STAFF PAPER

REDUCTION OF YIELD AND INCOME RISK UNDER ALTERNATIVE CROP INSURANCE AND DISASTER ASSISTANCE PLANS

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Abstract

This study compares the effectiveness of five crop insurance/disaster assistance plans: an individual farm yield insurance plan similar to the current FCIC multi-peril program; two area yield insurance plans; a farm yield disaster assistance plan; and an area yield disaster assistance plan. These methods are examined for reduction in yield and gross income variability with and without participation in the government deficiency payment programs using farm-level yield data from 98 dryland wheat farms and 38 dryland corn farms in Kansas. Although individual farm yield insurance is complex, suffers from moral hazard and adverse selection problems, and is likely to be the most expensive to administer, it provides more yield and gross income risk reduction than any of the alternative insurance/disaster assistance plans.

Key Words: Crop Insurance, Crop Disaster Assistance, Risk, Wheat, Corn

REDUCTION OF YIELD AND INCOME RISK UNDER ALTERNATIVE CROP INSURANCE AND DISASTER ASSISTANCE PLANS

Therefore the general condition in respect to the all-risk type of crop insurance is that it will work in a satisfactory manner only under a system of conditions so exacting in their specification that they will be found to rather limited extent in American Agriculture.

Harold G. Halcrow
JFE, August, 1949

Halcrow proposes an alternative to all-risk crop insurance which is based on an expected area yield and deviations from that yield rather than the expected farm yield and deviations therefrom. In his plan, the premiums and indemnities are based on yields received in an area of uniform crop production. Indemnities are paid in bushels to any insured producer in those years in which the area average yield falls below the guaranteed area yield level (the historical mean of the area average yield or a percentage thereof). All participating farmers receive the same per-acre indemnity and pay the same premium rate based on the historical area yield data. For example, if the historical area average yield for wheat is 32 bu/acre and the area average yield in the current year is 24 bu/acre, then each insured producer receives an indemnity payment of 8 bushels for each insured, planted acre of wheat (assuming a 0% deductible) regardless of their own produced yield.

To date, little analysis has been performed to determine the effectiveness of an area-yield measurement plan. Miranda recently completed a preliminary analysis of Halcrow's alternative using farm level data for 102 Western Kentucky soybean farms. By comparing the reduction in the variance of insured and uninsured yield distributions, without crop prices or deficiency payments, he concludes that an area yield measurement is capable of providing effective yield-loss coverage.

The objective of this study is to compare the effectiveness of the individual yield insurance plan in the current Federal Crop Insurance Corporation (FCIC) program with the area-yield methods proposed by Halcrow, Barnaby (1989,

1990), Barnaby and Skees (1990), and Miranda, as well as with two disaster assistance plans. These plans are examined for reduction in yield and gross income variability using farm-level yield data from 98 dryland wheat farms in southcentral Kansas and 38 dryland corn farms in northeast Kansas. Yield and gross income distributions are estimated for each farm with and without government deficiency payments.

BACKGROUND AND JUSTIFICATION

The Federal Crop Insurance Act of 1980, P.L. 96-365, expanded the availability of multiple peril (all risk) crop insurance with the goal of replacing the USDA's low-yield disaster assistance program. The direct payment disaster assistance programs have been criticized for being expensive (averaging $436 million per year between 1974 and 1980) and encouraging production in areas susceptible to natural disasters (GAO). Although the 1980 act expanded the scope of crop insurance and made it more widely available, Congress has continued to provide disaster assistance payments to farmers with the use of emergency loans and direct payments, most recently in the drought years of 1988 and 1989. One of the reasons that disaster assistance has been provided is that sales of crop insurance have remained relatively low. Although enrollment is increasing, the amount of eligible acres enrolled in 1988 was 24.5%, well below the 50% participation goal established for the program in 1980 (GAO). Even with the increase in current participation rates to about 46%, largely attributable to recent crop disasters and requirements of crop insurance participation for some producers in 1989 under the Disaster Assistance Act of 1988, the most ardent supporters of crop insurance will not dispute that the multi-peril program has not worked as well as expected.

Adverse selection and moral hazard are significant problems with the current crop insurance program, in addition to competition from other government programs that provide substitute income variability reduction such as

disaster assistance, FmHA emergency loans, and the deficiency payment program. 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 when yield guarantees are based on the expected individual farm yield (Skees and Reed). If farmers recognize this, over time the insurance program will attract a larger group with relatively high yield risks, thereby causing insurance rates to increase and compounding the adverse selection problem.[1] Under the pretense of increasing participation, this could create a situation in which indemnity payments increase relative to premiums if rates are not increased. In fact, indemnities paid to farmers in the 1980-1988 period exceeded the premiums collected (GAO). Moral hazard occurs when the 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 for yield losses.

Under the area-yield or "area-hedge" approaches suggested by Halcrow and Barnaby, the adverse selection and moral hazard inherent in the current crop insurance program are greatly reduced.[2] In the current FCIC program, insurance premiums are based on the insured pool of farmers. The pool has tended, over time, to have more farmers who have higher yield variability and fewer farmers with lower yield variability causing insurance rates to increase, exacerbating further the adverse selection problem. By contrast, the area plan pays each producer a uniform average area yield loss with no individual loss adjustment; the area yield loss measurement includes both insured and uninsured farmers,

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[1] Skees and Reed conclude that the current program leads to adverse selection because farmers with relatively high expected yields can expect small and infrequent indemnity payments when insurance guarantees are based on expected farm yield.

