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SDSU Extension

Trade-offs in the Pasture, Rangeland and Forage Rainfall Index (PRF-RI) Insurance Purchase Decision

NC-1177 Annual Meeting - Minneapolis, MN
October 3, 2017

Matthew Diersen & Scott Fausti

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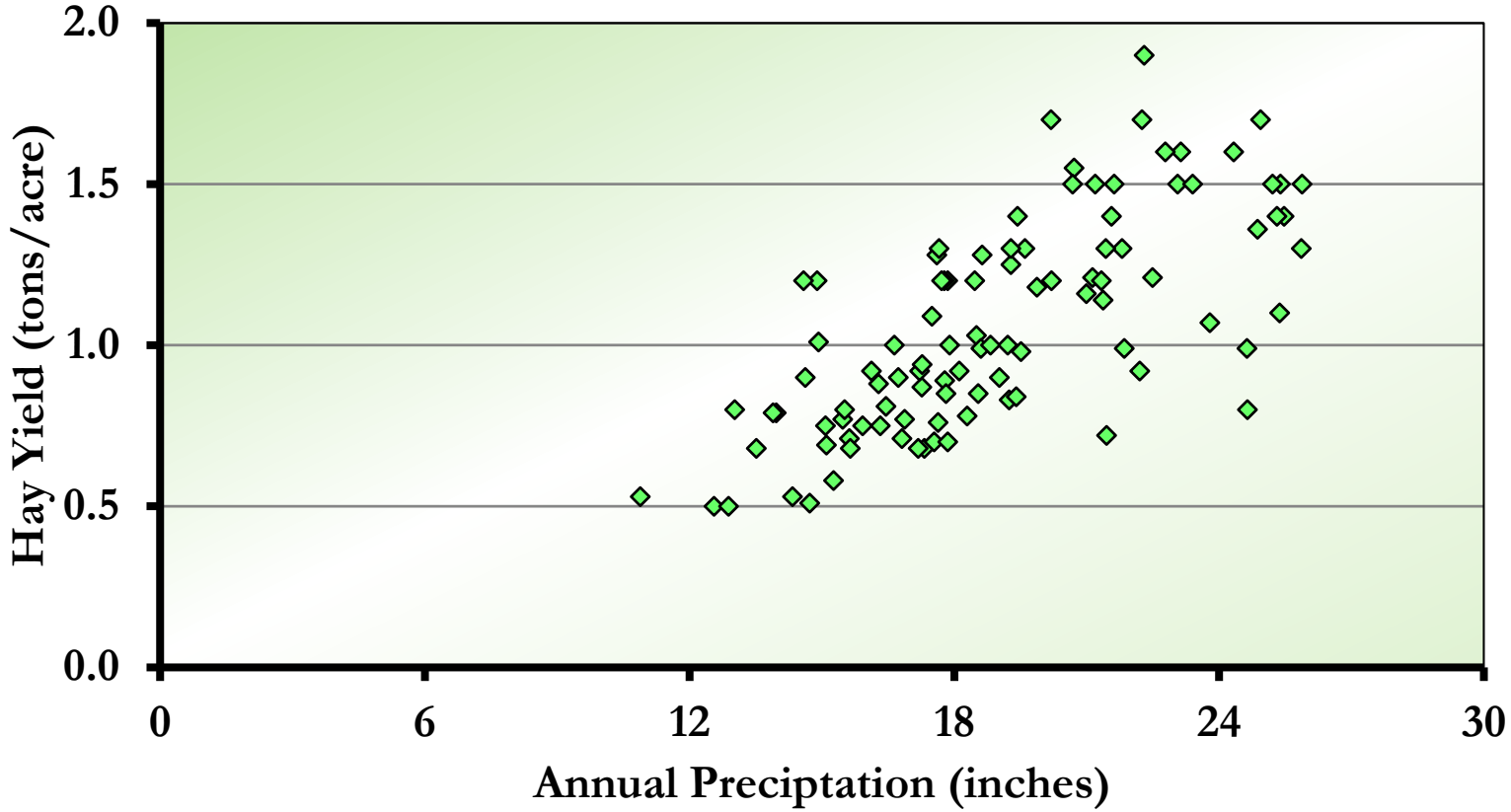
South Dakota Rainfall and Hay Yields, 1917-2016



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Ifft, Wu and Kuethe (2014)

- Explicitly test for changes in pasture land values before and after introduction of PRF
  - e.g., $V_{pasture} = X_{it}\beta + \delta PRF_t + \epsilon$
- Also test for impact of length of adoption (> 3 years) and intensity of adoption (% of eligible land covered)
- Found 4-9% increase or premium in $V_{pasture}$
  - May get capitalized like other payments

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Maples, Brorsen and Biermacher (2015)

- Cites Chavas and Jones (1993) study finding negative relationship between land prices and risk
- Present land values as a function of rents (+), variance of rents (-), risk aversion (-), and time- (and risk-adjusted) discount rate (-)
- Findings show riskier returns associated with:
  - Lower land values
  - Lower rental rates
  - Higher risk-adjusted returns

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Diersen, Gurung and Fausti (2015)

- Rainfall and hay yields are positively correlated at the state and county levels
- Possible to construct a portfolio with PRF intervals as decision set
- Optimal portfolio is "close" to equally-weighted interval loadings
- Variance reduction possible by weighting critical periods more heavily

