Modeling the Crop Insurance Industry Portfolio Gains and Losses

Economics and Management of Risk in Agriculture and Natural Resources Annual Meeting

Oscar Vegara, Gerhard Zuba, and Jack Seaquist

Gulf Shores, Alabama

March 13-15, 2008

www.air-worldwide.com

BETTER TECHNOLOGY
BETTER DATA
BETTER DECISIONS

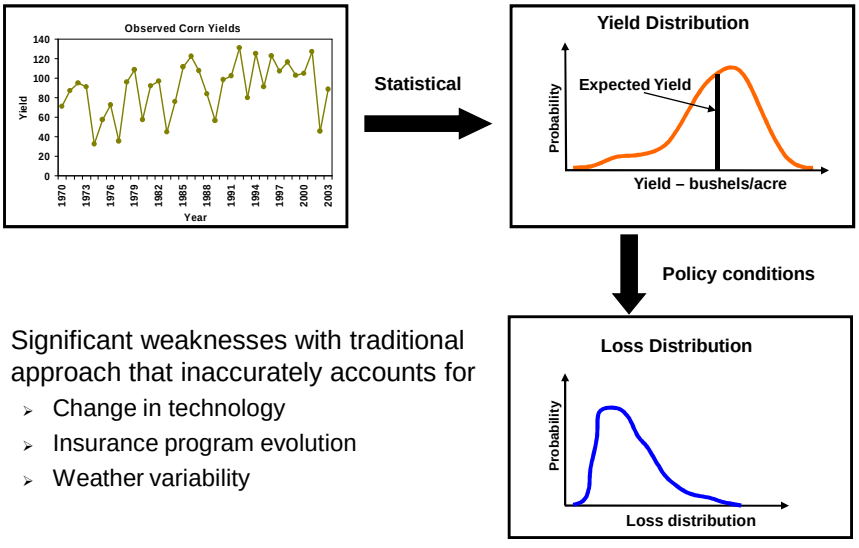
Agenda

- About AIR
- Weather-based yield model
- Agricultural portfolio loss model
- Applications for crop insurance/reinsurance

About AIR

- AIR was founded in 1987 as the first catastrophe modeling company
- Pioneered the development and application of probabilistic catastrophe loss estimation methodology that is now the standard technology for global risk assessment and management
- AIR models and software systems cover natural hazards in more than 50 countries, as well as terrorism in the U.S.
- Advanced scientific techniques help clients assess and manage catastrophe, weather and climate risk
  - Over 400 insurer, reinsurer, intermediary, and corporate risk manager clients
  - Research-oriented clients include Earthquake Engineering Research Institute, Pacific Earthquake Engineering Research Center, Los Alamos National Labs
  - Government clients include USDA, USGS, US Dept. of Homeland Security
- Offices in Boston, San Francisco, London, Hyderabad, Munich and Beijing
- AIR is a wholly owned subsidiary of Insurance Services Office (ISO)

