18.95	29.74	30.11	30.48	30.85
		(0.00)	(0.03)	(0.06)	(0.09)	(0.00)	(0.43)	(0.86)	(1.29)	(0.00)	(0.13)	(0.26)	(0.39)	(0.00)	(0.37)	(0.74)	(1.11)
	Number of times a strategy is dominated by the other[e]																
Generally risk neutral/	GCP + CI	0	14	16	16	5	7	7	8	0	9	12	17	4	12	12	14
Risk averse	GCP + ACI	6	0	0	0	7	0	0	0	8	0	0	0	10	0	0	0
Slightly risk averse																	
	GCP + CI	0	22	26	26	1	15	20	26	0	30	38	42	2	20	22	24
	GCP + ACI	3	0	0	0	4	0	0	0	5	0	0	0	5	0	0	0
Moderately risk averse																	
	GCP + CI	16	17	19	21	7	9	9	10	8	13	20	23	13	15	15	17
	GCP + ACI	15	12	10	10	35	29	25	19	23	15	6	3	17	15	14	12
Strongly risk averse																	
	GCP + CI	16	16	16	17	7	8	8	9	11	13	16	17	12	13	13	15
	GCP + ACI	17	16	15	15	37	36	35	34	29	27	22	20	21	21	20	19

[a] For complete definitions of the strategies, refer to the procedures section of the text.
[b] 45 farms in analysis.
[c] 36 farms in analysis.
[d] In dollars/acre/year. Dollar level of subsidy in parentheses.
[e] Refer to table 2 for specification of the Pratt-Arrow risk aversion coefficients.

table indicate the number of times a strategy is dominated by another strategy in each risk preference interval. For example, in the slightly risk-averse interval, the GCP + ADIS strategy for southcentral wheat is dominated on 24 of the 45 farms by other strategies when all strategies (set #1) are included (table 2). The least dominated strategy is then removed from the set of strategies analyzed (in this example, GCP + DIS), and the stochastic dominance analysis is repeated (set #2 – #5).

Individual disaster assistance (GCP + DIS) for southcentral wheat is dominated the least number of times in all risk-preference intervals. The second least dominated strategy for southcentral wheat is area disaster assistance (GCP + ADIS). Area disaster assistance (GCP + ADIS) is dominated the least number of times in all risk-preference intervals for the joint wheat/grain sorghum enterprise and northwest wheat. It is also dominated the fewest times for grain sorghum, with the exception of the strongly risk-averse interval in which individual crop insurance is dominated the least number of times. The second least dominated strategy for northwest wheat and the joint enterprise is individual disaster assistance (GCP + DIS), with an exception for northwest wheat; in the most risk-averse interval, GCP + CI is the second least dominated strategy. For grain sorghum, the individual crop insurance program (GCP + CI) is the second least dominated strategy in the moderately risk-averse interval, and the linked program (GCP + LDC) is the second least dominated strategy in the strongly risk-averse interval.

Individual crop insurance is the least dominated strategy, when the disaster assistance plans are no longer in the set of strategies being considered. In addition, individual crop insurance is more preferred than individual disaster assistance for moderately and strongly risk-averse grain sorghum producers in southcentral Kansas. The two most dominated strategies are generally LDC and GCP.

Individual strategies are then compared to each other, rather than within a group of all strategies, using the moderately risk-averse interval (table 3). An important comparison is made between individual crop insurance (GCP + CI) and area crop insurance (GCP + ACI). For southcentral wheat, GCP + ACI is preferred to GCP + CI on 16 of 45 farms (36%), whereas GCP + CI is preferred to GCP + ACI on 15 of the 45 farms (33%) and 14 have no preference. For northwest Kansas wheat, GCP + ACI is preferred on 13 of the 36 farms (36%); GCP + CI is preferred on 17 of the 36 farms (47%). The GCP + ACI strategy is preferred to the GCP + CI strategy on 7 of the 45 grain sorghum farms (16%); GCP + CI is preferred to GCP + ACI on 35 farms (78%). For farms that produce both wheat and grain sorghum in southcentral Kansas, GCP + ACI is preferred on 8 farms (18%) and GCP + CI is preferred on 23 farms (51%).

The final SDRF analysis determines the preferred crop insurance strategy, either individual crop insurance or area crop insurance with alternative government subsidy levels. The rationale for this analysis is twofold. First, the current crop insurance program suffers from moral hazard and adverse selection problems and, as reported previously, has a loss ratio substantially greater than 1.0. Second, an area program may have fewer total costs for administration, implementation, and enforcement than an individual insurance program because it would prevent moral hazard, reduce adverse selection problems, and would not require individual loss adjustments. Therefore, assuming that the government continues its role in the crop insurance market, part of the potential operational savings from adopting an area crop insurance plan could be used to offset the cost of insurance to producers in the form of a subsidy.