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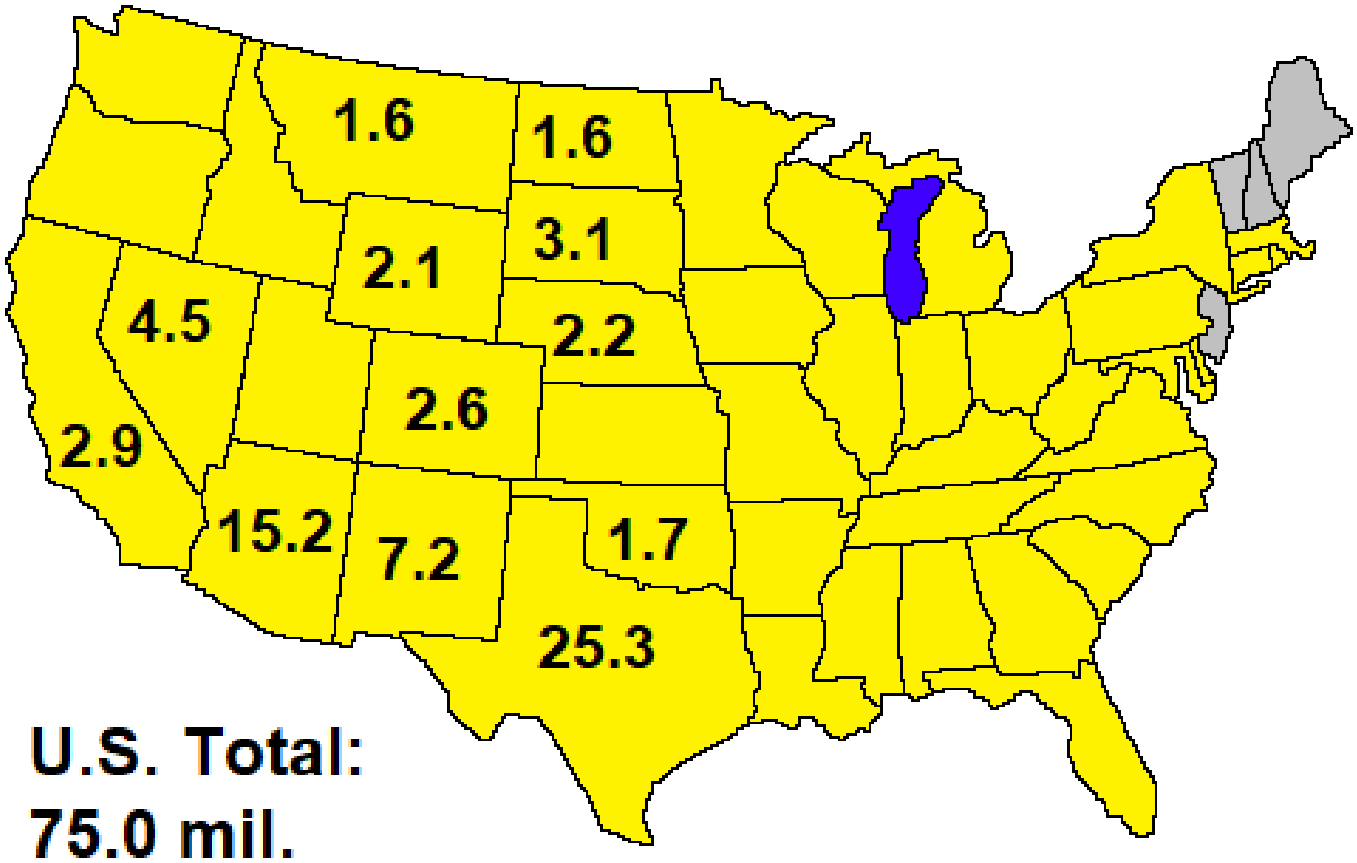
2017 Acres Insured with PRF



