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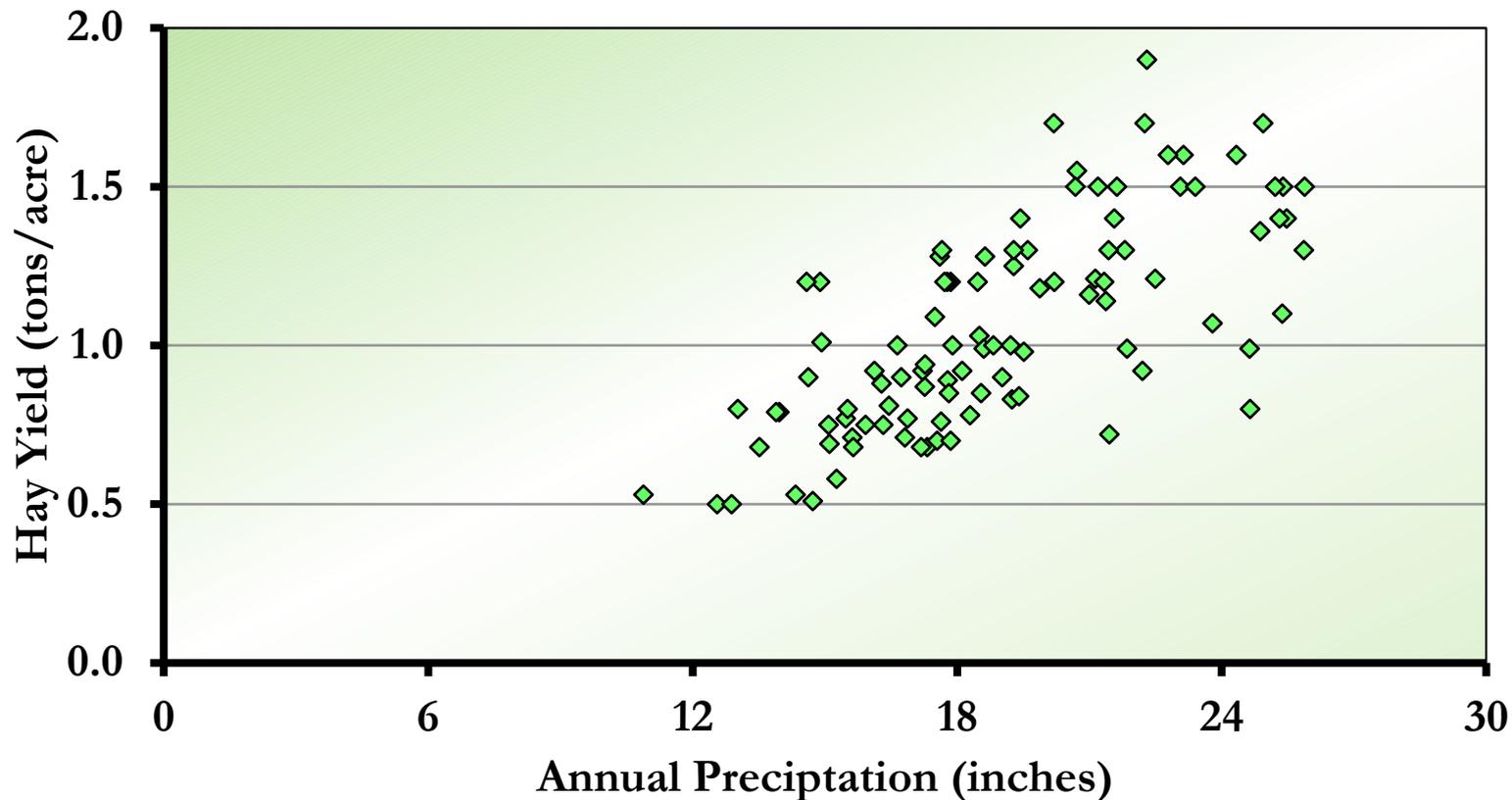


Trade-offs in the Pasture, Rangeland and Forage Rainfall Index (PRF-RI) Insurance Purchase Decision