Traditional Approach for Estimating Insured Loss Risk

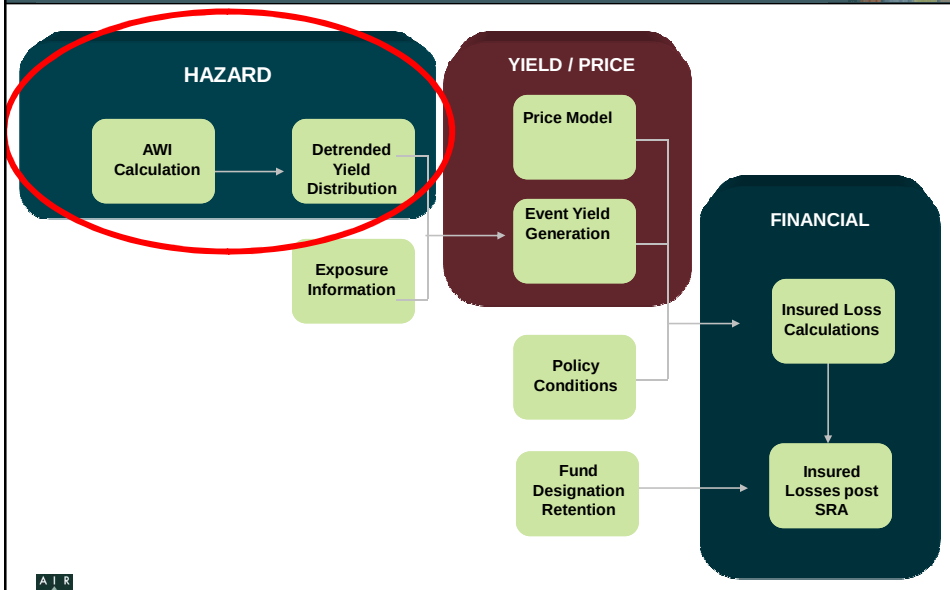


- Significant weaknesses with traditional approach that inaccurately accounts for
  - Change in technology
  - Insurance program evolution
  - Weather variability

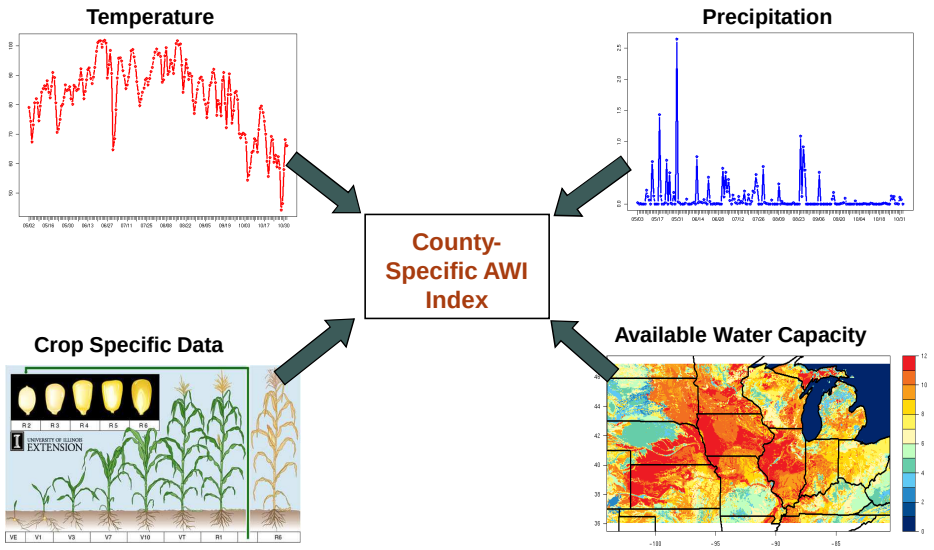
Weather Is the Key Source of Uncertainty Affecting Yields

	% Crop Loss
Drought & Heat	37%
Excess Moisture	33%
Hail	13%
Cold, Frost & Freeze	5%
Flood	1%
Wind, Hurricane	4%
Subtotal – Directly related to weather	**93%**
Disease	5%
Insects & Wildlife	1%
Other	1%
Subtotal – Other perils	**7%**
Total	**100%**