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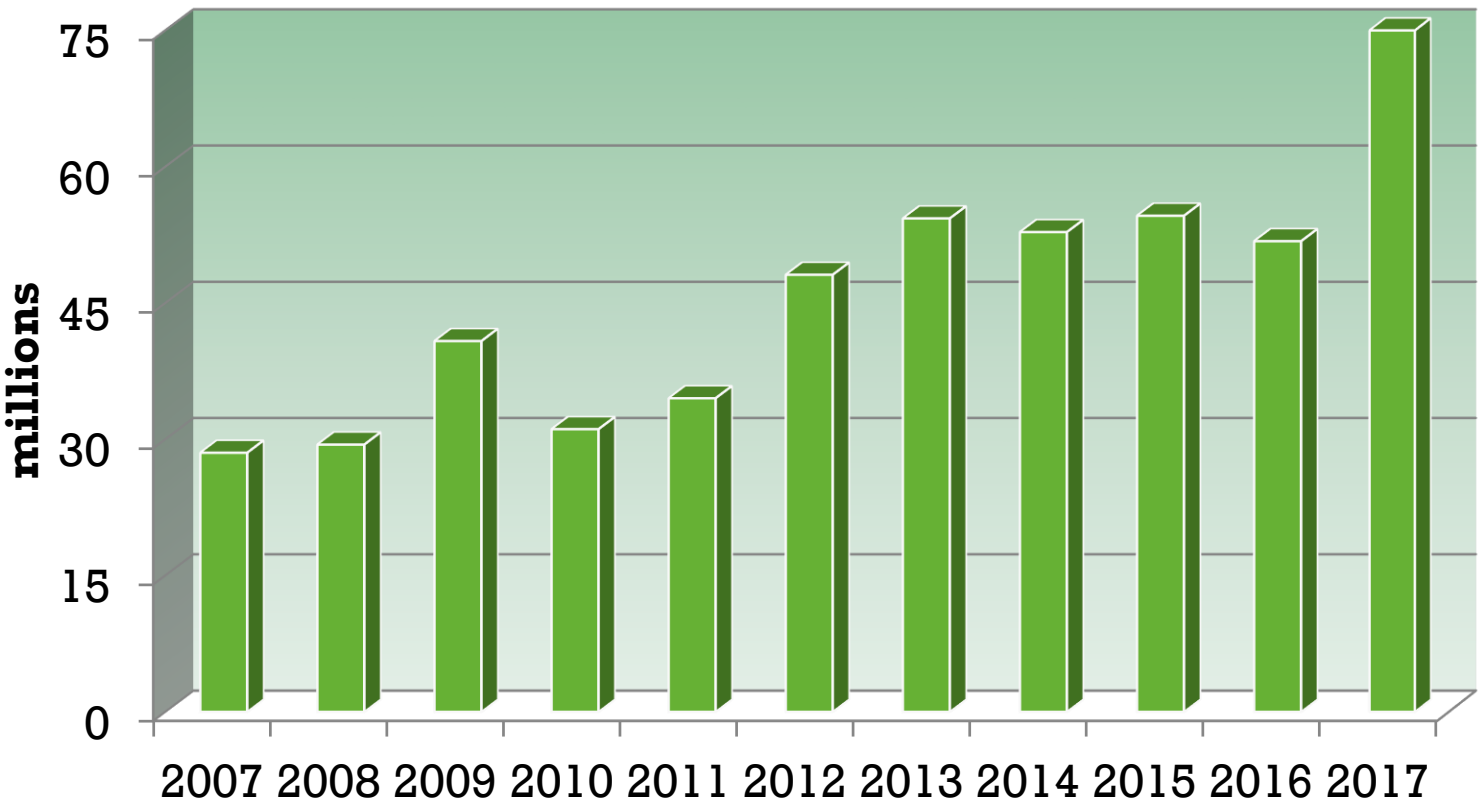
U.S. Acres Insured with PRF



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2012 Census of Agriculture, Land

Land Use	United States (acres)	South Dakota (acres)
Land in farms	914,527,657	43,257,079
Permanent pasture	415,309,280	22,545,069
Woodland pastured	27,999,006	180,751
Other pasture	12,802,847	518,702
Forage harvested	55,775,162	2,615,889

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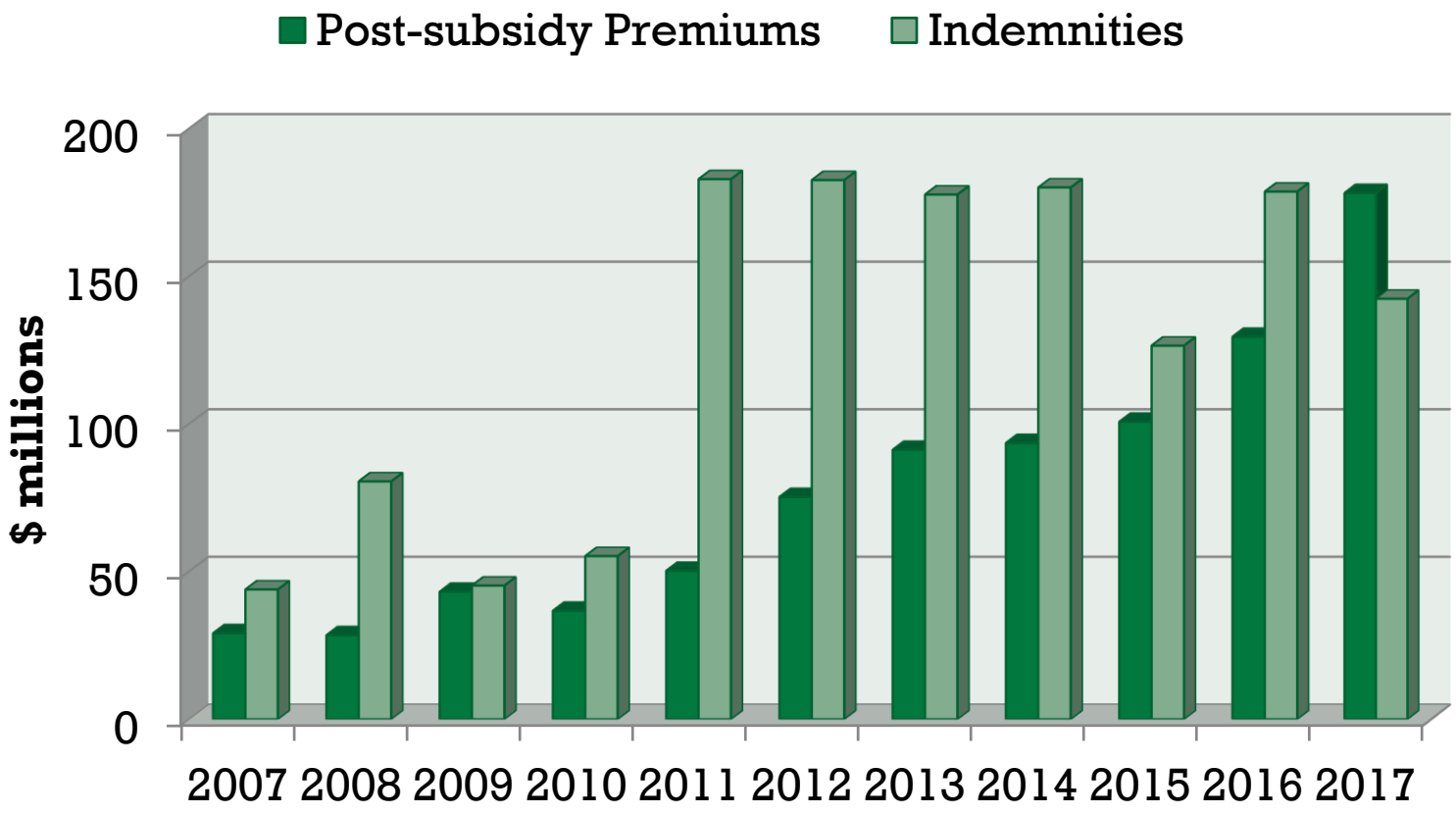
U.S. PRF Loss Summary