[2] The term "area-hedge" more appropriately describes this type of insurance to the industry because of its past experience with the FCIC area plan.

thus reducing adverse selection. The probability of collecting an indemnity is the same for all insured farmers in the area, although the "effective" cost and coverage vary. Moral hazard is prevented because an individual farmer cannot influence the indemnity by altering production and/or harvest practices. In addition, accurate farm level yield data, which historically have been difficult to obtain, are not needed to actuarially determine insurance premiums.

During discussion of the 1990 Farm Bill, several substitute/supplementary crop disaster assistance proposals have been put forth. In general, they differ only in the ways in which a disaster would be defined and the disaster payments would be calculated -- either at the individual farm level or the county level (area level). A farm-level disaster assistance program has been proposed by U.S. House Representative English (Democrat, Oklahoma).[3] An area-level disaster assistance program has been proposed by the Bush Administration (USDA).[4] Both of these plans are significantly different from current public policy: they establish a standing crop disaster assistance program that would likely reduce political pressure for ad hoc disaster assistance legislation such as that experienced during 1988 and 1989. However, they both would likely suffer from high administrative costs, because disaster payments are based on farm-level yields. The Administration Plan faces an obstacle because those farms that have yields higher than the county average would not benefit to the same relative degree as those farms that have average yields lower than the

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[3] In the English proposal, the FCIC insurance program is continued. A disaster is defined on a farm-level basis with assistance payments based on a percentage of either the ASCS program yield or the proven farm yield for program crops or the expected area yield for non-program crops.

[4] In the Administration proposal, the FCIC insurance program is discontinued. Disaster payments are available to crop producers in counties where the county average yield is less that 65% of the expected county average yield based on NASS data. Disaster payments are based on the difference between 60% of the expected county average yield and the actual farm yield (limited to $100,000).

county average.[5] Such provisions of the proposal would encourage production on less productive lands. Both proposals would suffer from adverse selection, though to different degrees. The English Plan allows for proven yields; therefore, those farmers who could prove higher yields would do so, whereas those with lower yields would accept the county average yield. The Administration Plan would allow regional adverse selection because farmers would grow crops in marginal areas that would not be planted if the disaster program were not available. Additionally, moral hazard would occur under both proposals, also to different degrees. Under the English Plan, moral hazard would arise if the price elections are above the market price and/or the growing season is poor; farmers could reduce production inputs and harvest efficiency with expectations of having a low yield and receiving a disaster payment. Under the Administration Plan, moral hazard would occur only when it is clear that the county is going to suffer a loss and farmers do not report some of their production; reporting of "true" yields would also be difficult to enforce through the legal process.

Little analysis has been undertaken to determine the effectiveness of any of the area crop insurance or the disaster assistance programs as they compare to the current FCIC program. Therefore, insight can be gained into which, if any, of these alternative insurance/disaster program alternatives is effective by simple examination of their ability to reduce yield and income risks faced by farmers.

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[5] For example, assume a 30 bushel expected county soybean yield and a current county yield of 19 bushels; this would trigger the county disaster designation. Also assume that Farmer A's expected yield is 40 bushels and Farmer B's expected yield is 20 bushels. Under the Administration proposal, if both farmers A and B suffer a 50% loss, Farmer A would not receive any disaster assistance payments, whereas Farmer B would receive the equivalent of an 8 bushel per acre disaster assistance payment.

PROCEDURES AND DATA

The first step in evaluating the crop insurance/disaster assistance programs is to compare the yield variation in the uninsured yield distribution to that in the insured yield distribution for each method by farm. The second step is to repeat the comparison using gross income including indemnity payments less premiums with and without government deficiency payments. These comparisons are made using distributions derived from the five insurance/disaster assistance methods described below. The coefficients of variation (C.V.) for wheat and corn yields and gross returns are calculated for each farm for each insurance/disaster assistance method and compared to the yield and gross returns C.V.s for no insurance.[6] Market prices for southcentral and northeastern Kansas for the period 1973 to 1987 are converted to 1988 dollars using the USDA index of prices received by farmers. Government deficiency payments are calculated using 1988 government program rules. For the analysis, the mean area yields and annual deviations from the area averages are the weighted average NASS county yields from planted acres for the 15-year period. Additionally, actuarially fair premiums are charged for all considered insurance plans.[7]

Continuous historical yield data for 98 southcentral Kansas dryland wheat farms and 38 northeast Kansas dryland corn farms from 1973-1987 obtained from the Kansas Farm Management Data Bank are used.[8] Yield statistics are reported

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[6] Coefficient of variation statistics, rather than standard deviations, are used to measure risk reduction because the mean returns and yields under disaster aid programs are different from those under actuarially fair insurance programs. Also, scenarios including deficiency payments have different mean returns than those without the payments.

[7] Actuarially fair assumes that total premiums equal total indemnities for the actuarial period.

[8] The average farm-level yields exceed the average county yields likely because of selection bias. The Farm Management Association farms tend to be larger and more profitable than average.

in Table 1. For the southcentral wheat farms, mean average farm yields always exceeded the average annual county yields except in McPherson County; the average C.V.s for farm-level yields exceeded those of the annual county yields in all counties. For the northeast corn farms, mean average farm yields exceeded the average annual county yields in all counties; the average C.V.s for farm-level yields were lower than those of annual county yields in 7 of the 11 counties.

