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Fixing Crop Insurance: Farmer Responses and Policy Implications

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The Federal Crop Insurance Act of 1980 designated federal multiple peril crop insurance (MPCI) to be the primary disaster assistance program aiding farmers in the event of crop failures due to natural causes. Disaster payments were to be replaced by insurance in order to make disaster relief less dependent on political forces and to improve efficiency of resource use by "privatizing" risk management. However, except in 1989, when 51% or 30 million acres were insured due to requirements linking insurance with disaster payments received in 1988, participation by farmers in federal crop insurance has not met target levels of at least 50% participation needed to replace disaster payments.

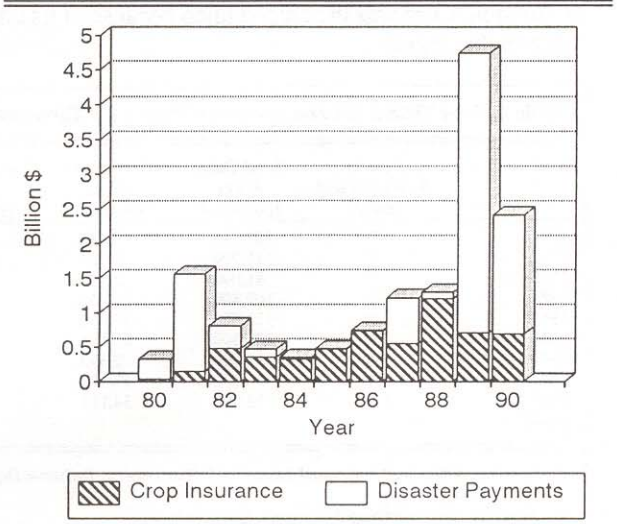
Federal disaster programs were the subject of extensive debate for the 1990 Farm Bill because of the high federal budget cost for the combination of disaster payments and insurance subsidies. USDA's Office of Budget and Program Analysis shows that disaster payments cost about $8.8 billion from 1980 to 1990, and crop insurance subsidies also cost about $5.7 billion over this same period (see Fig. 1). American Association of Crop Insurers' (AACI) data showed that, from 1981 to 1990, farmers received indemnity payments totaling $6.9 billion while they paid only $3.65 billion in premiums. In addition to direct premium subsidies of about 30% or $1.1 billion for this period, insurance subsidies also include the difference between indemnity payments and premiums and the cost for the Federal Crop Insurance Corporation (FCIC) to administer the program of $1.33 billion.

A ratio of indemnity payment to premium (called the "loss ratio") greater than one typifies problems of achieving actuarial soundness in insurance associated with problems known as "moral hazard" and "adverse selection." The loss ratio for MPCI for the 1981-1990 period, including the federal subsidies, was 1.46, meaning that $1.46 in indemnities was paid out for every $1.00 of premium. Excluding government premium subsidies from the loss ratio, farmers with insurance were paid $1.89 for every dollar of premium paid. (In comparison, loss ratios for private insurance are typically about 0.8.)

The federal government is the reinsurer for crop insurance in order to reduce the risk to private insurance companies which sell and administer 90% of the insurance contracts. Because of reinsurance, problems of actuarial soundness associated with moral hazard and adverse selection are passed on to the federal government.

During deliberations for the 1990 Farm Bill, there was much discussion regarding possible elimination of the current federal crop insurance program mainly because of the duplication of disaster payments and insurance indemnities. The Bush Administration's Farm Bill proposal advocated replacing insurance with disaster payments which would be automatically triggered if a county's yield losses exceeded a predetermined level (below 65% of average county yield). However, the final version of the Farm Bill approved continued funding for crop insurance, and in spite of a 25% cut

Figure 1. Federal Disaster Assistance 1980-1990 Billion Dollars



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in the five-year agricultural budget, crop insurance was not cut at all for 1991. The American Association for Crop Insurers attributes this to the strong grass roots support for the program expressed to elected officials. Future funding is still uncertain.

The Farm Bill did authorize certain reforms in crop insurance. It included efforts to increase participation, by allowing yield coverage to be based on ASCS yields and authorized some new types of contracts to be offered by private companies. It also included efforts to promote "actuarial sufficiency". The bill called for increases in premium rates up to 20%, improvements in recordkeeping procedures, and increases in civil penalties in cases of program abuse. But AACI has raised concerns that premium increases may price coverage out of reach of many producers, thus defeating program goals to expand participation.

New Approaches Are Needed

Because the crop insurance program essentially has been maintained in its original form in the 1990 Farm Bill, it can be argued that further changes are necessary to make significant improvements in participation and actuarial sufficiency. This article proposes some additional changes that could be made in insurance contract design and ratemaking. Specifically, our proposals are:

- base premium rates on a producer classification system considering both yield variability and average yield
- offer insurance contracts with higher yield coverage for "better" producers
- introduce coinsurance in the form of reduced price guarantees for higher yield coverage
- develop improved methods of calculating fair premiums

To increase participation and reduce moral hazard and adverse selection, these proposals to improve crop insurance are based on insurance contract design principles.

That implementing the above proposals could improve the crop insurance program is demonstrated by results for a study for Tippecanoe County, Indiana carried out at Purdue University. Tippecanoe was used as the study site because growing conditions are typical of central Indiana corn production. Corn was the crop studied because of its importance in this region.

In Tippecanoe County, as in other areas of the Midwest, participation in crop insurance has been low — about 3-5% prior to 1984 rising to 37% in 1989 when participation was required for those receiving disaster payments in 1988. Table 1 presents characteristics of production in Tippecanoe County and loss ratios for corn for Tippecanoe and Indiana for 1981-89. Over this period Tippecanoe had a higher loss ratio than the state ratio (an average of 1.21 compared to the state average of 1.02). Thus, if improvements in participation, subsidy cost, and actuarial sufficiency can be made in Tippecanoe, such improvements could also be anticipated for other similar areas in the Midwest.

Insurance Design Principles

In general, an insurance contract may include the following features: the premium, which is the price for purchasing the contract; coinsurance, which makes the insuree pay a share of loss to give incentives for reducing moral hazard; and a deductible, which defines a maximum loss level. Our proposals pertain to a more complete application of insurance design principles to reduce moral hazard and adverse selection.

Demand for Insurance and Adverse Selection. Low MPCI participation may indicate that farmers believe benefits from current crop insurance contracts are not worth their premium cost. Nelson (1990) found that the premiums computed by Federal Crop Insurance Corporation (FCIC) procedures overstate the yield risk for Corn Belt farmers with relatively low yield variability. Barnaby et al. also found that farmers were dissatisfied with yield guarantees. Demand for crop insurance could be increased both by improving rate-setting procedures to better reflect the risks faced by farmers and by improving contract guarantees.

Insurance literature suggests that charging a fair premium — plus a loading fee for administrative purposes — would lead to the greatest level of benefit for the insuree consistent with actuarial soundness of insurance. The fair premium is the rate which allows the insurance company to break even over time, with losses in some years offset by years with gains.

Typically, premiums are specified according to a system of assigning insurance purchasers to risk classes for which different premium rates are quoted. With adverse selection,

Table 1. Corn Yield and Crop Insurance History for Tippecanoe County, 1981-1989

Year	County Average Yield (bu/a)[1]	Total Corn Acres Harvested	Gross Corn Acres Insured[2]	Participation Rate (Percent)	Percent of Insured Acres With Losses[2]	Total Premium[2] ($)	Total Indemnity[2] ($)	Loss Ratio[2]	Indiana Loss Ratios for Corn[3]
1981	125	107,100	6,433	6	8	20,014	8,204	0.41	1.29
1982	135	116,200	6,224	5	0	21,187	0	0.00	.52
1983	73	81,000	2,333	3	79	8,913	108,467	12.17	6.65
1984	125	109,800	25,237	23	11	122,367	55,392	0.45	.92
1985	129	111,800	27,466	25	6	128,957	55,031	0.43	.52
1986	122	101,500	21,101	21	29	81,665	231,819	2.84	.89
1987	142	81,800	22,392	27	4	77,231	14,970	0.19	.25
1988	85	86,500	22,876	26	48	80,695	336,522	4.17	3.98
1989	139	92,800	34,111	37	2	137,384	8,479	0.06	.38
Total						678,413	818,884	1.21	1.02

1 Source: ***Annual Crop and Livestock Summary***, *Indiana Department of Agricultural Statistics and U.S. Department of Agriculture Statistical Reporting Service.*
2 Source: *Federal Crop Insurance Corporation.*
3 Source: *American Association of Crop Insurers.*

the insurance company may not be able to distinguish among producers of different types (e.g., "high risk" and "low risk"), and so charges the same premium (an average rate) to producers of both types. This average rate will be too high for "low risk" producers and too low for "high risk" producers; thus, only the "high risk" producers will buy the insurance and loss ratios will be greater than one.