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Accommodating, Complex Choice

Example 1. A portion of eligible acres is spread equally across several intervals.

Feb-Mar	Apr-May	Jun-Jul	Aug-Sep	Oct-Nov
	250	250	250	

Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec

Example 2. All eligible acres are covered with the maximum and minimum allowed in single intervals.

Feb-Mar	Apr-May	Jun-Jul	Aug-Sep	Oct-Nov
		200	100	

Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
	700				

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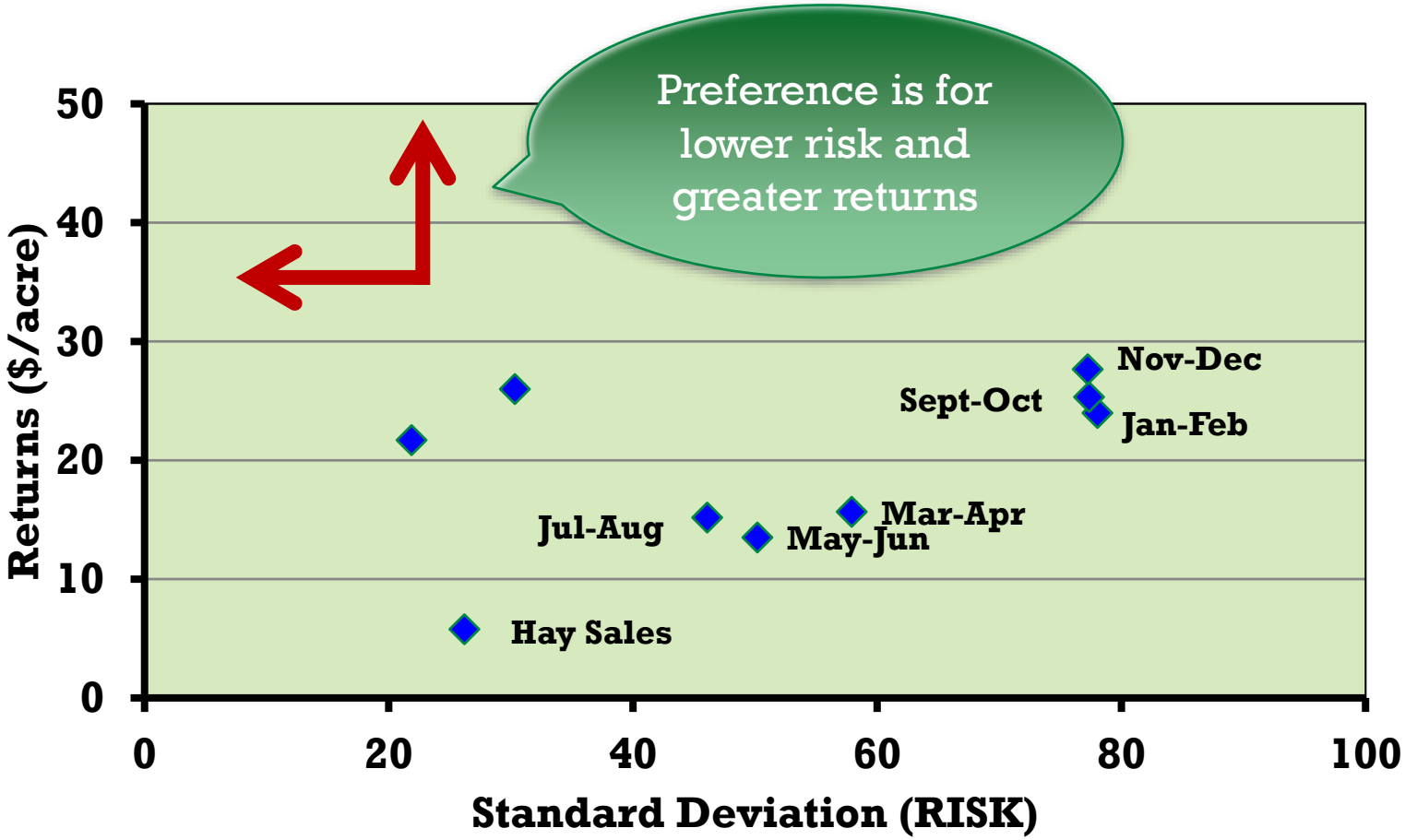
Hughes County Portfolio