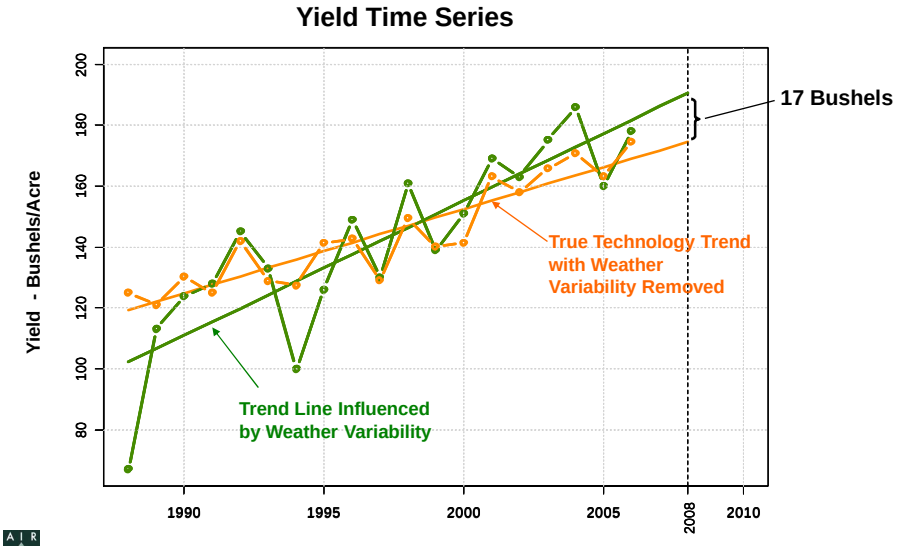
Probabilistic Agricultural Loss Model



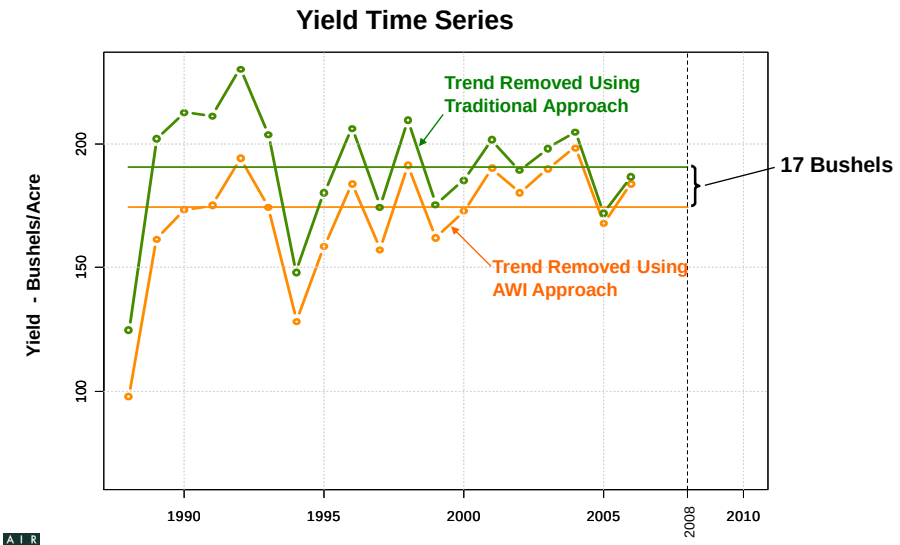
AWI (Agricultural Weather Index) is a Measure of Yield Variability Due To Weather



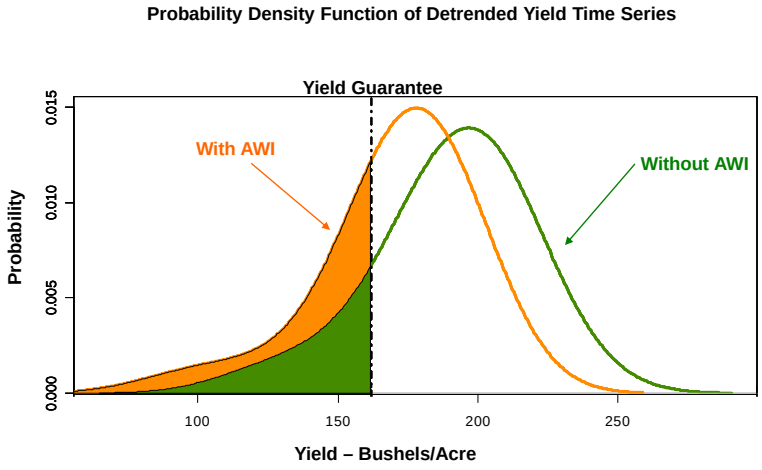
AWI Removes Weather Variability from the Historic Yields to Reveal True Technology Trend