One procedure to improve adverse selection is to obtain better information about the types of people to be insured. For example, in the case of automobile insurance, rates are set according to characteristics of the driver such as age, sex, mileage driven, and characteristics of the automobile. Because such indicators of care in driving may be imperfect signals of type, rates can later be adjusted according to driving history.

Similarly, in the case of rate making for crop insurance, producers could be typed according to yield loss characteristics. Yield variability and average yield are both important to identify the nature of yield risk. Therefore, in setting premium rates, the proposed classification system is based on both yield variability and average yield.

In comparison, current rate-making procedures are based only on average yield. Actual Production History (APH) is used to classify farmers according to their average yield over a 10-year period, and the same level of yield variability is assumed for all farmers with a given average yield. Both yield variability and average yield could be assessed from the historical data currently required for the Actual Production History.

Moral Hazard and Coinsurance. Moral hazard has to do with a producer changing production behavior after insurance is introduced, thus leading to losses greater than anticipated. One example of moral hazard behavior is not to irrigate a crop which is already failing. Another example is reducing the number of bushels harvested by changing combine settings in a year when the insurance price guarantee (the price paid per bushel of yield loss) is higher than the price which could be obtained through the market.

Moral hazard can typically be alleviated by the use of coinsurance which makes the insuree share the cost of losses with the insurance company. In contrast, the current crop insurance program uses a "full coverage" concept by applying close to the full market price (about $2.30 per bushel for corn) to yield losses. Coinsurance would set the payment rate at less than the market price for yield loss.

The Yield Guarantee as a Deductible. The deductible is a feature of insurance for which a loss is only covered by insurance if it is above the deductible level. The deductible level is thus the highest loss incurred. Insurance with a smaller deductible gives a lower exposure to risk, but requires a larger fair premium. For general types of insurance, a menu of deductible levels is offered to provide a range of expression of risk preferences.

In crop insurance, the yield guarantee acts as a deductible. An indemnity will only be paid if yield falls below the yield guarantee level. A higher yield guarantee level corresponds to insurance with a smaller deductible for which indemnity payments are more frequently received.

The highest yield guarantee currently available from MPCI is 75% of average farm yield. In Tippecanoe County, farms with high-quality soils may never experience yields below 75%, even in severe droughts like those seen in the 1980s, so that indemnity payments would not be received under this MPCI contract.

The Committee for the Improvement of the Federal Crop Insurance Program, appointed by Congress after the 1988 drought, suggested the establishment of a pilot program offering yield guarantees of 85% for corn and other crops, but such changes have not yet been incorporated into FCIC programs. Since offering higher yield guarantees could increase the potential for "moral hazard," higher yield guarantees should be coupled with coinsurance, that is, lower price guarantees.

Buyers and Nonbuyers and Adverse Selection

Adverse selection has to do with problems of determining premiums for "buyers" of insurance when they may have different risk characteristics. To compare differences in characteristics of "buyers" and "nonbuyers", a survey was conducted in Tippecanoe County in March and April of 1990. Respondents were categorized as either "buyers" or "nonbuyers" based on their decision whether or not to purchase MPCI for corn in 1988. The classification was based on 1988 instead of 1989, because farmers required to purchase MPCI in 1989 due to receiving disaster payments in 1988 may not have been voluntary buyers.

Telephone screening produced 55 respondents whose primary occupation was farming and who were willing to go through the lengthy personal interview. Twenty-two of these were classified as buyers and 33 were classified as nonbuyers. The proportion of buyers in the survey (40%) was higher than the proportion of actual buyers in Tippecanoe County in 1988, because the insurance participation rate for corn (in acres) was actually only 26% that year. Therefore, responses were analyzed separately for buyers and nonbuyers. Responses were combined in the proper statistical proportions to represent the county in the analysis of alternative types of disaster programs described below.

Table 2 describes the personal characteristics of the farmers and the characteristics of their farms. The average age of the farmers in the sample was not quite 50 years old, and the average number of years farming was over 20 years. Most farmers had completed high school. There also were no statistically significant differences between buyers and nonbuyers in terms of total acres or total sales. There may be some minor differences between the groups in the debt/asset ratio and the "survivability" of the farm, but these differences were not statistically significant at the 95% confidence level.

Corn yield characteristics were significantly different for the two groups (see Table 2). Yield variability can be assessed by the ratio of the lowest yield experienced since 1980 to the average yield; a low ratio indicates high variability and a greater probability of experiencing significant yield loss. Insurance buyers tended to have lower average yields and greater yield variability than nonbuyers.

Table 2. Farm and Personal Characteristics of Survey Participants.

Characteristic	1988 Non-Buyers	1988 Buyers
	------ Average values ------	
Farmer's age (in years)	49.6	45.7
Years as a farmer operator	26.3	23.2
Total acres farmed	828.4	978.6
Total acres owned	247.9	178.8
Percent of acres rented[4]	64.0	87.9
Corn Yield:		
Average corn yield (bu/a)[4]	140.9	128.9
Highest corn yield since 1980 (bu/a)	163.2	154.2
Lowest corn yield since 1980 (bu/a)[4]	86.8	60.8
Lowest yield/average yield	.60	.46
% of time yield is below 70 bu/a	3	8
	------ Percent Farmers ------	
Annual sales of agricultural products:		
Less than $50,000	9.1	4.6
$50,000 to $99,999	15.2	18.2
$100,000 to $249,000	33.3	50.0
$250,000 and over	42.4	27.3
Debt/asset ratio:		
0% (no debt)	18.2	4.6
1% to 40%	57.6	50.0
41% to 70%	24.2	45.5
Surviving years of low farm income:		
Could survive 1 year or less	24.2	45.5
Could survive at least 2 years	75.8	54.6

4 *The groups are significantly different at the 95% confidence level.*

About 25% of the sample of nonbuyers had never experienced yields below 70% of average. The association of buyers with a higher probability of yield loss than nonbuyers indicates that producers do make insurance choices that reflect differences in yield risk.

In order to compare the current system of classifying farmers only by average yield with a classification system based on both average yield and yield variability, the sample of buyers and nonbuyers was further subdivided into four types according to yield variability (see Table 3). The four types exhibit combinations of higher or lower average yields and higher or lower yield variability. The majority of nonbuyers are in the higher average yield, lower yield variability class, whereas the majority of buyers are in the higher variability class.

The bottom of Table 3 compares FCIC rates for these four types with fair premium computed from a yield risk model developed at Purdue. The comparison indicates that current premium rates are too high for the lower variability farms and too low for higher variability, higher yield farms. Therefore, lower variability producers would tend not to buy the current crop insurance contract at current FCIC rates unless they were extremely risk averse, whereas higher variability producers would be more likely to buy insurance. Thus, in order to increase participation by low variability farmers to reduce adverse selection, premiums should be determined to reflect differences in yield variability. Yield risk models such as those used in the Purdue study could be used to compute more appropriate premium rates.

Table 3. Corn Yield Characteristics of Tippecanoe County Farmers

High Yield (H) Low Yield (L)	Yield Risk Type H[5]	L[5]	H[6]	L[6]	Total
Farmers:			%		
Buyers	23	18	14	45	100%
Non-buyers	57	12	21	9	100%
Yield:		------ Average Values ------			
Average yield (bu/acre)	149	127	140	116	
Highest yield (bu/acre)	169	148	159	150	
Lowest yield (bu/acre)	104	86	52	38	
Lowest yield/Average yield	.70	.67	.37	.33	
% of time yield below 70 bu/acre	1	4	7	12	
Insurance Premiums ($/acre) for $2.30 price guarantee					
FCIC rate	5.14	5.48	5.31	5.60	
Fair premiums[7]	1.59	2.08	6.44	5.58	

5 *Low variability yield.*
6 *High variability yield.*
7 *Based on yield risk model developed at Purdue. Average yields are 130 and 110 for high and low yield variability.*

Tippecanoe County Farmers Respond

Farmers were asked to compare alternative types of insurance contracts, including contracts with higher yield guarantees and lower price guarantees than are presently used. Alternative types of insurance were priced at a fair premium. (Comparisons used a hypothetical farm which had average yield set at either 110 or 130 bu/acre to be representative of the farmer's own yield.) Combining higher yield guarantees with lower price guarantees produced greater probability of payment with premiums no greater than current levels.

When given detailed information about insurance and fair premium levels (probabilities and amounts of payment for various yield levels), 24% of the nonbuyers said they would buy the current yield and price guarantees. Participation in insurance by nonbuyers could be increased even further (up to 48%) by offering higher yield guarantees of 80 or 85%. Thus, adverse selection would be reduced by increasing yield guarantees.