Individual Farm Yield Insurance

Under current FCIC procedures, each farm has an insurance yield based on historical farm-level yields. The farm is reimbursed for any yield loss below the guaranteed yield (the insurance yield) less an adjustment for the deductible level selected by the producer. Under this plan, gross returns (net of the insurance premium) per acre are described as

$$[1] \quad GR_F = [max(P,EL) \bullet Y_F] + \{[TP - max(EP,EL)] \bullet Y_P\} - CIP + INDEM ,$$

where

GR_F = gross returns to the farm enterprise ($/acre);
P = market price ($/bu);
EL = effective national average loan rate ($/bu);
Y_F = actual farm yield produced on planted acres (bu/acre);
TP = target price ($/bu);
EP = expected national average price ($/bu);
Y_P = program yield based on 1980-1984 farm yields (bu/acre);
CIP = the actuarially fair crop insurance premium ($/acre);
$INDEM$ = $max\{0, IP \bullet [(HY_F \bullet LC) - Y_F]\}$; indemnity payment ($/acre);
IP = indemnity price election (the per bushel price at which the yield is insured) ($/bu);
HY_F = historical average farm yield from planted acres; the insurance yield (bu/acre); and
LC = 1 - % deductible; $LC \leq 1$ (percent).

Area Yield Insurance

The indemnity calculation described in Equation [2a] is based on an area yield average and negative deviations (losses) from the area average and does not use or require farm level data for calculating the indemnity payment.

Equation [2a] would replace INDEM in Equation [1]; the remainder of Equation [1] is unaffected.

[2a] $INDEM = max\{0, IP \bullet [(HY_A \bullet LC) - Y_A]\}$,

where

HY_A = historical average area yield; the insurance yield (bu/acre); and
Y_A = actual area average yield produced on planted acres (bu/acre).

Halcrow suggests that the indemnity be paid in bushels; therefore, when a gross income measure is not used (a strict interpretation using yields only), IP is removed from the equation.

Under Barnaby's area percentage method, the farmer is allowed to chose the level of dollar liability as well as the deductible level. The indemnity payment calculation for the method described by Barnaby is

[2b] $INDEM = max\{0, \$LIAB \bullet [((HY_A - Y_A)/HY_A) - (1 - LC)]\}$,

where

$\$LIAB$ = the dollar level of liability purchased ($/acre).

Equations [2a] and [2b] are identical when the liability level, denominated in bushels, is restricted to equal the historical area average yield ($\$LIAB = IP \bullet HY_A$). For simplicity, we carry this restriction throughout our analysis.

Optimal-Coverage Area Yield Plan

Although area-yield insurance may offer a method for limiting adverse selection and moral hazard compared to individual farm yield insurance, farmers whose yields (Y_F) are not highly correlated with the area yields (Y_A) may find an area yield plan ineffective in reducing risk. To test the relationship, Miranda suggests a simple analytical model

[3a] $Y_F = HY_F + \beta_F(Y_A - HY_A) + \varepsilon_F$,

where

$\beta_F = \rho_F \bullet [Var(Y_F)/Var(Y_A)]$; estimated for each farm;
ρ_F = the coefficient of correlation between Y_F and Y_A; and

ε_F = a random error term.

The estimated β_Fs have a central tendency toward 1 and indicate whether the farm has yield deviations identical to ($\beta_F = 1$), larger than ($\beta_F > 1$), or smaller than ($\beta_F < 1$) the area yield deviations. Generally, the higher the β_F, the greater the chance that an area yield measurement will be risk-reducing for the farm. Full-coverage (0%-deductible; LC = 1 in Equations [2a] and [2b]) area yield insurance will be risk-reducing for the farmer only if β_F is above a critical β value, β_c. Miranda presents a method for calculating β_c as

$$[3b] \quad \beta_c = -\frac{\mathrm{Var}(I)}{2 \bullet \mathrm{Cov}(Y_A, I)}$$

where

I = $max\{0, (HY_A - Y_A)\}$, the full-coverage area yield plan indemnity stated in bushels.

Under the area yield insurance plan (Equation [2a]), when the farmer is allowed to elect a coverage level, LC, in order to minimize his yield risk, the calculation for the optimal LC is derived by Miranda as

$$[3c] \quad LC = \beta_F / 2\beta_c \ .$$

Under this scheme, a farmer is allowed to "overinsure" his crop if he experiences relatively higher yield variability compared to the area; conversely, a farmer with relatively lower yield variability compared to the area would seek a higher deductible (lower coverage) level. Incorporating the optimal LC into Barnaby's method (Equation [2b]) results in a more flexible strategy, whereby the farmer could choose not only the level of coverage but also the dollar liability level.[9] A summary of the β_Fs, β_cs, and optimal coverage levels are presented in Table 2. Brief examination of the minimum β_Fs in relation to the

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[9] A strict interpretation of Barnaby's method limits LC $\leq$ 1 and places no restrictions on $LIAB. It can easily be shown that electing the optimal $LIAB level is identical to electing the optimal LC level.

β_cs indicates that we should expect a full-coverage area insurance plan to be yield risk-reducing for 89 to 93 of the southcentral farms and for all 38 of the northeast farms. The optimal coverage elections range from 0% to 248% for the southcentral wheat farms and from 101.6% to 246.6% for the northeast corn farms.

Farm Yield Disaster Assistance

Farm yield disaster assistance differs from farm yield insurance in two significant ways: (1) coverage is provided only if the farm experiences a yield disaster; and (2) coverage is provided at no cost to the farmer. In the analysis, a farm yield disaster is defined as a farm yield of less than 65% of the historical average farm yield on planted acres. Disaster assistance payments are calculated as the difference between 65% of the historical average farm yield and the actual farm yield. Gross returns under the farm yield disaster program are calculated as

$$[4] \quad GR_F = [max(P,EL) \bullet Y_F] + \{[TP - max(EP,EL)] \bullet Y_P\} + DAP \ ,$$

where

$DAP = max\{0, IP \bullet [(65\% \bullet HY_F) - Y_F)]\}$; the disaster payment ($/acre).