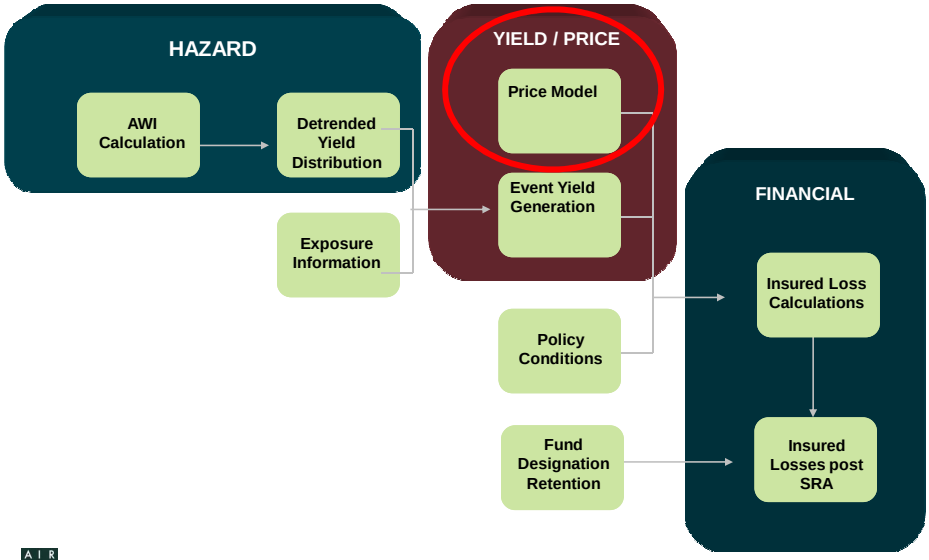
The Detrended Yield Time Series is Required to Estimate the Yield Probability Density Function



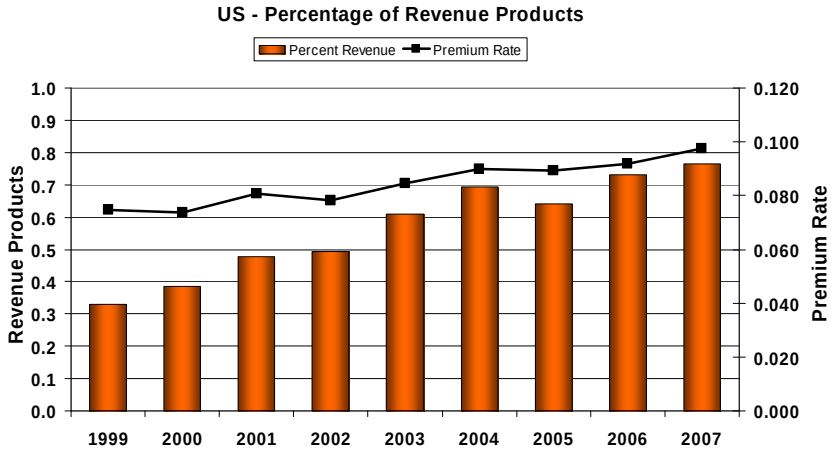
The Choice of Methodology Can Have a Large Impact on Insurance Contracts