Not all the 1988 buyers agreed to continue buying insurance after receiving insurance information — only 77% would continue to buy the current contract at a fair premium. The participation by buyers was 86% with the 80% yield guarantee.

Combining nonbuyers and buyers represents about 70% of the acres in the county which would be covered by insurance if the set of available contracts was extended to include higher yield guarantees (80% and 85%) with lower price guarantees ($1.40 and $1.70). Because of the hypothetical nature of insurance comparisons, farmers were asked if they would make similar choices for their own farm. All the buyers and most (about 90%) of the nonbuyers indicated they would make the same insurance decisions for their own farms.

Alternative Disaster Assistance Programs

Five alternative types of disaster programs (two types of disaster payment programs, the current program, farm insurance with the four improvements suggested above, and such a program with a 15% premium subsidy) were compared for Tippecanoe County (see Table 4).

Disaster payments with a 65% county yield loss trigger are similar to the Bush proposal for the 1990 Farm Bill and also similar to how indemnity payments were actually made after the 1988 drought. In this case, payment is based on individual farm losses but must be triggered by a county-wide loss. There is no premium cost to the farmer and all farmers automatically receive benefits if a county-wide yield loss occurs. The 80% trigger provides greater probability of indemnity payments for producers.

Farm yield insurance alternatives included: a base case similar to the current program with a 30% premium subsidy in which farmers are only classified by average yield and the highest yield guarantee is 75%; a case with improved farmer classification and improved contract design, for which farmers are categorized by both average yield and yield variability, and higher yield guarantees (up to 85%) are coupled with lower price guarantees of $1.70 or $1.40; and a case with improved classification of farmers and improved contract design which also has a 15% premium subsidy.

Criteria for comparing these alternative programs are participation rate, total government subsidy cost, premiums paid by farmers, the expected value of losses covered by indemnity payments, and the expected value of losses not covered by payments ("unrecovered losses") for yields below 65% of average yield — since 65% has been defined as the socially unacceptable level of yield loss in previous disaster programs. With no disaster assistance, the expected value of yield losses in Tippecanoe County for yields below 65% of average yield would be about $120,403.

Participation rates were predicted from insurance demand models developed at Purdue based on survey responses. Subsidy costs and expected loss values were evaluated using yield risk models developed at Purdue and assumptions about moral hazard and adverse selection. The loss ratio for the base case is taken to be 1.2, similar to the historical average. A lower loss ratio (1.1) is assumed for farm insurance with improved classification of farmers' yield risk. A loss ratio of 1.0 is assumed for disaster payments triggered by county losses because moral hazard and adverse selection would not occur with such a program.

The type of disaster payment program proposed by Bush, while having a much lower government subsidy cost than the current program, would have much higher unrecovered losses than the base program ($93,047 compared to $37,461), only about a third lower than if there were no disaster program. Using the 80% trigger would give lower unrecovered losses than the 65% trigger, but would also require a higher subsidy cost in an amount approaching the cost of the current program. Thus, such programs would not be improvements compared to the current program.

Farm insurance with improved classification of farmers and improved contract designs would increase participation with a small reduction in unrecovered losses at a reduced subsidy cost compared to the base case. A 15% premium subsidy with improved contracts and improved farmer yield risk classification would produce an even greater participation and reduce unrecovered losses by 50% compared to the base case for a similar subsidy cost. Therefore, either of these program modifications would be better on economic efficiency grounds than the current type of program. Which one to adopt would depend on whether government insurance subsidies could be continued at the current level. Either would allow the cost duplication for disaster payments to be eliminated.

Summary

These results indicate that federal crop insurance participation can be increased — in an area where it has been historically low — in a manner that provides adequate yield risk protection at reduced government cost. Implementation of the changes proposed here would require new methods of farmer classification and ratemaking as well as modification of current insurance contract designs.

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Table 4. Alternative Disaster Assistance Programs ($) for Tippecanoe County, Indiana in an Average Year

	Participation Rate (%)	Total Government Cost ($)	Premiums Paid by Farmers	Expected Value of Losses Covered	Farmer Unrecovered[8] Losses
No Government Program				0	120,403
Disaster Payment:					
County-Triggered Disaster Payments; 65%	100	27,356	———	27,356	93,047
County-Triggered Disaster Payments; 80%	100	67,887	———	67,887	52,516
Farm Yield Insurance:					
Current Program[9]	44	92,961	213,376	306,337	37,461
Improved Information and Contracts[10]	69	26,314	263,141	289,455	30,715
Improved Information and Contracts[10] and 15% premium subsidy	84	80,271	272,920	353,191	15,358

8 *Expected losses for yields below 65% of average.*
9 *FCIC premium; a 30% subsidy; highest yield guarantee is 75%; yield risk classified by average yield; a loss ratio of 1.2.*
10 *Modeled fair premiums; highest yield guarantee is 85%, yield risk classified by both average yield and yield variability; a loss ratio of 1.1.*

Live Hog Futures Lack Forecast Accuracy

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Live hog futures have become an important part of the pork industry since their introduction in 1966. Futures markets have several important economic functions which help our market-based economic system operate more efficiently. First, futures markets are important collection points for information regarding supply and demand factors critical to price determination. Secondly, futures markets not only collect information, but also evaluate the anticipated price impacts from changing information on a day-by-day basis. Third, futures markets provide a mechanism to allow price risk to be transferred from those who want to reduce their risk to those who seek price risk for the chance of profits. Finally, futures markets are viewed by many as market-determined price forecast. This article will focus on the accuracy of live hog futures prices as a price forecast.

A Guide To Producers and Retailers

Observations of live hog futures prices are used in the industry in many ways to direct both production and consumption. It is clear that pork producers and pork wholesalers and retailers use futures market prices as a guide in some of their decisions. Producers' observations of futures prices help guide production decisions. For example, when the June futures price is trading at a sharp premium to the May cash price, the producer can observe that the "best judgement" of the futures market is that prices will rise into the next month. In this situation, a producer may decide to keep hogs on feed somewhat longer to earn a potentially higher price in June. Producers also use futures price observations in their judgements about expansion or contraction of their herds. Live hog futures are traded for 12 to 14 months into the future. This period exceeds the approximately 10-month production period from breeding to market. Thus, high prices for futures 12 months in advance can stimulate production, while low prices can stimulate hog liquidation.

Retailers also use price signals sent from live hog futures. For example, retailers must plan meat features weeks or even months in advance. They attempt to feature meat products which are more moderately priced relative to other meat products during certain time periods. Their observations of futures prices help provide clues as to the market's anticipation of which meat species will provide the best featuring opportunities at specific times.

Interestingly, most large producers and retailers use futures price observations in decision making, but many do not directly buy or sell futures; rather, they observe the price forecasting information provided by the market. Exactly how accurate are the live hog futures as a price forecast?

1980s Decade Tested

To test the forecast accuracy of live hog futures, we used all hog contracts which expired in the 1980s as a base. Thus, there were 10 years for each contract month. For example, during the decade, there were 10 February contracts, spanning the February 1980 contract through the February 1989 contract.

Futures traders attempt to anticipate the actual price of live hogs at the delivery point for the specific contract delivery month. Therefore, the average daily settlement price during the delivery month was used as the "correct" or final price. This final price was then compared to the average monthly settlement prices for each month prior to expiration. For example, if the February 1980 contract averaged $50 during the February expiration month, this was compared to an average price of say $48 for trading in January of 1980. In this example, the futures market had a -$2 error one month before expiration.

For each of the 10 years, these errors were computed for the 12-month period prior to expiration for each contract. Then, these monthly errors were averaged over the 10-year period. Two simple statistical measures are used to evaluate forecast accuracy: bias, and the standard deviation of the errors.

Downward Biased and Highly Inaccurate

In general, live hog futures during the decade tended to be biased to the low side and not very accurate at forecasting the future. However, there were considerable differences by contract, and by the length of time prior to expiration. This evidence is provided in Table 1.