For this part of the analysis, stochastic dominance analysis is used to compare the full-cost individual crop insurance strategy (GCP + CI) to subsidized area crop insurance (GCP + ACI) at three subsidy levels (table 4). Recall, from table 1, that the difference between the liabilities under any of the crop insurance alternatives and the GCP strategy is a measure of the cost to the producer of that insurance program. For example, the average cost of the area crop insurance for the southcentral grain sorghum enterprise is \$4.30/acre/year (\$20.37 – \$16.07). The subsidies used in this part of the analysis are calculated as a percentage of the cost of the area crop insurance. Using the previous example, a 10% subsidy for area crop insurance for the southcentral grain sorghum enterprise increases the mean average net returns by \$0.43, from \$4.79 to \$5.22.

Full-cost area crop insurance (GCP + ACI) is dominated more times than individual crop insurance (GCP + CI) in the generally and slightly risk-averse intervals (0.0 to +0.105; 0.0 to +0.0105). However, as the subsidy increases, GCP + ACI becomes less dominated. With a 10% subsidy or greater, GCP + ACI is more often preferred in the slightly risk-averse and the generally risk-averse intervals for all crops. In the moderately risk-averse interval (+0.0105 to +0.052), GCP + CI is dominated fewer times than GCP + ACI without subsidization, with a narrow exception for southcentral wheat. With a 20% subsidy or greater, GCP + ACI is dominated fewer times than GCP + CI, with the exception of grain sorghum for which, even with a 30% subsidy, GCP + ACI is dominated more times than GCP + CI. In the most risk-averse category, the only situation in which GCP + ACI is preferred to GCP + CI is for southcentral Kansas wheat with a 20% or greater subsidy and the margin of preference is small.

Summary and Conclusions

Five crop insurance and disaster assistance alternatives are evaluated for their effectiveness in reducing net return risk for 45 southcentral Kansas wheat and grain sorghum farms and for 36 northwest Kansas wheat farms. The results suggest that, over the entire range of risk attitudes examined, wheat and grain sorghum producers would prefer either a crop insurance or disaster assistance program in addition to the government commodity program. Either disaster assistance design examined in this study is preferred to crop insurance (primarily because it comes at no cost to producers).

Although individual crop insurance is preferred over area crop insurance, the effectiveness of individual and area crop insurance designs varies depending on the risk associated with the growing conditions and cropping practices in a production region. Individual crop insurance is preferred to area crop insurance by risk-averse managers producing crops with relatively more risky yields such as southcentral Kansas grain sorghum or northwest Kansas wheat. Farmers growing lower risk crops located in more uniform production regions, such as wheat in southcentral Kansas, are more likely to prefer area crop insurance.

If adverse selection and moral hazard continue to be a problem for the current individual crop insurance program and budget constraints continue to force difficult choices to be made between agricultural disaster assistance and crop insurance policies, then a subsidized area insurance plan may be an alternative. A subsidized area insurance program might be less costly to administer than the present crop insurance program or disaster programs because it would not require individual farm loss adjustment and would reduce adverse selection and moral hazard. With a 10-percent subsidy of area crop insurance premiums, risk neutral and risk preferring farm managers prefer area crop insurance over individual crop insurance. Higher subsidy levels are required for more risk averse farm managers to prefer area crop insurance over full-cost individual crop insurance.

The effectiveness of the disaster assistance programs examined in this study also vary. The area disaster assistance design is an acceptable alternative to the individual disaster assistance program comparable to that provided in 1988. The results indicate that the area disaster assistance program is preferred to the individual disaster program in areas with relatively more risky crop yields. Even though the coverage levels, and therefore average liability, is higher for the area disaster program than the individual disaster assistance program, the area disaster program would be less expensive to implement and administer.

Further analysis of these and other crop insurance and disaster assistance program designs is needed. Total cost effectiveness for different crops and crop production regions, in addition to the farm-level analysis presented here, would provide useful information for future policy decisions.

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Appendix

Calculating Returns for Program Alternatives

The methods for calculating the per-acre net returns for the six alternative strategies are presented below.

Government Commodity Program (GCP)

(A1)
$$NR = [((\max\{P, EL\} * Y_f) - PRODC - HARVC) * (1 - SA)] + [(\max\{0, (TP - \max\{EP, EL\})\} * Y_p) * (1 - SA - FA)] - (SC * SA).$$

GCP and Individual Multiple Peril Crop Insurance (GCP + CI)

(A2)
$$NR = [((\max\{P, EL\} * Y_f) + \text{INDEM} - \text{CIP} - PRODC - HARVC) * (1 - SA)] + [(\max\{0, (TP - \max\{EP, EL\})\} * Y_p) * (1 - SA - FA)] - (SC * SA),$$

where $INDEM = \max\{0, IP * [(CL * IY_f) - Y_f]\}$.