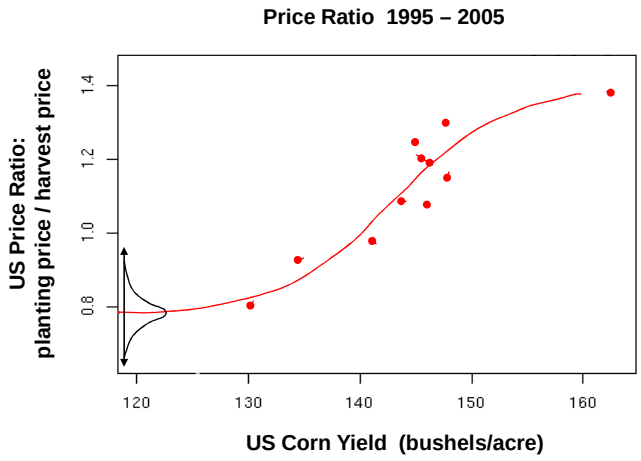
Probabilistic Agricultural Loss Model



Changing Policy Environment

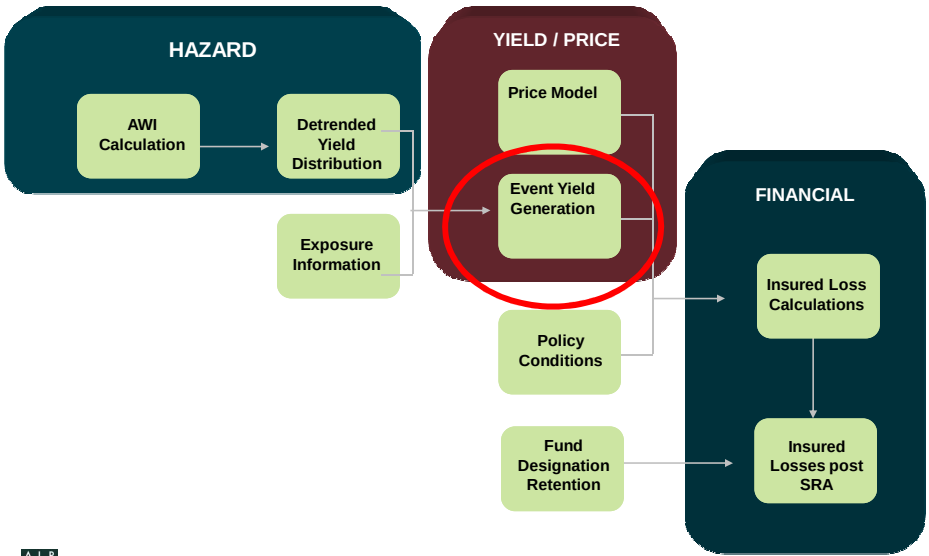


Harvest Price is a Function of Yield

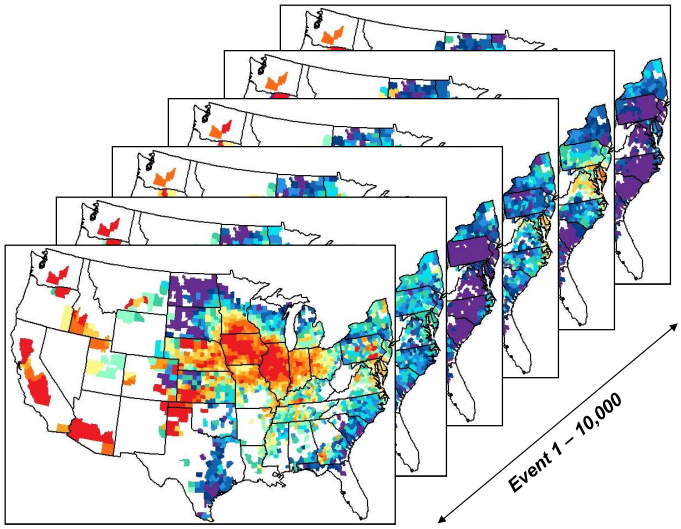


Each yield event in stochastic catalog is associated with a price scenario

Probabilistic Agricultural Loss Model

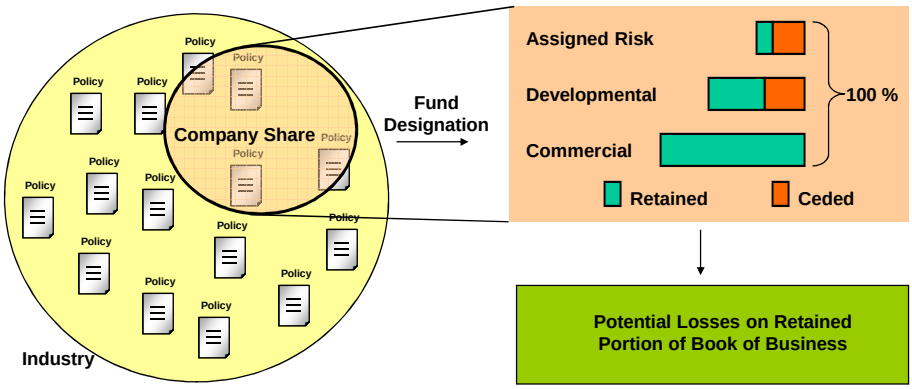


County Distributions form Basis of Event Catalog

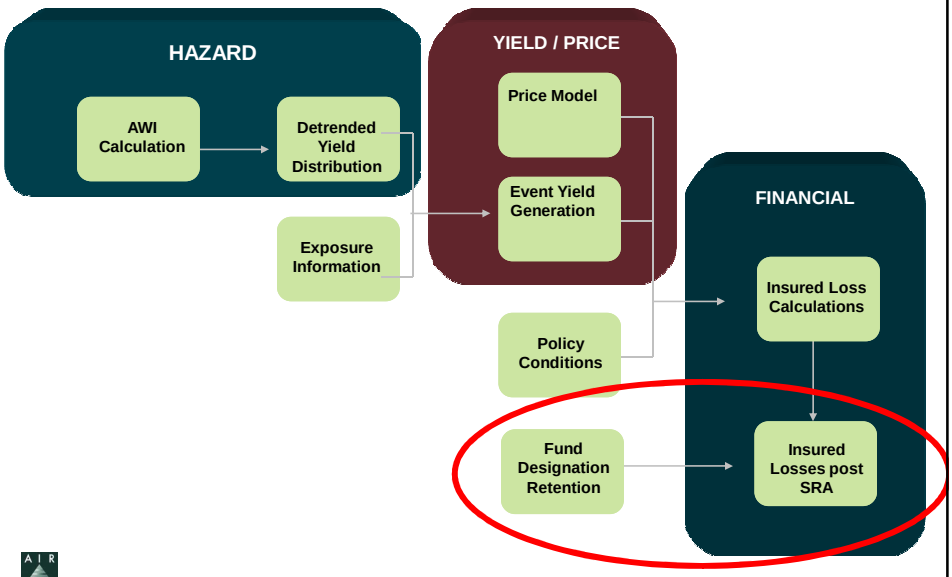


In Crop Insurance the US Government Provides the First Level of Protection through the SRA

SRA: Standard Reinsurance Agreement



Probabilistic Agricultural Loss Model



Applications

- Reinsurance
  - Loss analysis of individual programs and portfolios
  - EP curves and expected loss ratios
  - Pricing of reinsurance layers
  - Industry Loss Warranty analysis
- Crop Insurance
  - Modeling recommendations for fund designation and retention
  - Company specific loss analysis
  - Expected yield, expected revenues
  - Policy specific analysis (GRP, GRIP)
  - Real-time in-season estimates of expected yields (corn, soybeans)