For example, in the table, observe the February contract 10 months before expiration. The bias over the 10 contracts traded in the 1980s was a negative 47 cents per hundredweight. This means that, on average, in the month of

Table 1. Live Hog Futures Bias and Variability by Contract and Month Before Expiration ($/cwt.), Averages For 1980-1989

Futures Month		Months Before Expiration 12	11	10	9	8	7	6	5	4	3	2	1
Feb	Bias	-0.49	-0.86	-0.47	-0.23	0.02	-0.14	0.15	0.56	-0.12	0.63	0.3	0.41
	sd	6.44	5.54	5.27	4.74	5.21	3.22	2.62	3.66	4.02	4.37	4.8	2.31
April	Bias	0.75	0.77	1.06	1.08	1.07	1.68	0.82	1.34	1.15	1.47	0.52	0.12
	sd	7.29	6.9	7.06	5.35	3.96	5.26	6.05	6.97	7.59	5.67	5.01	3.08
June	Bias	-3.19	-2.84	-2.82	-1.85	-2.79	-2.22	-2.37	-1.54	-2.17	-2.32	-2.34	-1.2
	sd	8.06	7.02	6.72	7.39	7.64	8.69	9.4	8.25	7.6	6.37	4.75	2.64
July	Bias	-3.43	-3.37	-2.43	-3.13	-2.62	-2.76	-1.94	-2.43	-2.58	-2.5	-1.37	-0.76
	sd	7.23	7.1	7.44	7.76	8.42	8.89	8.2	8.05	7.46	7.27	6.05	3.65
Aug	Bias	-5.1	-4.2	-4.75	-4.29	-4.41	-3.46	-3.92	-4.1	-4.95	-2.95	-2.47	-2.37
	sd	8.05	8.27	8.55	9.16	9.86	9.19	9.04	8.39	8.7	7.85	6.57	2.56
Oct	Bias	-1.03	-1.61	-1.83	-1.34	-1.76	-2.02	-1.6	-0.88	-0.75	-1.35	-0.35	-0.37
	sd	7.54	8.01	8.51	7.65	7.75	7.24	8.37	7.66	6.96	3.87	4.06	3.71
Dec	Bias	-2.32	-1.73	-2.04	-2.25	-1.8	-1.21	-0.91	-1.4	-0.92	-0.91	0.01	-0.77
	sd	8.57	7.21	7.4	6.13	7.95	7.34	7.29	5.59	6.19	-6.21	6.85	2.55

sd is the standard deviation

April (10 months prior to February), the February futures averaged 47 cents lower than the final February price. This is a moderate downward bias. The standard deviation for this same example is $5.27 per hundredweight. This helps evaluate how badly the futures missed the final price, either on the high or the low side. For this particular month, the 10 yearly errors in dollars per hundredweight from 1980 to 1989 were as follows: +4.72, -2.55, +5.96, -5.10, -.94, +3.59, +3.88, -8.19, -7.88, and +1.86. For this group of numbers, there are five positive numbers when the market overpriced, and five negative numbers when the market underpriced. However, the underpriced errors tend to be larger than those of the overpriced years. This large underpricing in certain years is a characteristic related to hog futures. The large underpricings are generally in cycle high price years.

In a normal distribution, adding one standard deviation and subtracting one standard deviation provides about a two-thirds odds range. Applying this principle to the $5.27 standard deviation in the example suggests that about two-thirds of the errors were between -$5.27 and +$5.27 per hundredweight. Alternatively, about one-sixth of the time the errors would have been greater than +$5.27, and one-sixth of the time greater than -$5.27.

Some interesting observations regarding bias and forecast accuracy can be made from Table 1. The February and April contracts tended to have a positive bias of over-predicting the final futures price. The strongest positive bias was in the April contract with some months well over a dollar. However, the remaining contracts from June through December tended to have a negative bias, with the largest occurring in the June, July, and August contracts. August in particular had a downward bias which was as much as $5 per hundredweight. These are indeed very large downward biases that are detrimental for producers who hedge.

Errors were also very large in the summer months. Standard deviations of $7 to $9 per hundredweight were common in the summer contracts. It is also important to note that both the bias and the errors tend to be smaller as the contract approaches maturity. This makes sense, as the knowledge about the ultimate "correct price" should be better one month before maturity than 12 months before. However, while errors tended to be moderate for one month before maturity, two months before maturity the errors were in the range of $4.06 to $6.85 per hundredweight.

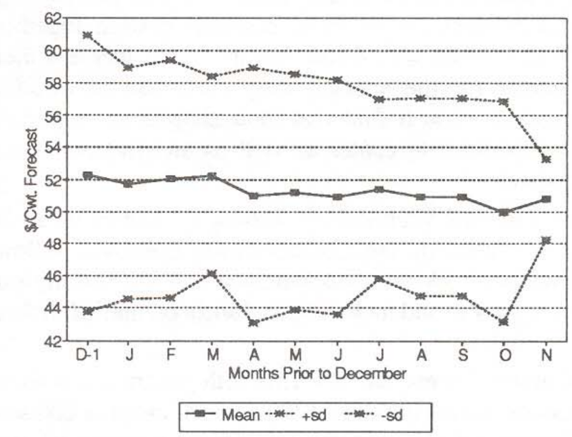
Using Hog Futures in Decisions

The pork industry uses futures price observations in a number of key decisions as outlined in the introduction. One important implication of this information is that the historical evidence from the decade of the 1980s shows live hog futures prices to be downwardly biased on average, and to be more inaccurate in price forecasting than many people may have believed.

To illustrate this point, say that in March, the December futures price quote is $50 per hundredweight. How would a hog producer or other market participant bring information about the historical accuracy into their decision making? Will hog futures be $50 in December? How large a range around $50 should the decision maker consider? From Table 1, the bias of the December futures contract nine months prior is -$2.25, and the standard deviation is $6.13 per hundredweight. Because the bias shows that the futures market historically tended to underprice futures at this point, one could add the bias to the futures quote for a mean futures price of $52.25. To this adjusted price, the application of plus-and-minus one standard deviation provides a range of $46.12 to $58.38 as a roughly two-thirds chance of occurrence. Historical errors suggest there may still be one-third odds that the final futures price will be outside this range. This indeed is a wide range, but it is based upon historical errors.

An example of this application to a futures price quote is shown in Figure 1. For illustration, it is assumed that the December futures price remained at $50 for a 12-month period prior to expiration. The mean line in the figure adjusts for monthly bias, and the upper and lower lines reflect the plus-and-minus one standard deviation rule. The two-thirds odds price ranges are large. For the prior December, which is 12 months before maturity and shown as D-1, the range is from $43.75 to $60.89.

Figure 1. Price Estimates with $50 December Futures and Average Historical Errors from 1980-1989



Conclusions

The live hog futures market tended to be downwardly biased and more inaccurate than many realized during the decade of the 1980s. The downward bias was greatest for contracts maturing in the summer, with the August contract bias reaching as much as -$5.10 per hundredweight. Generally, the longer the period prior to maturity, the greater the downward bias. Standard deviations of forecast errors for the live hog futures market were as low as a few dollars close to maturity, and as much as $9 per hundredweight for certain contracts and time periods.

When this historical accuracy of the futures market is projected to a current futures price quote, the price ranges are very wide. The implication is that while the futures market attempts to make an accurate forecast through the efforts of well informed traders, no one is truly able to peer into the future and derive an accurate forecast. Therefore, producers and others in the pork industry who observe and use futures quotes in their decision making need to consider these inaccuracies, and certainly also include other types of information in their decision making process.

While live hog futures have been shown historically to have sizeable inaccuracy, this does not necessarily mean they will have these same errors in the future. It is also important to remember that even if futures prices are not very accurate forecasts, they can still serve as a risk-shifting mechanism. In addition, while the futures have been shown to have difficulty accurately predicting prices, so do other market analysts, authors included.

Schedule for 1991 Indiana Farm Management Tour
Miami and Wabash Counties
June 19 and 20, 1991

Wednesday, June 19

1) **Doud Orchard** — Tour begins at 8:30 a.m., interview at 9:30 a.m. The contribution of farm diversification to a profitable business has been stressed often in recent years. The visit to this 67-acre Miami County orchard will provide an opportunity to explore many important aspects of farm diversification and successful orchard operation. Join us to learn from experienced managers how niche markets can be identified and profitability filled.

2) **Jerry Renbarger Farm** — Tour begins at 10:30 a.m., interview at 11:30 a.m. Jerry Renbarger is farming with his son and his son-in-law. Come hear why these strong, independent people have decided to farm together. They'll share with us the factors to consider and their secrets for the success they have had in farming together. You'll find that their shop is an important communication center as well as an effective repair center.

3) **Southwood Elementary School** — Lunch at 12:30 p.m. Slides of the Curless swine operation follow. Luncheon tickets may be purchased for $5.00 at any tour stop prior to and including the luncheon until all tickets are sold.

4) **Curless Farms, Inc.** — This fifth-generation Wabash County farm combines 1200 acres of crops, a 200 sow farrow-to-finish operation, and a 60 commercial cow herd with a full-time bookkeeping/tax service. Learn how Randy monitors performance and identifies problems through his records. A slide tour of the hog operation and a visit to a unique office utilizing old barn timbers and farm antiques highlight this tour stop.

5) **Dean/Barry Eppley** — Pleasant Home Farm Inc. Tour and interview begin at 3:30 p.m. Dean and Barry Eppley will demonstrate the 1991 version of their 16-row planter. They are veteran ridge-tillers on 2000 acres. Come and see their planter's new features: three Rawson coulters per row up front, provision for starter fertilizer up front on one coulter, and Case IH cyclo air seed delivery to Case IH planter units on an Orthman toolbar, hung under a "Pushmobile" tractor. Also, hear Barry describe his experiments with organic farming. The Upper Tippecanoe Water Quality Project and other conservation activities will also be reported at this tour.