Area Yield Disaster Assistance

Area yield disaster assistance differs from area yield insurance in the same manner as farm yield disaster assistance differs from farm yield insurance except in the ways in which a disaster is defined and the disaster payments are calculated. In the analysis, an area yield disaster is defined as an area yield of less than 65% of the NASS weighted historical average county yield on planted acres. The disaster assistance payments are then calculated as the difference between 65% of the historical average county yield and the actual

county yield.[10] All farms within a disaster-designated area receive the same disaster assistance payment

$$[5] \quad DAP = max\{0, IP \bullet [(65\% \bullet HY_A) - Y_A)]\}.$$

The disaster assistance payment calculation in Equation [5] replaces that in Equation [4]; the rest of Equation [4] remains unaltered.

Initially, the reduction in yield variability offered by the five crop insurance/disaster assistance programs represented in Equations [1] through [5], ignoring crop prices and government program deficiency payments, is examined.[11] In addition, to simplify the comparison, we assume that the crop is insured using a 0% deductible plan (except for the optimal coverage area yield insurance) and that the premiums are actuarially fair.[12] Further analysis is presented that compares the gross income variability reduction under the crop insurance/disaster assistance programs with and without government deficiency payments. Indemnity and disaster assistance payments are based on a price election (IP) equivalent to the 1988 target price. Finally, consideration is given to the total indemnity and disaster assistance liabilities under the various programs that would be paid to the farms studied.

RESULTS

The variability reductions in yield and gross income distributions under the insurance and disaster assistance programs relative to those without insurance or disaster assistance coverage, as measured by the percent reduction in the coefficients of variation, are presented in Tables 3 and 4. The

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[10] This disaster assistance plan is equivalent to the area insurance described in Equation [2a] with a 35% deductible (LC = 65%) and provided at no cost to the farmer (CIP = 0).

[11] In effect, this is equivalent to fixing the value of each bushel produced and reimbursed and charging a crop insurance premium in bushels rather than dollars.

[12] By using actuarially fair premiums, the means of the yield and gross income distributions are not influenced by the insurance method.

individual farm yield insurance plan (1Y) is the most effective at reducing relative yield variability. Relative variability in yields is reduced between 27.5% and 67.2% for all wheat farms and between 36.1% and 63.8% for all corn farms; average reductions are 41.9% and 48.7%, respectively. The second most effective plan at reducing yield variability is the optimal coverage area yield insurance plan (3Y). Relative yield variability is reduced by an average of 17.2% and 43.0% for the wheat and corn farms, respectively, under this insurance plan. As anticipated earlier, the full-coverage area yield insurance plan (2Y) reduces relative yield variability for 89 of the southcentral wheat farms and all of the northeast corn farms; it is the least effective of the three insurance plans at reducing the relative variabilities of the wheat and corn yields on the studied farms. Of the two disaster assistance plans, the farm yield disaster assistance plan (4Y) is most effective and reduces relative yield variability between 0.0% and 31.5% for the southcentral wheat farms and between 4.8% and 38.3% for the northeast corn farms, with average relative variability reductions of 3.9% and 22.3%, respectively. During the 15-year period, the NASS county yield estimates for the southcentral wheat farm counties never fell below 65% of the expected county yields; therefore, no area yield disaster occurs for these counties under an area yield disaster assistance plan (5Y). For the northeast corn counties, there are eight years in which none of the counties experienced area yield disasters (as defined previously); however, under this plan, relative yield variability is reduced for all the corn farms between 3.3% and 26.0%, with an average of 14.8% reduction per farm. Neither of the disaster assistance plans is as effective at reducing relative yield variability as the three insurance plans. All of the insurance and disaster assistance programs provide a greater reduction in yield variability, on average, for the corn farms than for the wheat farms. Relative

yield variability is much greater for the corn enterprises than for the wheat enterprises (see Table 1).

When consideration is given to the effectiveness of these five programs in reducing gross income variability, cursory comparisons indicate that the reductions in relative gross income variabilities are less than the reductions in their yield-measured counterparts; this is explained by the additional risk from price variations. Examination of gross income without government deficiency payments indicates that the individual farm yield insurance plan (1GWO) provides the highest average relative reduction in gross income variability (19.8% and 47.1% reductions for the wheat and corn farms, respectively) in comparison to the alternative plans. The area yield insurance plan (2GWO) reduces relative gross income variability on 90 (92%) of the wheat and 37 (97%) of the corn farms; relative gross income variability is reduced by an average of 7.3% and 24.4% per farm for the wheat and the corn farms, respectively. The optimal coverage area yield insurance plan (3GWO) is only slightly more effective in reducing gross income variability for the wheat farms than the full-coverage area yield insurance plan. Since price risk is not taken into account in determining the optimal insurance coverage level under this plan, it is less effective at reducing gross income variability for the corn farms than the full-coverage area yield insurance. The farm yield disaster assistance plan (4GWO) reduces relative gross income variability by an average of 2.8% and 26.9% for the southcentral wheat farms and for the northeast corn farms, respectively; it is the second most effective at reducing relative variability in gross income for the corn farms. The area yield disaster assistance plan (5GWO) reduces relative gross income variability for the northeast corn farms between 2.5% and 26.5%; it is the least effective at reducing gross income variability for the corn farms.