Industry Exposures

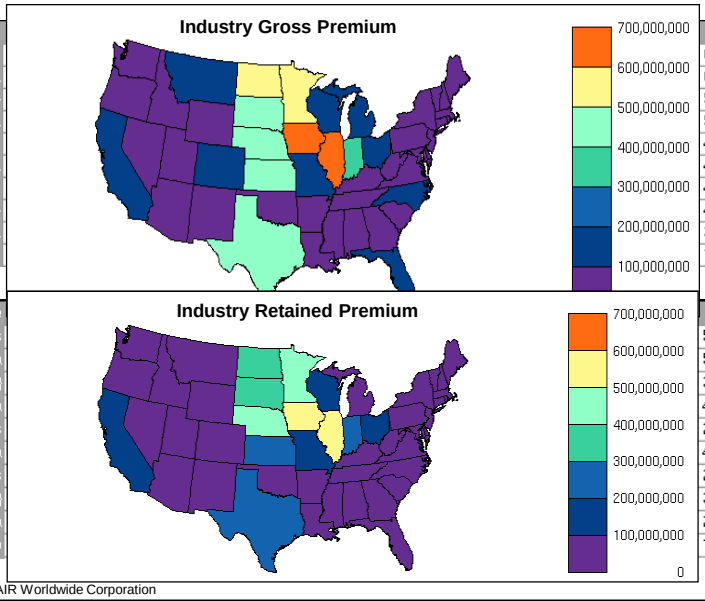
Industry Gross Premium

State	ARI	B.DEV	C.DEV	R.DEV	B.COM	C.COM	R.COM	Total
Illinois	65,539,237	1,978,162	72,942	104,284,072	26,622,575	6,928,264	414,992,956	620,418,208
Iowa	22,177,185	517,251	4,955	12,102,917	30,977,060	1,991,117	532,623,726	600,394,211
{North Dakota}	176,641,112	24,374,993	79,581	79,329,021	53,755,986	2,027,565	198,939,406	535,147,664
Minnesota	38,399,198	3,359,692	10,170	12,742,970	41,964,953	4,468,890	419,125,836	520,071,709
Texas	218,728,758	27,137,734	315,678	51,383,405	44,304,876	18,460,546	107,958,092	468,289,089
Nebraska	43,528,026	1,714,712	5,636	24,237,490	32,305,200	1,439,740	344,196,206	447,427,010
Kansas	172,300,710	4,091,789	20,161	49,071,541	21,740,595	2,572,331	192,603,974	442,401,101
{South Dakota}	132,738,446	3,282,503	39,486	41,579,443	15,600,666	918,970	229,961,656	424,121,170
Indiana	32,174,811	3,521,727	19,151	65,469,023	15,377,960	1,509,344	182,860,347	300,932,363
Ohio	20,138,102	1,876,827	2,024	33,993,206	11,975,346	1,699,111	123,307,123	192,991,739