Thursday, June 20

6) **Bechtold Farms Inc.** — Tour begins at 8:30 a.m., interview at 9:15 a.m. This is a four-generation grain and livestock family farm in Wabash County. Duane, Bob, and Bret are farming over 1850 acres and feeding 500 to 750 steers annually. The corporation rents 1120 acres from 11 landlords under various leasing arrangements. There are no additional full-time employees. The Bechtolds have achieved a high level of labor efficiency by substituting machinery for labor. Come and see which of their management practices you can take home and apply to your farming operation.

7) **Ringel Farms, Inc.** — Tour begins at 10:30 a.m., interview at 11:40 a.m. Herb Ringel and his son, Craig, operate Ringel Farms, Inc. They farm 1100 acres, produce about 1500 market hogs from a farrow-to-finish enterprise, and finish 500 heifers each year, while using less than one month of hired labor. The farm is characterized by high labor efficiency and steady growth. Learn how the third generation of this successful farm family is being included in the decision-making process.

8) **Chamberlain Farm** — Lunch at 12:30, interview at 1:15 p.m., awards to host families at 2 p.m. Luncheon tickets may be purchased for $5.00 at any tour stop prior to and including the luncheon until all tickets are sold.

   See why this will be the **fourth** time the Chamberlain farm has been chosen for a Farm Management Tour visit (previous tours were in 1939, 1952, and 1967). Observe and hear about the management secrets that have contributed to the success of the Chamberlain farm for more than 60 years. Learn how and why this crop-hog-cattle farm has changed since 1930 and about plans for the future.

➤ Following the tour of the Chamberlain Farm, Agricultural Economist J. William Uhrig will present an outlook update.

➤ Luncheon tickets for each day may also be purchased prior to June 14 by mailing a check payable to IFMA to Don Pershing, Ag Economics Dept., Purdue University, 1145 Krannert, W. Lafayette, IN 47907-1145. Specify the number of tickets and the day for the luncheon. Cost of each luncheon is $5.

Note: You may want to bring a lawn chair.

Crop Intensification vs. Production Of A New Crop To Raise Farm Income?

*S. A. Bruner, Agricultural Statistician, Alabama Agricultural Statistics Services; G.F. Patrick, Extension Economist and C.L. Dobbins, Extension Economist**

Many midwestern farmers encountered financial difficulties in the 1980s because of high interest rates, sharp reductions in crop returns, and the decline in land values. This led farmers to explore ways of increasing profitability. Additional uncertainties related to weather and prices (the droughts of 1983 and 1988) have also focused farmers' attention on the variability of production and income. Interactions of price and yield variability with the debt level of the farm are important determinants of financial progress or vulnerability of the farm.

Two common methods of increasing crop returns are: 1) more intensive production of current crops, and 2) diversification into the production of alternative crops. In the sandy soils of northern Indiana, irrigation provides one method of intensifying corn production and has the additional benefit of decreasing yield variability. Contract production of cucumbers for processing is an alternative crop with possibilities in the area because of the closeness of processing plants.

What is the potential of irrigated corn and processing cucumber production on northern Indiana farms? Specifically, 1) how is the level and variability of net farm income affected by irrigated corn and processing cucumbers? 2) how do the investments necessary for these activities affect cash flow, net worth accumulation, and the probability of survival? and 3) how does the level of debt affect these alternatives?

**Appreciation is expressed to Jim Simon, Howard Doster, and Chris Hurt for assistance and helpful comments at earlier stages of this project.*

Procedures

A whole-farm simulation model was used to analyze the effects of irrigated corn and cucumber production alternatives on a representative northern Indiana farm. The model accounts for annual production expenses, borrowing, debt repayment, cash flow, replacement of machinery and equipment, family living expenditures, and federal income taxes over a 10-year planning period. Each production alternative was simulated for a 10-year period with 50 replications. This allowed information about both the average value and variability of economic variables to be obtained. Each alternative was simulated under two debt levels for the farm to assess the interactions between yield and price variability and the level of debt.

Yield and Price Levels

Table 1 summarizes the yield, direct costs, operator labor requirements, and price data used in the model. Both the average levels of prices and yields and the distribution of outcomes about these averages were used in the analysis. Since weather outcomes have such a major impact on yields, the correlation among yields was also included in the analysis. The correlation measures the degree to which yields move together. For this research, there was a positive correlation between the yields of all crops except for cucumbers. For cucumbers, there was a negative correlation. This means that an increase in corn or soybean yield is associated with a decrease in cucumber yield. Since cucumber yields move in a direction opposite the other crops, this makes them a good crop to use in trying to stabilize income fluctuations.

Table 1. Yields, Direct Costs, Operator Labor Requirements, and Prices of Crop Enterprises Analyzed.[1]

Enterprise	Yield (bu/A)	Yield Variation[5] (%)	Direct Costs[6] ($/Acre)	Operator Labor[7] (Hr./A)	Price ($/bu.)	Price Variation[5] (%)	Return Above Direct Costs ($/Acre)
Dryland Corn[2]	105	27.2	107.22	3.7	2.25	16.7	121.03
Soybeans[3]	42	13.7	84.03	2.8	6.00	19.9	167.91
Irrigated Corn[2]	166	12.7	152.81	4.8	2.25	16.7	221.82
NHH Cucumbers[4]	517	20.1	1,247.87	10.0	2.98	4.7	275.28
IHH Cucumbers[4]	625	12.2	1,497.96	10.0	2.98	4.7	394.51
IMH Cucumbersd[4]	283	12.1	455.52	10.0	2.48	4.1	276.32

1 *Price and yield variability were based on data from the years of 1975 to 1984. For further information on how these coefficients were developed, see Samuel A. Bruner, "The Potential Diversification of Northern Indiana Cash Grain Farms to Include Irrigated Corn or Cucumbers for Processing." Unpublished M.S. thesis, Purdue University, August 1989.*

2 *Dryland and irrigated corn yields were based on experimental plot and variety trial data for South Central Michigan on Montcalm-McBride soils. Prices were based on marketing year average prices for Indiana.*

3 *Soybean yields were based on experimental plot trials conducted in Northern Indiana on Runney-Mede soils. Prices were based on marketing year average prices for Indiana.*

4 *Cucumber yields and prices were estimated with help from T. Meredith of Pilgrim Farms.*

5 *Yield and price variations were measured using the coefficient of variation which measures the variation relative to the mean in percentage terms. If prices and yields follow the normal or bell-shaped distributions, two-thirds of the years would fall within a range of plus and minus the percentage indicated.*

6 *Direct costs reflect the additional hired labor required for irrigation and the contract labor necessary for hand-harvested cucumbers.*

7 *Operator labor represents time in actual field operations and management by the operator and/or family labor.*

By using corn planting and cultivating equipment, non-irrigated hand-harvested cucumbers (NHH) could be produced with no additional investment in machinery or equipment. In addition to investments in irrigation equipment and wells, irrigated cucumbers which are hand-harvested (IHH) or machine-harvested (IMH) would involve the use of a $10,000 precision air planter to obtain the proper seed placement at the higher required populations. A used harvester costing $11,000 would be necessary for the mechanically-harvested cucumbers (IMH).

The irrigation system for cucumbers and corn was assumed to be a 160-acre high-pressure center-pivot irrigation system which will actually irrigate 132 acres. The system had an estimated installation cost of $34,000 for the pivot, $32,000 for two wells and pumps, and $9,000 for a diesel engine. Annual ownership costs would be about 16% of the system's cost or $12,000.*

Using average yields and prices, irrigated corn and the cucumber alternatives provide a larger return above direct costs than either dryland corn or soybeans. The reductions in yield variability for the irrigated crops and the price variability of contract cucumbers indicate that returns might not only be higher but also more stable.

Representative Farm

The representative farm situation was a northern Indiana farm of 750 tillable acres, 300 acres of owned land, and 450 acres leased under a customary 50-50 share arrangement. For the base farm situation, corn and soybeans were assumed to be grown in rotation. The soil types are Montcalm-McBride and Runney-Mede. Montcalm-McBride is a light sandy loam which is well-drained soil with thin bands of finer soil in the substructure and suitable for irrigation. Runney-Mede is a soil with a sand substructure, high in organic matter and poorly drained. The crop acreage for the base and other alternatives were as follows:

Crop	Base Farm	Irrigated Corn	Dryland Cucumbers	Irrigated Cucumbers
	----------	----------	Acres ----------	----------
Soybeans	350	350	300	218
Dryland Corn	360	228	360	360
Irrigated Corn		132		
Dryland Cucumbers			50	
Irrigated Cucumbers				132
Set-Aside	40	40	40	40
Total	750	750	750	750

The farm was a sole proprietorship which had the equivalent of two full-time workers provided by the family. Timely planting and harvest of the corn and soybeans was assumed.