Government deficiency payments reduce gross income variability for most of the farms, as indicated by the average relative reductions in gross income variability over those with no deficiency payments (1GW) of 35.2% and 0.5% for the wheat and corn farms, respectively. Under all the insurance/disaster assistance alternatives, except the area yield disaster assistance plan (4GW) for the northeast corn farms, the reductions in gross income variability with deficiency payments included are larger, on average, than the reductions in gross income variability with deficiency payments excluded.

The total insurance indemnity/disaster assistance liability outlays, calculated as the sum of all indemnities/assistance payments to all farms not allowing for administrative costs, occurring under the alternative plans are presented in Table 5. As anticipated, the alternative that would result in the smallest outlay per acre, for both farming regions, is the area yield disaster assistance plan; the farm yield disaster assistance plan is slightly more expensive. If the level of insurance coverage is restricted to 100% of the expected farm or area yield, the largest liability occurs under the individual farm insurance plan. If farmers are allowed to "overinsure," then the optimal coverage area yield plan results in the largest outlay for corn enterprises but the individual farm yield plan is still the most expensive for wheat enterprises. This result is likely due to higher variability in yields experienced on the corn farms.

CONCLUSIONS AND IMPLEMENTATION CONSIDERATIONS

Although an individual farm yield insurance plan is complex, it provides more reduction in farm-level yield and gross income variability than any of the alternative crop insurance or disaster assistance plans. The government deficiency payment program alone provides some degree of relief from gross income variability; however, for some of the sampled farms, it augments gross income variability. When a crop insurance or disaster assistance plan is combined

with the government deficiency payment program, relative gross income variability is reduced more than by any of the programs alone for nearly all of the sampled farms. This poses two policy considerations:

(1) an adjustment in the deficiency payment program may be as effective in reducing gross income variability as any crop insurance or disaster assistance program; and

(2) implementation of a crop insurance or disaster assistance program and elimination of the deficiency payment program may be more effective than the existing deficiency payment program.

Implementation of these crop insurance and disaster assistance plans requires further research consideration. The area "yield hedge" insurance plans could be based on percentage measures and dollars of liability, as Barnaby proposes, rather than bushels of liability, as originally proposed by Halcrow. This would eliminate the need for price forecasting to determine premiums, an issue that FCIC presently faces, and would allow for implementation procedures similar to those for private hail insurance with which the insurance industry is already acquainted. Each farmer would have to determine the optimal amount of liability and deductible level to purchase, thereby eliminating the need for the insurer to maintain farm-level records.

Additional analysis should consider these insurance and disaster assistance methods using a broader scope. Important issues to consider in future analyses include the ease of implementation for farmers as well as for FCIC or other insurance institutions, administrative costs, and cost effectiveness of insurance plans in comparison to direct disaster assistance programs.

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Table 1. Summary Statistics for the Kansas Dryland Wheat and Corn Yield Data, By County, 1973 to 1987

County	National Ag. Statistics Service Data[a]					Kansas Farm Management Association Data				
	No. of Years	Mean[b] Yield	Minimum Yield	Maximum Yield	C.V.	No. of Farms	Mean[c] Avg. Yield	Mean C.V.	Minimum C.V.	Maximum C.V.
		- - - bu/acre - - -			percent		bu/acre	- - - percent - - -		
Southcentral Kansas Dryland Wheat										
Barton	15	28.51	18.63	30.06	19.66	11	36.07	20.54	14.38	24.34
Harper	15	29.06	22.94	37.52	15.66	9	36.56	20.50	16.97	26.88
Harvey	15	29.70	22.67	35.93	14.56	9	34.87	20.62	14.25	28.20
Kingman	15	29.62	23.14	36.63	13.91	2	30.01	19.27	16.88	21.66
McPherson	15	30.69	21.48	38.86	15.45	7	29.33	28.97	20.68	35.67
Pratt	15	29.34	20.16	36.85	19.19	3	32.97	19.66	15.88	22.77
Reno	15	29.01	21.35	35.46	14.14	11	35.41	19.39	11.45	34.21
Rice	15	32.97	25.76	39.67	14.06	14	35.17	22.12	15.30	31.38
Sedgwick	15	29.30	20.97	37.20	15.39	13	34.61	18.75	14.14	28.42
Stafford	15	30.82	24.36	37.03	14.53	6	32.74	23.29	16.00	32.32
Sumner	15	29.86	20.28	39.77	15.64	13	34.16	17.87	9.03	25.91
Northeast Kansas Dryland Corn										
Atchison	15	57.93	18.10	102.57	48.78	3	69.33	43.68	38.43	48.64
Brown	15	68.43	23.79	118.92	41.54	9	79.16	42.51	31.53	54.51
Doniphan	15	82.77	47.39	131.68	31.30	3	93.11	30.38	24.65	36.01
Douglas	15	60.95	12.13	120.87	47.36	3	105.48	34.68	25.04	45.13
Jackson	15	53.36	11.53	87.50	45.58	2	79.27	47.70	42.89	52.51
Jefferson	15	61.20	17.46	105.45	43.65	1	67.32	47.09	47.09	47.09
Leavenworth	15	57.32	19.28	94.32	40.87	11	82.56	42.31	31.22	58.18
Pottawatomie	15	71.17	35.75	128.72	38.60	1	88.56	34.88	34.88	34.88
Shawnee	15	81.59	19.15	134.04	37.91	3	86.61	37.67	34.61	42.48
Wabaunsee	15	48.98	5.08	84.79	44.79	1	89.23	35.14	35.14	35.14
Wyandotte	15	58.52	14.67	111.69	53.48	1	88.60	44.14	44.14	44.14

[a] Source: Kansas State Board of Agriculture.

[b] Average annual county yield from planted acres weighted by planted acres.