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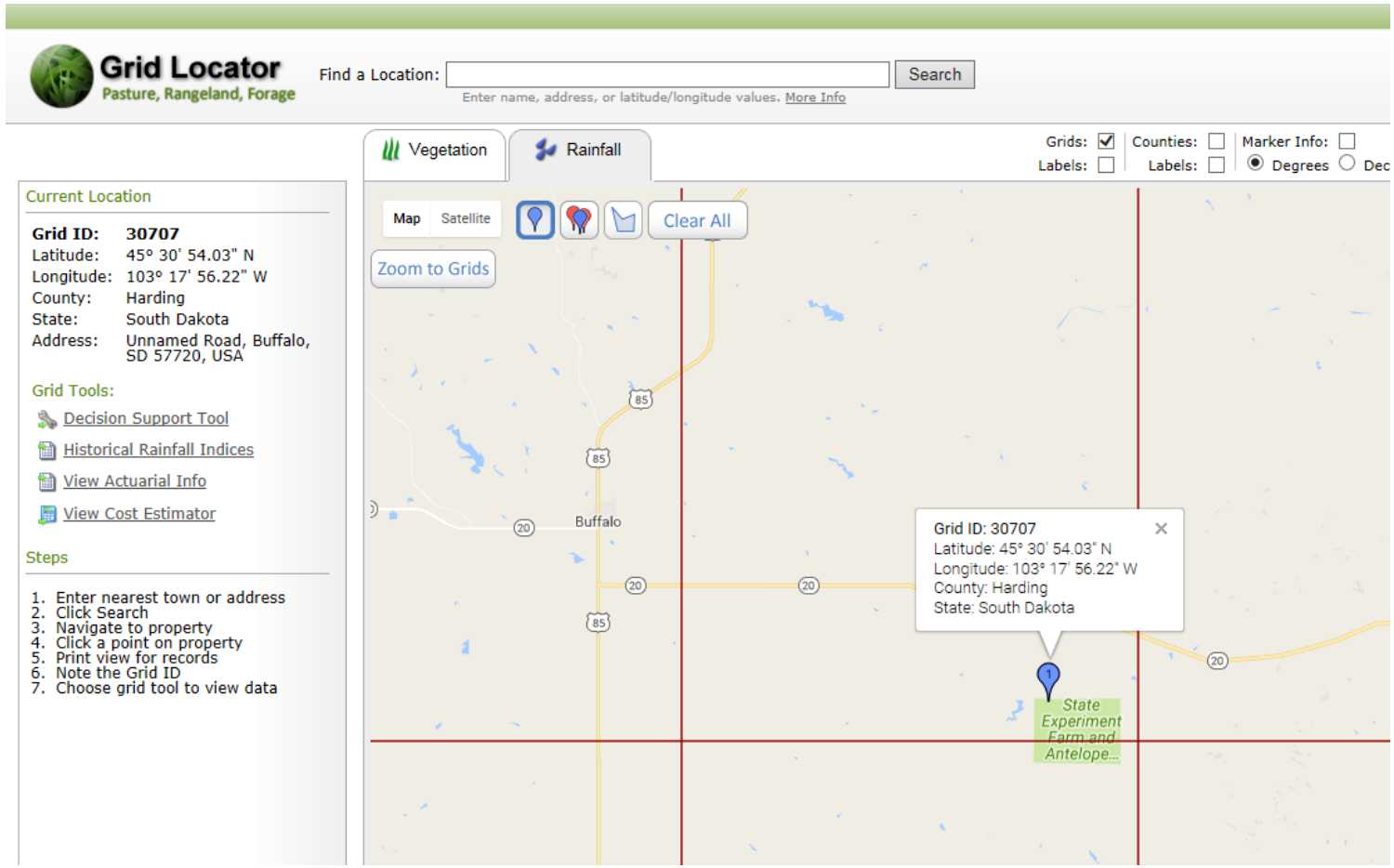
RMA Grid ID Locator



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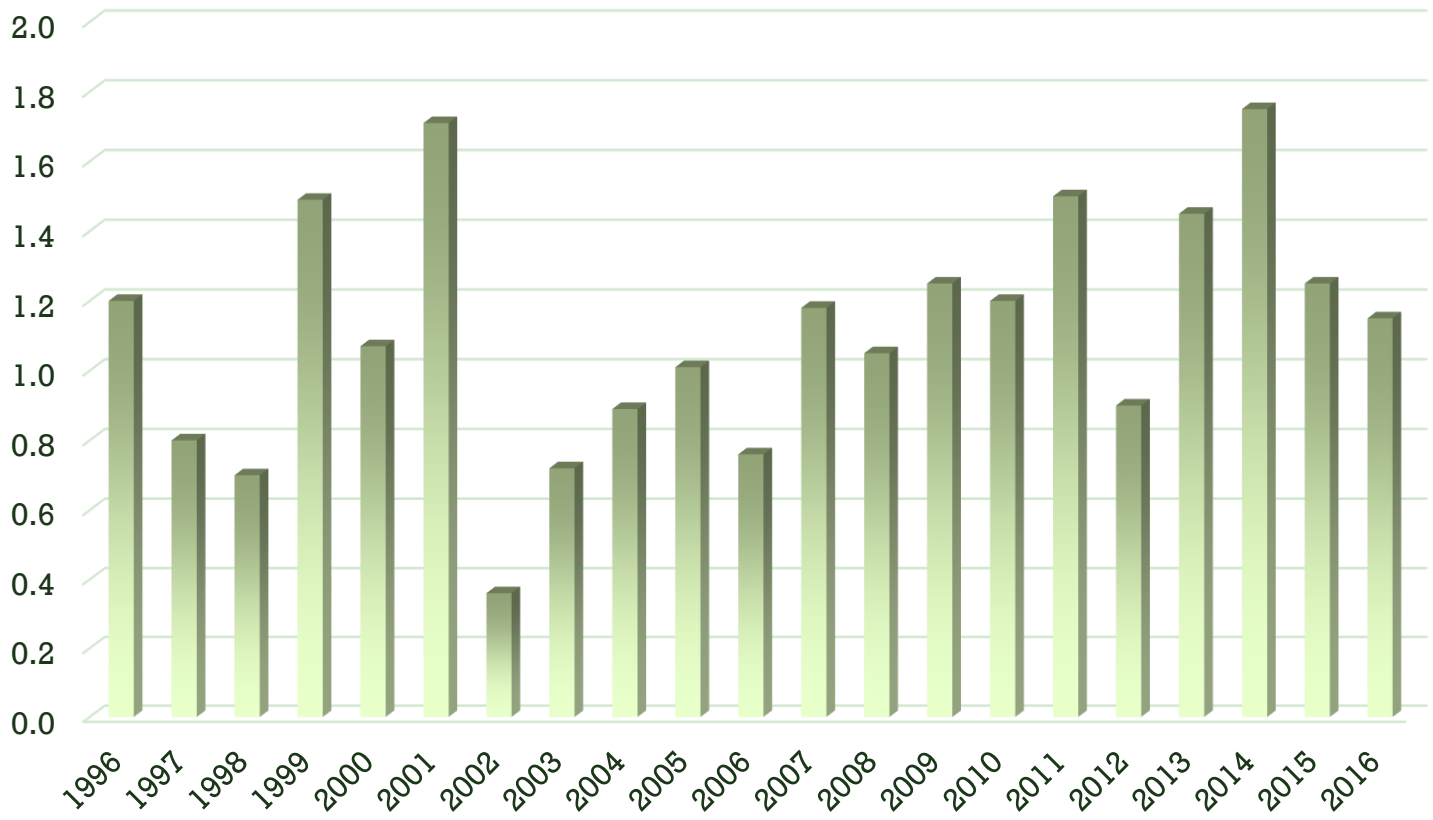
Harding County/District Grass Hay Yields (tons/acre), 1996-2016