Industry Retained Premium

State	ARI	B.DEV	C.DEV	R.DEV	B.COM	C.COM	R.COM	Total
Illinois	16,384,811	1,849,499	71,556	91,415,714	26,622,575	6,928,264	414,992,956	558,265,375
Iowa	5,544,297	466,370	4,955	11,397,073	30,977,060	1,991,117	532,623,726	583,004,598
{North Dakota}	26,496,167	19,767,492	70,543	68,263,943	53,724,464	2,027,565	198,602,310	368,952,484
Minnesota	9,599,800	2,778,443	5,965	9,229,029	41,964,953	4,468,890	419,125,836	487,172,916
Texas	32,809,314	18,219,463	183,444	27,583,295	38,991,077	18,423,641	97,655,074	233,865,308
Nebraska	10,882,007	1,271,042	2,629	16,466,374	32,305,200	1,439,740	344,196,206	406,563,198
Kansas	34,460,142	2,082,411	11,515	27,264,935	21,740,595	2,572,331	192,603,974	280,735,903
{South Dakota}	26,547,689	1,718,573	14,175	28,386,374	15,600,666	918,970	229,961,656	303,148,103
Indiana	8,043,704	3,246,811	17,795	61,470,027	15,377,960	1,509,344	182,860,347	272,525,988
Ohio	5,034,528	1,674,028	1,631	31,341,869	11,975,346	1,699,111	123,307,123	175,033,636

Industry Exposures



State	Total
Illinois	620,418,208
Iowa	600,394,211
{North Dakota}	535,147,664
Minnesota	520,071,709
Texas	468,289,089
Nebraska	447,427,010
Kansas	442,401,101
{South Dakota}	424,121,170
Indiana	300,932,363
Ohio	192,991,739

State	Total
Illinois	558,265,375
Iowa	583,004,598
{North Dakota}	368,952,484
Minnesota	487,172,916
Texas	233,865,308
Nebraska	406,563,198
Kansas	280,735,903
{South Dakota}	303,148,103
Indiana	272,525,988
Ohio	175,033,636

Industry Average Gains and Losses

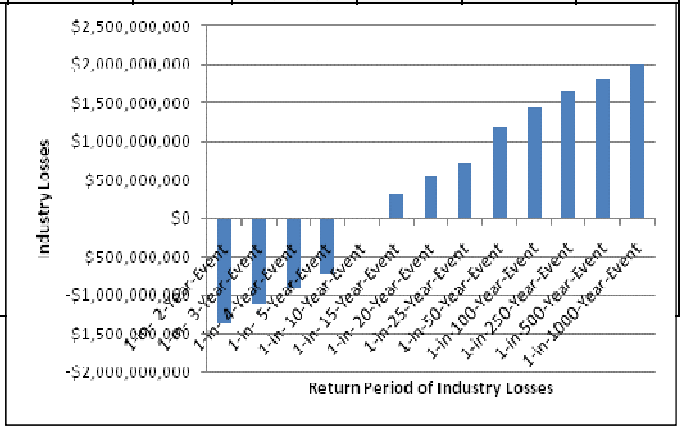
FCIC Fund	Allocation (percent)	Retention (percent)	Gross Premium (dollars)	Retained Premium (dollars)	Average Annual Retained Losses Pre-SRA (dollars)	Average Annual Retained Loss Ratio Pre-SRA (percent)	Average Annual Retained Loss Ratio Post-SRA (percent)	Average Annual Gains and Losses Post-SRA (dollars)
Fund A	22	18	$1,450,543,750	$265,731,841	$341,100,391	128	102	-$5,504,104
Fund D - Other	2	74	$157,786,417	$116,550,779	$110,128,505	95	92	$8,940,063
Fund D - CAT	< 1	89	$5,620,035	$5,012,024	$14,895,751	292	131	-$1,560,544
Fund D - Revenue	9	78	$602,228,348	$471,327,535	$444,425,549	94	93	$35,112,441
Fund C - Other	10	98	$677,704,906	$665,283,862	$429,382,606	65	74	$174,998,466
Fund C - CAT	4	100	$255,272,837	$255,236,005	$172,736,479	68	83	$44,185,251
Fund C - Revenue	52	100	$3,381,564,562	$3,365,156,487	$2,190,097,665	65	74	$875,147,692
Total	100	79	$6,530,720,855	$5,144,298,533	$3,702,766,948	72	78	$1,131,319,266