[c] Arithmetic mean of the average yields from planted acres for Kansas Farm Management Association member farms within the county for which continuous time-series data were available.

Table 2. Summary of β_F and β_c Estimates and Optimal Coverage Levels (LC) Under an Area Insurance Plan, by County

County	No. of Farms	Frequency of β_F Estimates: ≤ 0.25	0.26 to 0.50	0.51 to 0.75	0.76 to 1.00	1.01 to 1.25	1.26 to 1.50	≥ 1.51	Min. β_F	Max. β_F	β_c	Optimal LC Level (%): Min.	Optimal LC Level (%): Max.
Southcentral Kansas Dryland Wheat													
Barton	11	.	.	2	4	4	1	.	0.602	1.279	0.341	88.3	187.5
Harper	9	.	3	1	3	1	1	.	0.299	1.290	0.260	57.5	248.1
Harvey	9	.	.	2	2	2	2	1	0.624	1.646	0.350	89.1	235.1
Kingman	2	.	1	.	.	1	.	.	0.383	1.099	0.332	57.7	165.5
McPherson	7	2	.	.	.	3	1	1	-0.027	1.642	0.333	0.0	246.5
Pratt	3	.	.	1	1	1	.	.	0.606	1.019	0.305	99.3	167.0
Reno	11	1	1	2	3	3	.	1	0.098	1.613	0.331	14.8	243.7
Rice	14	.	.	2	4	4	3	1	0.569	1.520	0.333	85.4	228.2
Sedgwick	13	2	3	.	5	2	1	.	0.230	1.303	0.347	33.1	187.8
Stafford	6	.	.	.	2	2	2	.	0.918	1.492	0.300	153.0	248.7
Sumner	13	.	1	4	5	3	.	.	0.359	1.141	0.351	51.1	162.5
Cumulative	98	5	9	14	29	26	11	4	---	---	---	---	---
Northeast Kansas Dryland Corn													
Atchison	3	.	.	1	1	.	1	.	0.643	1.274	0.268	120.0	237.7
Brown	9	.	.	1	5	2	1	.	0.640	1.303	0.315	101.6	206.8
Doniphan	3	.	.	1	1	.	1	.	0.733	1.307	0.265	138.3	246.6
Douglas	3	.	.	1	2	.	.	.	0.708	0.978	0.319	111.0	153.3
Jackson	2	.	.	.	.	1	1	.	1.235	1.477	0.307	201.1	240.6
Jefferson	1	.	.	.	.	1	.	.	1.029	1.029	0.309	166.5	166.5
Leavenworth	11	.	.	.	2	2	6	1	0.946	1.532	0.326	145.1	235.0
Pottawatomie	1	.	.	.	1	.	.	.	0.891	0.891	0.272	163.8	163.8
Shawnee	3	.	.	.	3	.	.	.	0.933	0.997	0.341	136.8	146.2
Wabaunsee	1	.	.	.	.	1	.	.	1.206	1.206	0.305	199.7	199.7
Wyandotte	1	.	.	.	.	1	.	.	1.049	1.049	0.294	178.4	178.4
Cumulative	38	.	.	4	15	8	10	1	---	---	---	---	---

Table 3. Frequency of Relative Reduction in Yield and Gross Income Variability[a] for 98 Southcentral Kansas Farm Management Association Dryland Wheat Farms, by Crop Insurance/Disaster Assistance Plan, 1973 to 1987

Reduction in Variability (Percent)	Yield					Gross Income w/o Deficiency Payments					Gross Income w/ Deficiency Payments					
	1Y[b]	2Y	3Y	4Y	5Y[c]	1GWO	2GWO	3GWO	4GWO	5GWO[c]	0GW	1GW	2GW	3GW	4GW	5GW[c]
-16 to -20	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
-15 to -11	.	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.
-10 to -6	.	2	.	.	.	.	1	.	.	.	.	.	4	.	.	.
-5 to 0	.	5	8	.	.	.	6	5	.	.	.	.	2	7	.	.
0 to 5	.	10	9	73	.	1	29	35	82	.	.	.	13	13	74	.
6 to 10	.	15	15	13	.	5	35	22	9	.	.	.	17	15	11	.
11 to 15	.	22	16	4	.	20	21	22	2	.	1	.	21	20	7	.
16 to 20	.	18	14	4	.	26	4	10	4	.	4	3	18	9	3	.
21 to 25	.	15	9	3	.	27	.	3	1	.	8	6	13	11	2	.
26 to 30	4	9	9	.	.	15	1	.	.	.	12	14	6	9	1	.
31 to 35	12	.	9	1	.	4	.	1	.	.	25	25	3	8	.	.
36 to 40	34	.	5	.	.	.	.	.	.	.	22	14	.	2	.	.
41 to 45	22	.	4	.	.	.	.	.	.	.	18	21	.	4	.	.
46 to 50	15	.	.	.	.	.	.	.	.	.	7	9	.	.	.	.
51 to 55	4	.	.	.	.	.	.	.	.	.	1	4	.	.	.	.
56 to 60	6	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.
61 to 65	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
66 to 70	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Average	41.9%	13.2%	17.2%	3.9%	-	19.8%	7.3%	8.6%	2.8%	-	35.2%	36.9%	13.0%	16.2%	3.8%	-
Minimum	27.5%	-13.6%	- 3.8%	0.0%	-	3.4%	-10.8%	- 5.2%	0.0%	-	14.2%	15.5%	-18.2%	- 3.0%	0.0%	-
Maximum	67.2%	29.0%	42.5%	31.5%	-	32.6%	28.3%	31.7%	22.6%	-	54.8%	55.7%	31.6%	43.8%	28.5%	-

[a] The reduction in relative variability is measured as the percent change in the coefficient of variation between the insurance, disaster assistance, or deficiency payment scenario and no insurance, no disaster assistance, nor deficiency payment participation. Under the crop insurance plans, the reduction in relative variability is also the percent change in the standard deviation between the insurance plans and no coverage because of the use of actuarially fair premiums.