Initial Financial Positions

Two financial situations were developed. In both cases, the value of owned cropland and buildings was $344,500 and the total assets were $490,029. One financial situation represents a moderate debt position with a debt-to-asset ratio of 0.37. Total debt was divided between $131,000 in real estate debt and $50,000 in intermediate term debt and accrued liabilities. The second financial situation represents a high debt position with a debt-to-asset ratio of 0.66. Total debts for this situation were divided between $240,000 in real estate debt and $81,000 in intermediate debt and accrued liabilities.

Because of differences in financial strength, the farms faced different borrowing restrictions. Interest rates for operating funds and intermediate assets were 10.25% and 11%, respectively, for the farm in the moderate debt position. The high debt farm faced interest rates of 11% for operating loans and 13% on intermediate assets. Refinancing was permitted, but neither farm could sell land to remain solvent.

The additional investments necessary for corn irrigation and cucumber production were financed as intermediate term debt for farms in both financial positions. For the moderate debt situation, the 0.37 debt-to-asset ratio increased to 0.45 with irrigation and to 0.47 with irrigation and mechanical cucumber harvesting. For the high debt situation, the debt-to-asset ratio increased from 0.66 to 0.71 with irrigation and to 0.72 with irrigation and mechanical cucumber harvesting.

Economic Scenario

Asset values and production costs were assumed to increase at a 4% rate of inflation. It was assumed that an agricultural policy with set-asides, target prices, and deficiency payments similar to the 1988 feedgrain and wheat program would continue with the farmer participating. For a farmer with irrigated corn, the ASCS corn yield base for deficiency payments would be the same as dryland corn.

Initial average corn and soybean prices were assumed to be $2.25 and $6.00 per bushel, respectively. The initial target price for corn was $2.84 per bushel. The mean prices for corn and soybeans, as well as the target prices for corn, increased at the 4% rate of inflation.

Three cases were analyzed for the irrigated corn alternative. In the first case, the 60 bushel per acre yield increase achieved in the experimental plots was assumed. For second and third corn irrigation alternatives, yield gains of 45 and 30 bushels per acres were assumed.

Results

The simulation results are reported in Table 2. The base farm organization provided an average real net farm income of $31,300 and $13,200 for the moderate and high debt situation respectively. Both financial situations encountered cash flow difficulties—62.8% of the years for the moderate debt situation and 95.2% of the years for the high debt situation. All replications of the moderate debt farm survived, but the probability of survival was only 76% for the high debt situation. The average real net worth increase was $165,100 for the moderate debt situation compared to an average of $58,700 for the high debt level farms which

* *P.R. Robbins, E.E. Carson, R. Z. Wheaton, and J. V. Mannering, "Irrigation of Field Crops in Indiana," Purdue University Cooperative Extension Service, ID-119, 1977.*

remained solvent (only 76% of these farms survived to the end of the 10-year period).

Introduction of irrigated corn with either 60 or 45 bushel yield increases resulted in substantial increases in average real net farm income and reductions in income variability relative to the base organization. However, the percentage of years with cash flow deficiencies changed only slightly with the 45-bushel increase. The probability of survival in the high debt situation increased from 76 to 98%. The real net worth increases were also substantially greater with 60 to 45 bushel yield increases from irrigated corn than in the base case.

If only a 30-bushel per acre increase in average corn yields resulted from irrigation, the economic results were less favorable. For the moderate debt situation, average real net farm income was somewhat lower (about $1,700 less) than for the base case, indicating the increase in yield was not large enough to cover the increased debt and production costs associated with the irrigation alternative. The percentage of years with cash flow deficiencies was larger than the base case. For the high debt situation there was a very slight increase in average real farm income, about $200, and the variation in income was reduced. As with the moderate debt situation, the percentage of years with cash flow deficiencies was larger than the base case. For all irrigation alternatives, both financial situations had larger increases in real net worth for all irrigation alternatives other than the base case. These real net worth increases were greater for the high debt situation than for the moderate debt situation, illustrating the importance of managing income fluctuations when the farm business is in a highly-leveraged financial position.

The cucumber alternatives provided mixed results. For the moderate debt situation, all three cucumber alternatives resulted in a slight increase in average real net farm income relative to the base case. However, the variability of income was also slightly higher with irrigation. The percentage of years with cash flow deficiencies was lower for the hand harvest alternative (NHH), about the same for the irrigated hand harvest alternative (IHH), but higher than the base for the irrigated mechanical harvest alternative (IMH).

For the high debt situation both hand harvest alternatives, NHH and IHH, provided higher and less variable average incomes than the base organization. However, the irrigated mechanical harvest (IMH) alternative resulted in a lower and more variable average income than the base organization. The probability of survival in the high debt situation improved for both of the hand harvest alternatives relative to the base organization, but was sharply lower, only 58%, for the IMH alternative.

All cucumber alternatives provided increases in real net worth larger than the base organization for the moderate debt situation. The irrigated alternatives, IHH and IMH, had larger increases than the nonirrigated alternative, NHH. This increase represents approximately the value of additional investment in the irrigation system. Although the cucumber alternatives resulted in larger net worth increases than for the base case, the increases were not as large as for the 60 and 45 bushel irrigated corn situations.

Increases in average net worth of the high debt situation in Table 2 must be interpreted with caution. While all of the cucumber alternatives provided an increase in real net worth greater than the base case, only 58% of the cases remained solvent for the entire 10-year period for IMH cucumber alternative. The net worth change of all farms, including those forced to liquidate, would be substantially lower. Both NHH and IHH cucumbers provided a greater average net worth increase and higher probability of survival than the base case.

Table 2. Economic Results of Alternative Farm Enterprise Organizations for Moderate and High Debt Level Farms.

Variables	Base	Irrigated Corn 60 bushels	Irrigated Corn 45 bushels	Irrigated Corn 30 bushels	Cucumbers NHH	Cucumbers IHH	Cucumbers IMH
Moderate Debt Level Farm							
Ave. Real Net Farm Income[8] ($1,000)	31.3	39.3	34.8	29.6	32.9	33.7	33.6
Variation in Real Net Farm Income[9] (%)	43.3	32.1	35.7	41.4	41.0	44.4	45.9
Cash Flow Deficiencies[10] (%)	62.8	45.6	61.0	77.0	53.6	62.6	68.8
Probability of Survival[11] (%)	100	100	100	100	100	100	100
Real Net Worth Increase	165.1	273.6	243.0	208.3	182.6	236.6	237.9
High Debt Level Farm							
Ave. Real Net Farm Income ($1,000)	13.2	22.5	17.6	13.4	15.8	17.3	10.2
Variation in Real Net Farm Income[9] (%)	126.1	59.5	76.9	102.5	89.9	87.9	185.7
Cash Flow Deficiencies[10] (%)	95.2	91.6	95.8	98.2	91.0	92.8	98.2
Probability of Survival[11] (%)	76	98	98	80	100	88	58
Real Net Worth Increase[12] ($1,000)	58.7	205.6	147.1	118.3	114.7	150.3	74.4

8 Real net farm income is net cash income minus depreciation adjusted for inflation.
9 Variation in farm income is measured using the coefficient of variation.
10 Percentage of years in which cash is deficient without borrowing.
11 The probability of survival is the percentage of the 50 replications in which the farm was not forced to liquidate.
12 The net worth increase for this financial situation is for only those businesses that survive to the end of the 10-year period. Firms were forced to liquidate if equity dropped below 25 percent of total assets.

Summary

The results indicate the intensification of current crop production, irrigated corn, provided a better alternative than diversification into cucumber production. While cucumber production generally did provide some increase in net farm income and reduction in cash flow deficiencies relative to the base organization, the improvements were less than could be achieved through irrigated corn.

With irrigated corn production, it is possible to have cropping alternatives which both increase average income and reduce income variability. If producers can expect to achieve irrigated corn yields of 45 or 60 bushels more than dryland yields, net farm income can be increased and the variability of income and frequency of cash flow deficiencies reduced for farms with moderate debt levels. However, the size of the yield increase is critical in determining whether investments in irrigation are profitable. If irrigated corn yields are only 30 bushels per acre more than dryland corn production, there is little or no increase in net farm income and the variability of net farm income is only slightly less. Because of the additional investment required for irrigation, cash flow deficiencies with a 30-bushel increase become more frequent.