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Hypothetical Antelope Station Situation

- Buying replacement hay would have occurred in 7 of 21 years
- Average feed cost of $11.23 per acre for sample (in today's dollars)
- Masks per acre extremes of $12.80 (2012), $30.30 (2006) and $80.30 (2002)
- Likely capitalized in "lower" land values
- Quantifies "cost" that could be reduced with insurance

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PRF-RI Returns

- Rainfall index is actuarially robust
  - A subtle point often ignored by researchers and practitioners
- Premiums by interval reflect underlying distribution of rainfall
- Overall cost is about 15% of the full program cost; aggregate indemnities are typically 85% of aggregate premiums
- PRF-RI buyer typically pays less than 50% of total premium; expect to net $0.70 per $1.00 spent

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Antelope Station Back Test

	J-F	M-A	M-J	J-A	S-O	N-D
Premium ($/acre)	11.90	11.00	7.80	7.40	15.00	14.24
E(Indemnity)	8.33	7.70	5.46	5.18	10.50	9.97
E(NPV)	106.80	98.72	70.00	66.41	134.62	127.80
Correlation w/Hay Loss	0.24	-0.45	-0.34	-0.37	-0.43	-0.44
Actual Average Net						
NPV_{21}						

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Antelope Station Back Test

	J-F	M-A	M-J	J-A	S-O	N-D
Premium ($/acre)	11.90	11.00	7.80	7.40	15.00	14.24
E(Indemnity)	8.33	7.70	5.46	5.18	10.50	9.97
E(NPV)	106.80	98.72	70.00	66.41	134.62	127.80
Correlation w/Hay Loss	0.24	-0.45	-0.34	-0.37	-0.43	-0.44
Actual Average Net	8.34	3.00	9.26	-0.48	1.62	15.01
NPV_{21}	140.23	32.3	141.71	-17.90	1.36	154.62

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Variables

P – Hay price ($/ton)

Y – Hay yield (ton/acre)

C – Coverage level (e.g., 90%)

b – Base price ($/acre)

Z – Productivity index (0.6-1.5)

R_i – Interval indemnity ($/acre)

S_i – Interval weight (0 or .1-.7)

sp_i – Subsidized premium ($/acre)

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Expected Returns & Risk

$$\textbf{Max} \sum_t [-PE(Y - C\bar{Y}) + \varphi bE[(R_1 - C)S_1 + \cdots +$$

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Modeling

- Used Excel solver to back test portfolios with equal weights and those on the frontier with C=0.90
- Used county hay yields (NASS) and rainfall data from 1996 to 2016 (RMA)
- Used 2018 base prices and premiums (assumes historic yield losses occur at current costs)