[b] Strategies:
- 1Y = Individual Farm Yield Insurance versus No Insurance (Yield)
- 2Y = Area Yield Insurance versus No Insurance (Yield)
- 3Y = Optimal Coverage Area Yield Insurance versus No Insurance (Yield)
- 4Y = Farm Yield Disaster Assistance (35% Loss Trigger) versus No Insurance (Yield)
- 5Y = Area Yield Disaster Assistance (35% Loss Trigger) versus No Insurance (Yield)
- 1GWO = Individual Farm Yield Insurance versus No Insurance, No Deficiency Payments (Gross Income)
- 2GWO = Area Yield Insurance versus No Insurance, No Deficiency Payments (Gross Income)
- 3GWO = Optimal Coverage Area Yield Insurance versus No Insurance, No Deficiency Payments (Gross Income)
- 4GWO = Farm Yield Disaster Assistance (35% Loss Trigger) versus No Insurance, No Deficiency Payments (Gross Income)
- 5GWO = Area Yield Disaster Assistance (35% Loss Trigger) versus No Insurance, No Deficiency Payments (Gross Income)
- 0GW = Deficiency Payments versus No Insurance, No Deficiency Payments (Gross Income)
- 1GW = Individual Farm Yield Insurance versus No Insurance, With Deficiency Payments (Gross Income)
- 2GW = Area Yield Insurance versus No Insurance, With Deficiency Payments (Gross Income)
- 3GW = Optimal Coverage Area Yield Insurance versus No Insurance, With Deficiency Payments (Gross Income)
- 4GW = Farm Yield Disaster Assistance (35% Loss Trigger) versus No Insurance, With Deficiency Payments (Gross Income)
- 5GW = Area Yield Disaster Assistance (35% Loss Trigger) versus No Insurance, With Deficiency Payments (Gross Income).

[c] During the 15 year period, none of the counties experienced a disaster. A disaster is defined herein as the annual county yield dropping below 65% of the historical weighted county average yield.

Table 4. Frequency of Relative Reduction in Yield and Gross Income Variability[a] for 38 Northeast Kansas Farm Management Association Dryland Corn Farms, by Crop Insurance/Disaster Assistance Plan, 1973 to 1987

Reduction in Variability (Percent)	Yield					Gross Income w/o Deficiency Payments					Gross Income w/ Deficiency Payments					
	1Y[b]	2Y	3Y	4Y	5Y	1GWO	2GWO	3GWO	4GWO	5GWO	0GW	1GW	2GW	3GW	4GW	5GW
-15 to -11	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
-10 to -6	.	.	.	.	.	.	1	3	.	.	3	.	.	.	.	.
-5 to 0	.	.	.	.	.	.	.	1	.	.	10	.	.	.	.	.
0 to 5	.	.	.	1	4	.	1	3	.	6	23	.	.	.	.	3
6 to 10	.	.	.	3	3	.	3	1	3	4	1	.	.	.	1	4
11 to 15	.	.	.	4	12	.	4	4	4	6	1	.	.	3	6	9
16 to 20	.	1	.	8	13	.	5	6	4	13	.	.	3	1	3	12
21 to 25	.	7	1	8	5	1	3	5	5	6	.	.	5	4	6	9
26 to 30	.	10	7	7	1	.	6	1	4	3	.	.	7	4	10	1
31 to 35	.	8	3	6	.	2	9	3	11	.	.	.	9	4	4	.
36 to 40	4	7	4	1	.	8	6	8	4	.	.	1	8	3	6	.
41 to 45	10	5	6	.	.	4	.	1	3	.	.	3	5	5	2	.
46 to 50	8	.	5	.	.	6	.	1	.	.	.	7	1	5	.	.
51 to 55	11	.	8	.	.	12	.	.	.	.	.	6	.	5	.	.
56 to 60	2	.	3	.	.	3	.	.	.	.	.	15	.	3	.	.
61 to 65	3	.	1	.	.	2	.	.	.	.	.	4	.	.	.	.
66 to 70	.	.	.	.	.	.	.	.	.	.	.	2	.	1	.	.
Average	48.7%	32.0%	43.0%	22.3%	14.8%	47.1%	24.4%	20.5%	26.9%	15.2%	0.5%	54.9%	32.4%	38.9%	24.4%	16.0%
Minimum	36.1%	18.5%	22.1%	4.8%	3.3%	24.8%	-6.1%	-10.9%	7.2%	2.5%	-10.3%	40.4%	15.9%	13.2%	5.6%	3.8%
Maximum	63.8%	45.2%	64.9%	38.3%	26.0%	60.9%	40.2%	48.8%	43.2%	26.5%	11.1%	69.4%	47.4%	66.0%	37.4%	26.8%

[a] The reduction in relative variability is measured as the percent change in the coefficient of variation between the insurance, disaster assistance, or deficiency payment scenario and no insurance, no disaster assistance, nor deficiency payment participation. Under the crop insurance plans, the reduction in relative variability is also the percent change in the standard deviation between the insurance plans and no coverage because of the use of actuarially fair premiums.