GCP and Area Multiple Peril Crop Insurance (GCP + ACI)

(A3)
$$NR = [((\max\{P, EL\} * Y_f) + INDEM - CIP - \text{PRODC} - \text{HARVC}) * (1 - SA)] + [(\max\{0, (TP - \max\{EP, EL\})\} * Y_p) * (1 - SA - FA)] - (SC * SA),$$

where $INDEM = \max\{0, LIAB * [((CL * IY_a) - Y_a)/IY_a)]\}$ (Barnaby Method)

or

$$INDEM = \max\{0, IP * [(CL * IY_a) - Y_a]\}$$

(Halcrow Method).

The Barnaby method and Halcrow method are identical when $LIAB = IP * IY_a$.

Linked Deficiency Payment/Crop Insurance Program (LDC)

(A4)
$$NR = [((\max\{P, EL\} * Y_f) + INDEM - CIP - PRODC - HARVC) * (1 - SA)] + [\min\{Y_f, Y_p\} * \max\{0, (TP - \max\{EP, EL\})\}] * (1 - SA - FA)] - (SC * SA),$$

where $INDEM = \max\{0, IP * [(CL * Y_p) - Y_f]\}$.

GCP and Individual Disaster Assistance (GCP + DIS)

(A5)
$$NR = [((\max\{P, EL\} * Y_f) - PRODC - HARVC) * (1 - SA)] + [PAY * (1 - SA - FA)] - (SC * SA),$$

where a) If $Y_f \geq Y_p$, then $PAY = DP * Y_p$;
b) If $Y_p > Y_f \geq 0.65Y_p$ and $DP \geq ADP$, then $PAY = DP * Y_p$;

c) If $Y_p > Y_f \geq .65Y_p$ and $DP < ADP$, then
$PAY = [(Y_p - Y_f) * (ADP - DP)] + (DP * Y_p)$;

d) If $0.65Y_p > Y_f \geq 0.35Y_p$, then
$PAY = (DP * Y_f) + [0.65TP * (0.65Y_p - Y_f)] + (\max\{DP, ADP\} * 0.35Y_p)$;

e) If $.35Y_p > Y_f \geq .25Y_p$, then
$PAY = (DP * Y_f) + [0.65\mathrm{TP} * (0.65Y_p - Y_f)] + (\max\{DP, ADP\} * 0.35Y_p) - (CIP * (1 + r)^{-1})$;

f) If $0.25\ Y_p > Y_f$, then
$PAY = (DP * Y_f) + (0.65TP * 0.40Y_p) + [0.90TP * (0.25Y_p - Y_f)] + (\max\{DP, ADP\} * 0.35Y_p) - (CIP * (1 + r)^{-1})$.

GCP and Area Disaster Assistance (GCP + ADIS)

(A6)

$$NR = [((\max\{P, EL\} * Y_f) - PRODC - HARVC + PAYA) * (1 - SA)] + [(\max\{0, (TP - \max\{EP, EL\})\} * Y_p) * (1 - SA - FA)] - (SC * SA),$$

where $PAYA = \max\{0, LIAB * [((CL * IY_a) - Y_a)/IY_a)]\}$.

Variable Definitions

The variables used in equations A1 through A6 are defined as

NR	=	net returns ($/acre);
P	=	market price ($/bu.);
EL	=	effective national average loan rate ($/bu.);
Y_f	=	actual farm yield produced on planted acres (bu./acre);
$PRODC$	=	production costs ($/acre);
$HARVC$	=	harvest cost ($/acre);
SA	=	set-aside acreage requirement (%);
TP	=	target price ($/bu.);
EP	=	expected national average price ($/bu.);
Y_p	=	program yield (bu./acre);
FA	=	flex acreage requirement (%);
SC	=	maintenance costs on set-aside acres ($/acre);
$INDEM$	=	the indemnity payment ($/acre);
CIP	=	crop insurance premium ($/acre);
IP	=	indemnity price, the value at which bushels are insured ($/bu.);
CL	=	−1% deductible, the coverage level (%);
IY_f	=	historical average farm yield (bu./acre);
$LIAB$	=	total potential liability, the insurance yield (Y_p in the area insurance and area disaster assistance plans) valued at IP ($/acre);
IY_a	=	historical average area-yield (bu./acre);
Y_a	=	actual area-yield produced on planted acres (bu./acre);
PAY	=	total disaster assistance and deficiency payments ($/acre);
DP	=	$\max\{0, (TP - \max\{EP, EL\})\}$, the deficiency payment ($/bu.);
ADP	=	advanced deficiency payment ($/bu.);
r	=	annual discount rate; and,
$PAYA$	=	area disaster assistance payments ($/acre).