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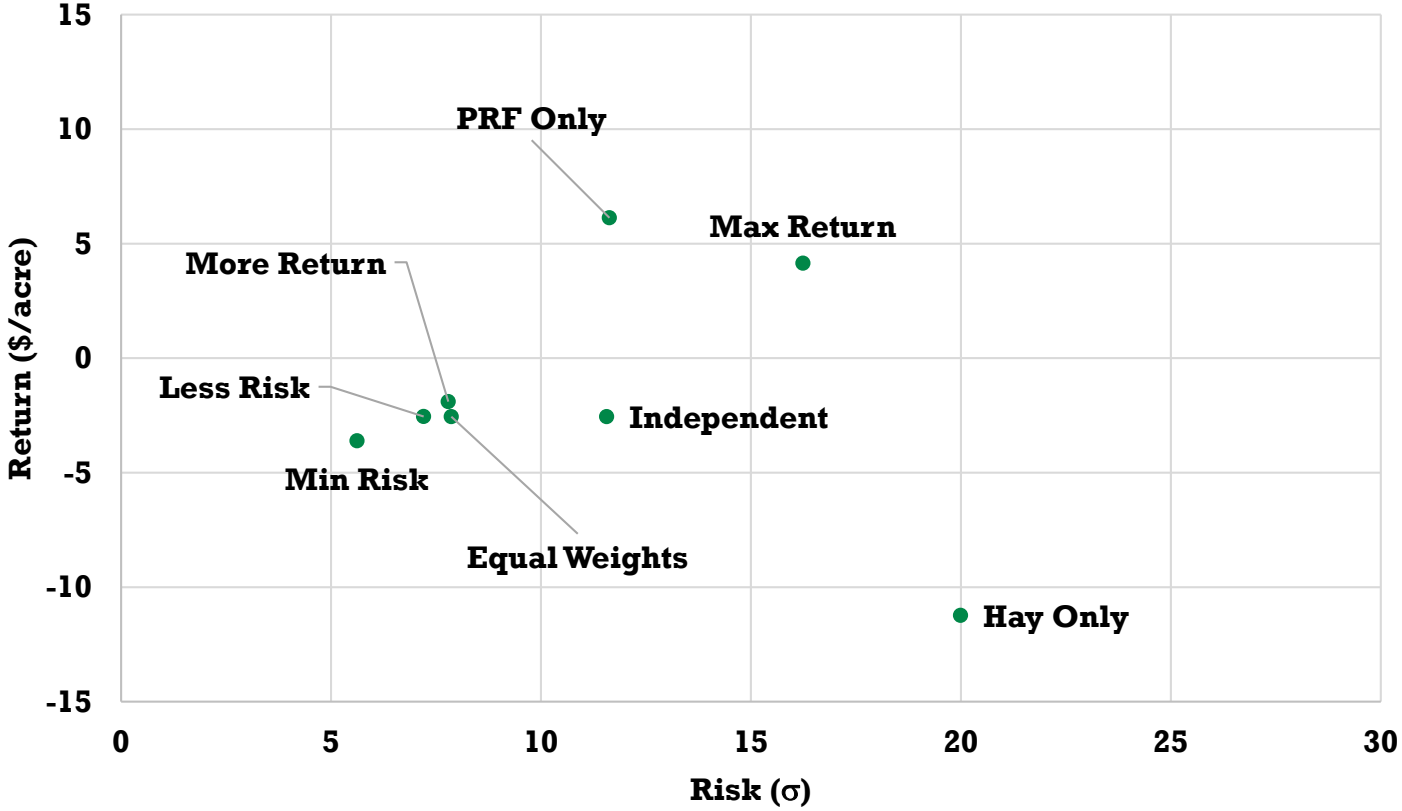
Antelope Station Portfolios



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Antelope Station Weights

(% Acres per Interval)						
	J-F	M-A	M-J	J-A	S-O	N-D
Equal Shares (-.62)	17%	17%	17%	17%	17%	17%
Correlation	0.24	-0.45	-0.34	-0.37	-0.43	-0.44
Less Risk (-.69)	0%	39%	0%	27%	0%	43%
Min. Risk (-.83)	0%	35%	0%	37%	18%	10%
More Return (-.65)	0%	38%	0%	20%	0%	43%
Max. Return (-.37)	30%	0%	0%	0%	0%	70%

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PRF Implications

- Draws from any single interval may:
  - Lead to very long lags in indemnities
- Payoffs from an inclusive portfolio capitalizes on covariance across intervals
  - Premium of \$11.22, E(NPV)=\$100.77, NPV_{21}=\$75.39
- Inclusive portfolio is unlikely to need other equity or financing to sustain coverage
- Productivity index may be adjusted to match feed replacement needs without affecting indemnity frequency