The financial position of a farm had relatively little effect on the ranking of the irrigated corn alternatives considered in this study, but the situation is considerably different with respect to cucumbers. For the moderate debt farm, the cucumber alternative with the largest average real income was IHH. However, the hand harvest alternative provided reduced income variability and frequency of cash flow deficiencies. For the high debt situation, the irrigated hand-harvested cucumbers continued to provide the largest income among the cucumber alternatives, but also provided the lowest income variability. If the farm were to go into cucumber production and is highly leveraged it would probably select NHH, the nonirrigated hand-harvested alternative, because of the lower financial risk and higher probability of survival. The moderate debt farm, in contrast, would probably select one of the irrigated cucumber alternatives, either IHH or IMH. However, both of these irrigated cucumber alternatives involve lower and more variable real net farm income than some irrigated corn alternatives.

The results of this study suggest that there are diversification alternatives for cash grain farmers in northern Indiana, but the more intensive production of existing crops is a better alternative. Yield increases obtained and financial position of farms are important factors in determining the most viable alternatives. Although not examined in detail, operational expertise and available labor could also have substantial impacts on alternatives selected.

1991 Top Farmer Crop Workshop

The 24th Annual Top Farmer Crop Workshop will be held at Purdue's West Lafayette campus beginning Sunday, July 21 and running through Wednesday, July 24, 1991. The cost for the workshop is $160 for the first person, and $60 for each additional person. Almost 7,000 Cornbelt farmers from 10 states have attended this workshop since its inception in 1968, and last year, a record number of farmers participated.

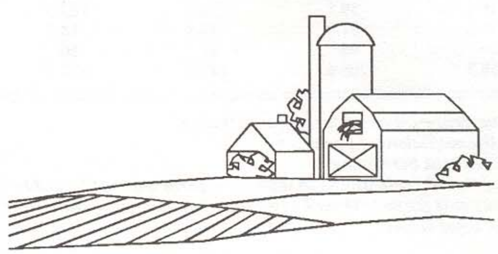
Nationally-known speakers on this year's program include: Bill Richards, Chief of the United States Soil Conservation Service; Louis Thompson, Associate Dean Emeritus of Iowa State University; John Marten, staff economist with *Farm Journal* magazine; and Sonny Beck, president of Beck Hybrids.

The schedule for the workshop is loaded with the best in technical and economic topics to meet your needs. The program emphasizes tillage concerns, as well as conservation and water quality. Participants will hear farmers from five states share their experiences.

The workshop's goal is to help you increase your personal productivity and your competitiveness. The workshop facilitators recognize that there's no good alternative to being a low cost producer. Their purpose is to help you achieve that goal on your own farm.

Learn the latest in crop and machinery technology. You'll be able to work with the Purdue B-10 computer budget to "test before you invest" in these changes on your own farm. Four hands-on computer sessions are planned so that you can try out the budget yourself.

To register or for more information, call D. Howard Doster at (317) 494-4250.



Reforms on Private Polish Farms: Can the Five-Acre Family Farm Survive?

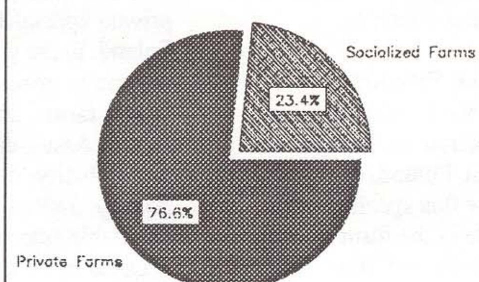
Jozef Kania, Agricultural Economist at The Agricultural University in Cracow, Poland and visiting professor at Purdue University in 1991

Polish agriculture is a mixture of large socialized farms and small private family farms. In sharp contrast to other Eastern block countries, former governments were never able to fully collectivize Polish agriculture, even though the rest of the food system, including farm inputs and the food processing sector, was incorporated into central planning.

In Poland, agriculture employs about 28% of the labor force and over 40% of the population reside in the rural countryside. Nearly 60% of Poland's land is agricultural.

Private farms operate 76.6% of the agricultural land. The remaining 23.4% is in socialized farms. (See Figure 1.) The average size of the 2.8 million privately owned farms in 1987 was only 12.8 acres. Over half were 12.5 acres or smaller. In the last 30 years, we received much criticism from economists because of our farm structure. Table 1 shows an increase of the smallest farms and the largest farms. For example, farms that were one to five acres increased from about 23% of all farms in 1960, to nearly 30% in 1987. Farms that were over 37 acres in size represented about 3% of all farms in 1960 but increased to about 7% in 1987. It is interesting to note that the largest farms still represent less than 10% of all farms, but they control about one-fourth of the agricultural land. Facilitating this consolidation into more efficient sizes of farms will be a primary focus of future agricultural policy.

Figure 1. Polish Land Control by Type of Farm



Private farms supplied about 85% of total agricultural production. The principal crops and their percentage of cultivated land are: rye 20%; wheat 14.8%; potatoes 13.4%; fodder beets 9.8%; barley 8.7%; oats 5.9%; and sugar beets 2.9%. Average yields were poor compared to Western Europe because of infertile soil, insufficient use of fertilizer, and inadequate mechanization. Table 2 compares average yields for Poland, the EEC, and the United States. There were 855,000 tractors in 1985 in Poland, of which 667,000 were owned by private farmers. Most of these tractors were purchased used from the socialized farms. This inventory represents an average of one tractor for four private farms. Poland has become an importer of grains instead of an exporter, particularly wheat. Imports of wheat and corn amounted to 6.9 million tons in 1980, but shortages of foreign exchange since have limited imports to about 2 million tons annually. Polish agriculture produces very little high-protein feed supplements. Thus, livestock feed efficiency is poor. Because of the short growing season, we have little production of corn, and no commercial soybean production. Production of rapeseed, whose protein meal is suitable for livestock, is expanding. We have some production of corn cob mix, which uses the plant and the immature ear as a protein source, but this too is limited by a shortage of appropriate grinding machines.

Former governments encouraged the development of livestock production through increased fodder supply from the state monopolies, through improvement in breeding stock, and through partial tax relief for raising hogs. Emphasis has been placed on producing both hogs and sheep.

Milk Production on Private Farms

Milk production on private farms is the least developed and the most extensive livestock enterprise in Poland. In total production, Poland ranks fifth in the world, but yield per cow ranks twenty-third in the world. Production is also

Table 1. Number, size, and structure of private farms in Poland.

Specification	1960	1980	1987
Number of private farms in thousands	3216	2896	2778
Average size of farms in acres	10.6	12.1	12.8
		%	
1.00-5.00 ac.	23.1	30.0	29.6
5.01-12.50 ac.	31.1	29.5	27.6
12.51-17.00 ac.	13.2	12.8	12.3
17.01-25.00 ac.	12.9	13.0	12.9
25.01-37.00 ac.	7.9	9.7	10.7
37.01 ac. and more	2.8	5.0	6.9

Source: Rocznik statystyczny. GUS, Warszawa 1969, 1988.

Table 2. Average Yields in Comparison With EEC Countries and USA, 1988/89

Crops		Poland	EEC	USA
Wheat	bu/A	52.4	72.4	31.1
Rye	bu/A	37.7	45.7	24.8
Barley	bu/A	45.6	62.0	38.6
Oats	bu/A	39.3	46.8	39.1
All Four Grains	bu/A	43.1	66.0	34.9
Potatoes	cwt/A	165.7	330.0	282.0
Sugar beets	tons/A	15.3	22.8	19.1

Source: Agricultural Statistics, USA, 1989 very seasonal. For example, milk production in the winter is 52.2 million pounds per day, but in the summertime daily production is 95.4 million pounds.

In Poland, private farms raising cows tend to be very small, especially in the Southern region. The Southern region is much different than other areas of Poland. Farms there have an average size of under 7.5 acres. Additional characteristics of the Southern region are: more part-time farming, a smaller degree of mechanization, a smaller scale of livestock production, smaller mixed livestock buildings, a higher percentage of pasture, and a large population of residents and tourists.

Approximately two million farms in Poland were raising cows in 1984. On these farms, about 65% had either one or two cows, and 29% had two to five cows. See Table 3. In the Southern region, 87% of the farms had either one or two cows. Farms with six or more cows represented only 6% of the entire country's farms, but less than 1% of the farms in the Southern region. In addition to small farms, there is a lack of milk marketing and processing capacity throughout the country. As an example, only 2% of milk producers and 40% of local dairy stations have equipment to refrigerate milk. These numbers reflect the magnitude of the problem in milk production and processing for our country.

Intensified Livestock Farms: More Efficient

In the late 1970's, a movement towards specialization and concentration of livestock production took place on private as well as socialized farms in Poland. New and remodeled structures were the basis for this specialization. This process was supported by the state in the form of debt capital with very low interest rates, with building plans, material allotments, and help from local extension offices. Farmers received tax credits if they increased their amount of agricultural land and production. This process, of course, was controlled by the state, so farmers were afraid to build large new buildings or buy too much land because of the general government goal to socialize more private farms at that time. During the mid-to-late '70s, construction was completed on approximately 100,000 specialized buildings for cattle, hogs, sheep, and poultry.