[b] Strategies:
1Y = Individual Farm Yield Insurance versus No Insurance (Yield)
2Y = Area Yield Insurance versus No Insurance (Yield)
3Y = Optimal Coverage Area Yield Insurance versus No Insurance (Yield)
4Y = Farm Yield Disaster Assistance (35% Loss Trigger) versus No Insurance (Yield)
5Y = Area Yield Disaster Assistance (35% Loss Trigger) versus No Insurance (Yield)
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2GWO = Area Yield Insurance versus No Insurance, No Deficiency Payments (Gross Income)
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4GWO = Farm Yield Disaster Assistance (35% Loss Trigger) versus No Insurance, No Deficiency Payments (Gross Income)
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0GW = Deficiency Payments versus No Insurance, No Deficiency Payments (Gross Income)
1GW = Individual Farm Yield Insurance versus No Insurance, With Deficiency Payments (Gross Income)
2GW = Area Yield Insurance versus No Insurance, With Deficiency Payments (Gross Income)
3GW = Optimal Coverage Area Yield Insurance versus No Insurance, With Deficiency Payments (Gross Income)
4GW = Farm Yield Disaster Assistance (35% Loss Trigger) versus No Insurance, With Deficiency Payments (Gross Income)
5GW = Area Yield Disaster Assistance (35% Loss Trigger) versus No Insurance, With Deficiency Payments (Gross Income).

Table 5. Total Insurance Indemnity/Disaster Assistance Liabilities Under 5 Crop Insurance/Disaster Assistance Plans, Southcentral Kansas Dryland Wheat Farms and Northeast Kansas Dryland Corn Farms, by Year and County, 1973 to 1987

	Southcentral Kansas Wheat Farms							Northeast Kansas Corn Farms					
	Planted Acres	1[a]	2	3	4	5		Planted Acres	1[a]	2	3	4	5
		1988 dollars							1988 dollars				
By Year													
1973	43,678	84,510	0	0	13,130	0		8,735	24,083	21,065	31,041	0	0
1974	49,796	1,242,262	900,676	1,329,108	52,026	0		10,079	876,922	858,229	1,512,773	171,110	220,594
1975	53,711	769,185	526,966	739,755	6,799	0		8,630	384,336	602,351	1,078,791	27,791	76,068
1976	54,498	892,455	840,849	1,108,697	56,190	0		8,977	683,821	435,030	780,836	74,856	47,907
1977	55,180	1,191,883	797,666	1,187,450	75,246	0		6,467	234,777	219,381	390,613	11,847	5,023
1978	48,140	643,796	468,021	713,998	57,886	0		6,941	52,181	318	448	0	0
1979	49,875	95,943	0	0	0	0		8,759	2,149	0	0	0	0
1980	54,845	890,780	469,469	685,454	81,950	0		9,014	1,645,196	1,056,713	1,778,925	888,239	485,175
1981	59,942	999,910	915,848	1,330,403	54,181	0		7,326	3,976	0	0	0	0
1982	58,307	191,115	0	0	8,858	0		7,353	0	0	0	0	0
1983	46,217	93,822	282,442	383,883	0	0		6,373	854,403	665,193	1,136,493	325,500	261,067
1984	48,393	195,804	1,484	2,309	197	0		7,468	276,781	112,148	202,614	47,662	18,187
1985	48,189	410,046	265,840	349,680	0	0		8,341	0	0	0	0	0
1986	46,471	340,980	172,206	231,897	0	0		8,857	0	0	0	0	0
1987	47,778	653,542	195,950	259,741	11,667	0		8,247	11,402	0	0	0	0
By County													
Barton	77,837	919,536	760,777	1,014,948	31,241	0	Atchison	9,468	426,702	362,867	720,741	117,021	106,692
Harper	85,411	1,051,990	614,667	920,880	26,511	0	Brown	35,136	1,408,234	1,106,701	1,740,164	506,773	338,382
Harvey	46,297	503,552	313,270	459,455	19,472	0	Doniphan	9,181	352,350	306,973	633,531	31,762	13,513
Kingman	6,183	60,965	43,323	50,106	0	0	Douglas	10,727	430,619	303,946	418,602	133,548	115,934
McPherson	29,939	413,701	271,175	385,688	79,163	0	Jackson	3,164	123,791	83,993	181,121	34,349	25,350
Pratt	26,347	279,907	267,038	360,803	9,254	0	Jefferson	2,222	86,757	72,753	121,295	32,036	22,175
Reno	92,307	988,521	636,241	820,111	33,369	0	Leavenworth	24,166	1,055,905	758,747	1,463,802	304,471	207,342
Rice	101,618	1,282,779	818,264	1,345,371	96,031	0	Pottawatomie	2,243	85,096	69,863	114,497	23,337	5,375
Sedgwick	85,410	958,889	609,183	790,940	31,884	0	Shawnee	9,022	325,547	353,784	498,018	100,834	84,527
Stafford	54,842	699,342	431,404	852,803	60,278	0	Wabaunsee	7,445	276,997	191,721	379,505	68,285	53,763
Sumner	158,828	1,536,851	1,072,076	1,321,270	30,925	0	Wyandotte	8,793	478,029	359,077	641,258	194,587	140,967
Total	765,019	8,696,032	5,837,418	8,322,374	418,128	0		121,567	5,050,028	3,970,427	6,912,533	1,547,004	1,114,020
Avg. Per Acre		11.37	7.63	10.88	0.55	0.00			41.54	32.66	56.86	12.73	9.16

[a] Strategies: 1 = Individual Farm Yield Insurance
2 = Area Yield Insurance
3 = Optimal Coverage Area Yield Insurance
4 = Farm Yield Disaster Assistance (35% Farm Loss Trigger)
5 = Area Yield Disaster Assistance (35% Area Loss Trigger).