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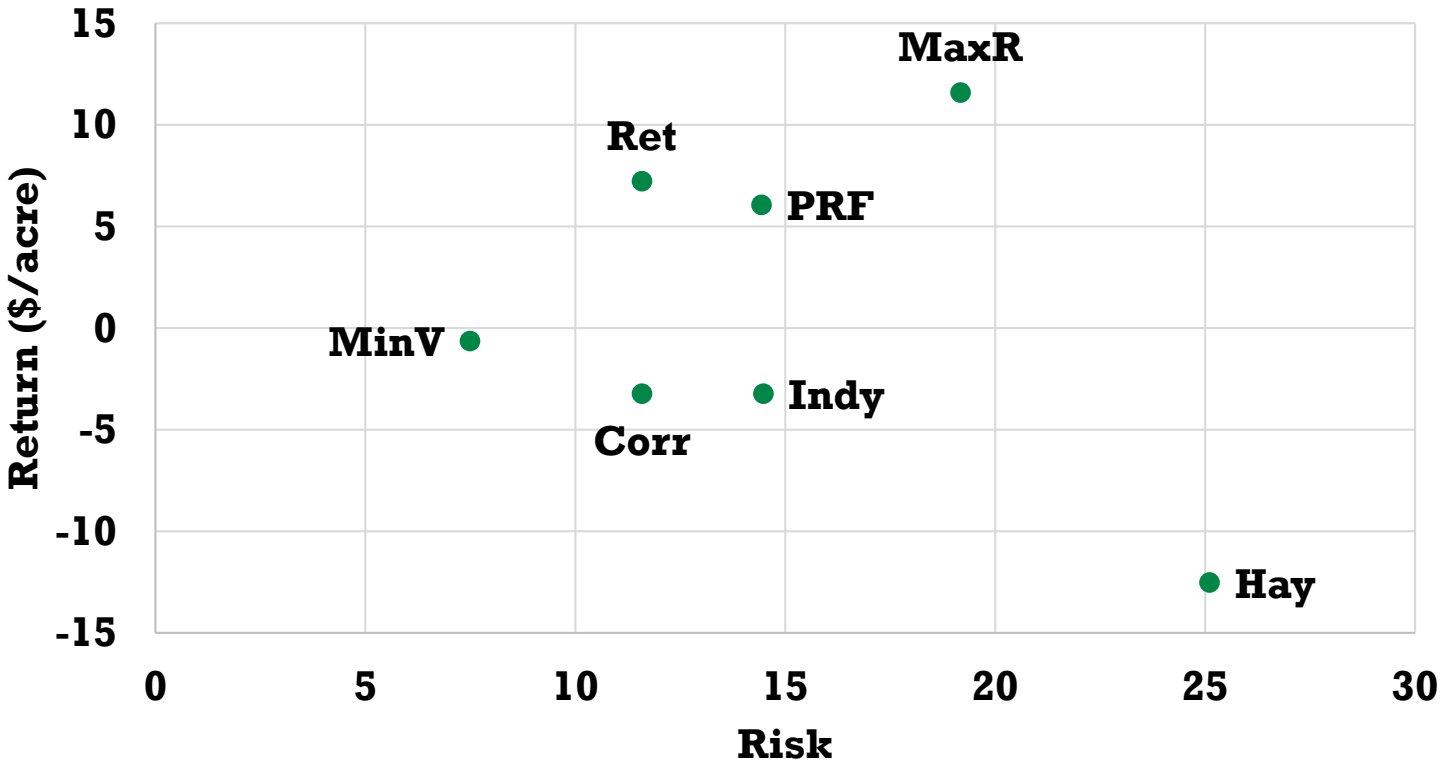
Tripp County Portfolios



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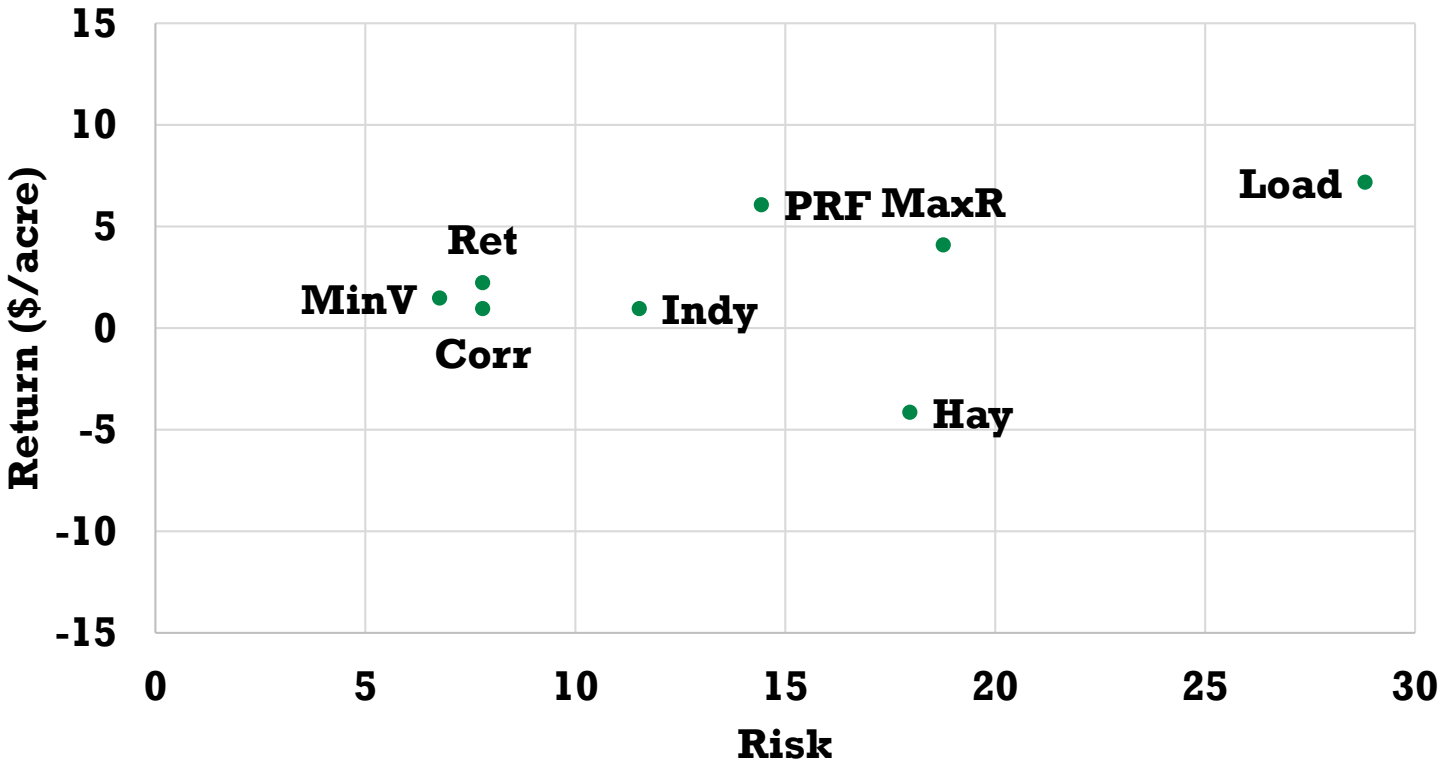
Marshall County Portfolios



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