The National Institute of Agricultural Economics in Warsaw and our University Department of Agricultural Economics in the Southern region investigated this intensification process. Our goal was to evaluate the future prospects for these specialized farms from a social and economic prospective.

Table 3. Structure of private farms raising cows and other production factors.

Specification	Poland (1984)	Southern region: Cracow, Tarnow, Nowy Sacz (1985)
Number of farms with cows	2,000,000	223,100
% of total with:		
1 to 2 cows	64.6%	87.4%
2 to 5 cows	29.3%	12.3%
6 and more cows	6.1%	0.3%
Yield of milk per cow in pounds	7000	6570
Number of cows per 100 acres	14.4	18.1
Production of milk per acre in #	817	1073
Purchase of milk per cow in pounds	4353	2170

Source: Kania, J. (1990).

Economic results clearly show there is a distinct advantage for the specialized private farms compared to average private farms. As a whole, total inputs per unit of production for specialized farms compared to private farms were: 56.6% for dairy cattle; 66.5% for beef feeders; 51.4% for sheep; and 56% for swine farms. It appears that net output per work day is from 2.0 to 3.1 times higher than the average for private farms in Poland.

The advantage realized by specialized farms over total private farms in labor productivity is a result of higher efficiency of inputs, higher volume of production, higher crop yields, and lower labor requirements. Net worth of specialized farms was also two times higher than for average farms.

Individual effects of specialization were expressed in higher agricultural income per person. Social effects included higher net final production per acre and lower than average costs of agricultural products.

Similar results were reached in our investigation on private specialized farms in a specific Southern region of Poland. In the years 1976 to 1988, we observed much better economic results on specialized than on the traditional mixed farms, and also much better than on the socialized farms. Assuming dairy returns had an index of 100, the profitability of specialized livestock enterprises was: poultry 350%; hogs 225%; and sheep 180%. The least profitable enterprise of livestock production was dairy cattle because of relatively low price ratios, very high costs of buildings and equipment, and higher costs of mechanization for feed production.

Perhaps surprisingly to many Americans, the highest incomes were from the smallest farms with three to five cows and from the largest farms with 12 to 15 cows. Both of these groups of farms require high levels of inputs. The small farms require large amounts of labor. The opportunity value of labor to move into other jobs is low, thus returns are favorable for working with the small herds. The larger farms, which had 12 to 15 cows, employ much more capital. While debt capital has relatively high interest rates, the larger sized farm was able to gain substantially greater production efficiencies. Thus the increase in production efficiency for the larger sized farms offset the higher capital cost. If the farmers wish to increase their net income in the dairy business, they will need to organize larger farms with a herd size of more than 12 to 15 cows. This size will be sufficient for the use of milking equipment and for machinery to both plant and harvest the required fodder feed crops.

Many would ask why incomes tend to go down as producers increase herd size between five cows and 12 cows. This is because the small dairy farms that expand generally continue to use the same type of technology. As they increase the numbers of cows, they divert more of their plant commodity production into feed production for their cattle. On the other hand, they tend not to use more machinery and milking equipment that help larger farms make their use of labor more efficient. Consequently, they lower their total income because of the reduction in vegetable crops and other crops produced, but do not gain the efficiencies of production from the larger sized dairies.

Unfortunately, milk production does not provide very profitable returns, and intensification of many farms would require large amounts of capital. Therefore we must take into consideration these low returns and high capital inputs as we reform the dairy production sector.

The final output per acre in the private sector is increasing at the rate of about 2% each year. With this rate of increase, we expect the average private farm to reach the production level of the specialized farms in the year 1999.

Part-time Farms are Important

In Poland, there are a great number of farms of mixed income sources, called either part-time farms or peasant-worker farms. Thus, besides large economically efficient farms, there are small farms of low production capacity which supplement their income from farming with earnings from off-farm work.

Part-time farming is a subject of severe criticism based on the belief that part-time farms are characterized by a low level of production. However, the results of recent research show that the agricultural production level is not always low on such farms. Many believe that the owner of a part-time farm would be overburdened with work and would be unable to work efficiently either on his farm or in his off-farm job. This opinion has not been confirmed by our research. It appears that owners of part-time farms are efficient workers both on and off-farm.

In 1980, 27.5% of the farm operators were engaged in permanent work off the farm. These farmers are concentrated mostly in the Southern section of Poland. Future agricultural policy should not be indifferent to this group of farmers, but should introduce economic mechanisms which would activate the entire production potential of these farms, including a better use of their labor resources.

How can we better utilize their labor? Keep in mind the need for our agriculture to have structural changes which will move us to larger farms. If we do not want these changes to be more difficult and expensive in the future, we must now encourage some part-time farmers to switch to a production system which would utilize the existing labor resources in full on their farm, but yet would not require costly investments.

There are two ways available to make better use of the large labor resources on small part-time farms. One is an intensification of agricultural production. Examples of intensification would include: greater quantities of commercial concentrated fertilizers, improved seed varieties, and increased use of agricultural chemicals. The larger private farms, mechanized co-ops, or collective farms could help them with machinery services. The new processing and cold storage plants could provide incentives for the small farms, and the whole region's specialization in very labor-intensive products such as: strawberries, wild strawberries, black and white currants, raspberries, gooseberries, and green peas. Such efforts would increase production for the market as well as increase the incomes of small farms. For many years most fresh vegetables on the agricultural free market came straight from small, part-time farms located close to the cities.

The second way to increase labor productivity and incomes on part-time farms would be to encourage small farm owners to operate private workshops. These workshops would use the labor resource as well as local raw materials to produce products. Examples of these types of workshops might include production of small novelty items, production of topsoil products, forest products, and mushrooms. Since the marketing industry for many of these products is not developed, it would be the responsibility of governmentally organized industries to provide transportation of the raw materials to the rural areas, as well as transportation of the finished products into cities or to export destinations.

Because of the limited skills in marketing, the organization of these enterprises cannot rest with part-time farmers alone. A number of cooperatives as well as the food processing industry should be vitally involved. This certainly provides an important opportunity for foreign partners in joint ventures. Our experience to date for this kind of activity on small farms has produced positive effects. Efforts should be made to widen its scope and make it a common practice all over the country.

In my opinion, the future of Polish agriculture is tied with this type of movement toward commercial family farms. However, under present economic and political conditions, a speedy transfer of land from small to larger farms may not be feasible. Even in the long run, there should be a place for part-time farms which can complement the agricultural output of larger farms, and which in some regions can help the development of agriculture. Part-time farms should be seen as an opportunity to help develop the local economy in some regions.

Many Challenges Ahead

Polish people have taken pride in the fact that theirs was the only former Eastern Bloc country which saved private family farms. At present, a new democratic system of law and economics is being realized. However, movement to a market economy will be harsh for many Polish farmers because of necessary structural changes in the farm and marketing sectors. From my point of view, agricultural policy should not be focused on the whole agricultural sector, but rather on certain types of farms with good management and high production efficiency. In addition, we must begin to think more about enterprise specialization in areas where we can compete. Only economically efficient producers will survive in the new competitive conditions.

While the economic effects of specialized farms in Poland are positive, the social effects on farm families are also a concern. For many of these part-time farmers who are not able to gain the economics of size, it may be possible to intensify the use of their labor through special types of enterprises or workshops.

In the short term, Polish farmers can sharply improve total production if inputs are available. Those most needed include: high-protein feeds for livestock, fertilizers, crop chemicals, fuel, machinery and spare parts to enable farmers to produce more fruit, vegetables, potatoes, sugar beets, food grains, and feed grains to support further increases in livestock output. The second Borlaug Mission to Poland in August of 1989 concluded that "The genetic potential of the crop varieties and livestock breeds is high, but farmers now are achieving only 50 to 70% of the potential, and inadequate production inputs are one of the major limiting factors."

In the long term, development of agriculture and the food system in my country must evolve with continued economic reforms in the general economy. Reform of the banking system and development of financial markets should create opportunities for farmers and other businesses to use debt capital, to make investments, and to begin modern farming and new ventures in agribusiness. We must develop a market for land, although none has previously existed. This will require new legal and regulatory systems to increase the size of farms by allowing consolidation of existing fields into larger sizes. We must increase both the volume of inputs and the availability of inputs — this is an immediate need. Growth and development of the marketing and food processing sectors are essential, and perhaps this will occur with Western joint ventures. We must create efficient private farm production systems and use private Western agribusiness technology and capital. Our research and educational specialists need to travel abroad to study farm management and food marketing, as I now have the opportunity to do at Purdue University. Finally, we need to revitalize the extension service for the enormous educational task ahead of us.

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