Industry Exceedance Probability Curve

Return Period (years)	Gross Losses (dollars)	Gross Loss Ratios (percent)	Estimated Retained Losses Pre-SRA (dollars)	Loss Ratios Pre-SRA (percent)	Estimated Retained Losses Post-SRA (dollars)	Loss Ratios Post-SRA (percent)
2	-$1,688,304,329	74.2	-$1,925,623,890	62.6	-$1,370,510,304	73.4
3	-$989,028,000	84.9	-$1,394,520,554	72.9	-$1,107,626,027	78.5
4	-$506,101,232	92.3	-$1,010,652,150	80.4	-$906,700,550	82.4
5	-$90,631,798	98.6	-$681,203,456	86.8	-$729,887,373	85.8
10	$1,427,922,250	121.9	$765,001,370	114.9	-$20,843,275	99.6
15	$2,305,575,688	135.3	$1,571,051,272	130.5	$327,240,073	106.4
20	$3,086,331,565	147.3	$2,282,923,097	144.4	$543,922,965	110.6
25	$3,807,308,761	158.3	$2,846,155,723	155.3	$710,766,889	113.8
50	$5,667,038,474	186.8	$4,397,574,874	185.5	$1,201,563,808	123.4
100	$6,797,522,217	204.1	$5,376,369,342	204.5	$1,439,318,423	128.0
250	$8,206,490,803	225.7	$6,630,226,513	228.9	$1,649,074,519	132.1
500	$9,287,900,022	242.2	$7,600,430,750	247.7	$1,821,741,323	135.4
1,000	$10,111,984,347	254.8	$8,179,101,616	259.0	$1,999,496,534	138.9

Industry Exceedance Probability Curve

Return Period (years)	Gross Losses (dollars)	Gross Loss Ratios (percent)	Estimated Retained Losses Pre-SRA (dollars)	Loss Ratios Pre-SRA (percent)	Estimated Retained Losses Post-SRA (dollars)	Loss Ratios Post-SRA (percent)
2						
3						
4						
5						
10						
15						
20						
25						
50						
100						
250						
500						
1,000						



Industry Recast of Losses (1974-2006)

Year	Industry Modeled Loss Ratios (Gross)	Industry Modeled Loss Ratios (Post-SRA)	Year	Industry Modeled Loss Ratios (Gross)	Industry Modeled Loss Ratios (Post-SRA)
2006	66.2	69.6	1989	92.4	83.6
2005	55.8	66.6	1988	189.5	123.5
2004	69.6	71.0	1987	41.7	61.8
2003	70.6	70.2	1986	57.1	66.0
2002	87.7	79.4	1985	54.4	64.6
2001	71.4	68.8	1984	59.6	66.3
2000	73.8	72.9	1983	121.1	96.9
1999	69.4	72.2	1982	86.9	82.9
1998	77.0	75.2	1981	67.3	69.5
1997	41.7	61.6	1980	89.7	78.9
1996	56.7	66.8	1979	37.2	60.4
1995	81.2	75.1	1978	43.4	62.1
1994	52.9	65.4	1977	98.5	87.1
1993	110.2	98.4	1976	99.3	88.3
1992	60.7	69.2	1975	59.2	66.6
1991	76.0	74.6	1974	114.2	96.9
1990	61.2	67.4	**Average**	**75.6**	**75.1**

Summary

- Traditional approaches for estimating insured crop loss need to account for changes in technology, insurance program evolution and, most significantly, weather variability
- A weather-based agricultural loss model based on a fully probabilistic yield catalog can take into account the spatial and temporal correlations of crop yields
- Leading reinsurers are using this model for pricing programs and for quantifying their portfolio risk
- Crop insurance companies are using this model for improved fund allocation