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

Matthew Diersen & Scott Fausti

South Dakota Rainfall and Hay Yields, 1917-2016



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

Maples, Brorsen and Biermacher (2015)



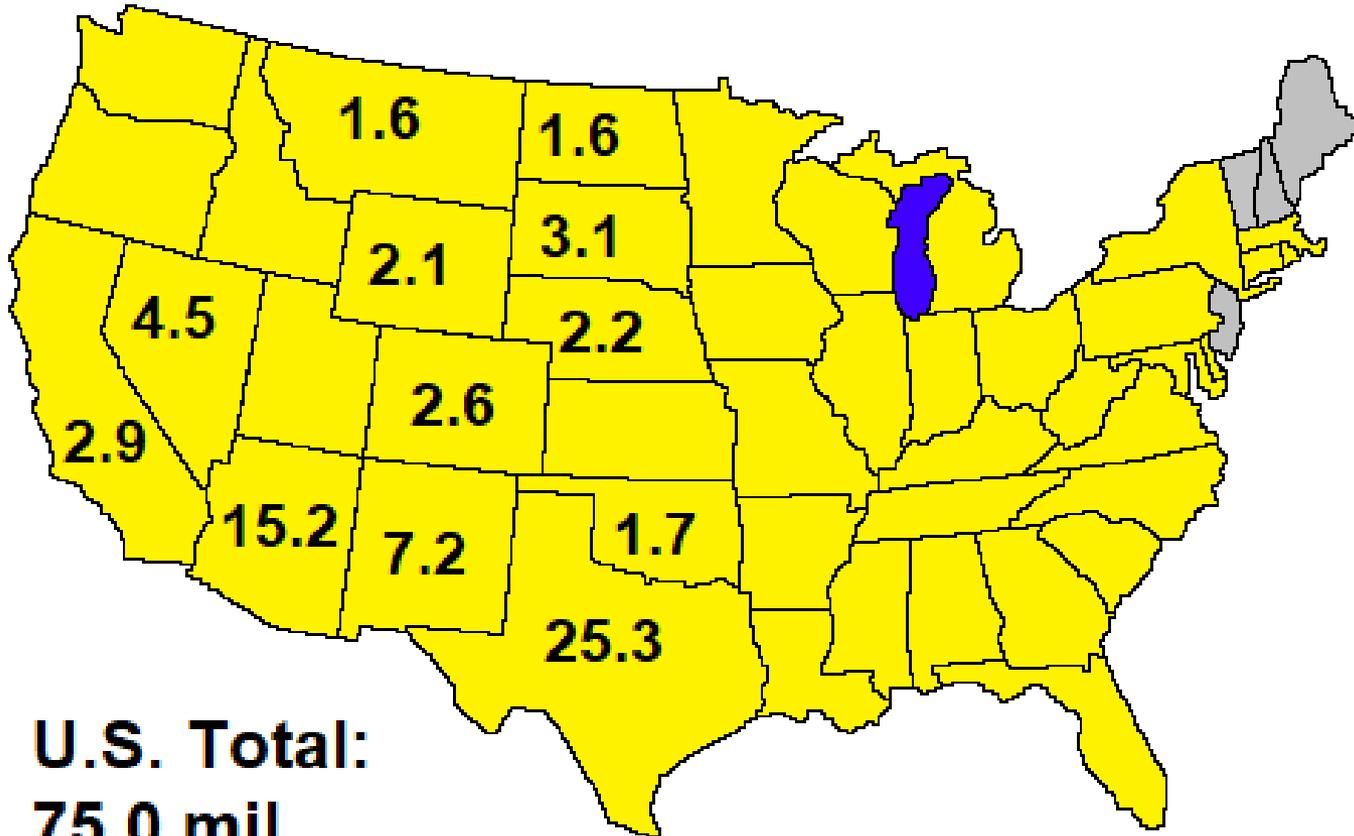
- Cites Chavas and Jones (1993) study finding negative relationship between land prices and risk
- Present land values as a function of rents (+), variance of rents (-), risk aversion (-), and time- (and risk-adjusted) discount rate (-)
- Findings show riskier returns associated with:
 - Lower land values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

Diersen, Gurung and Fausti (2015)



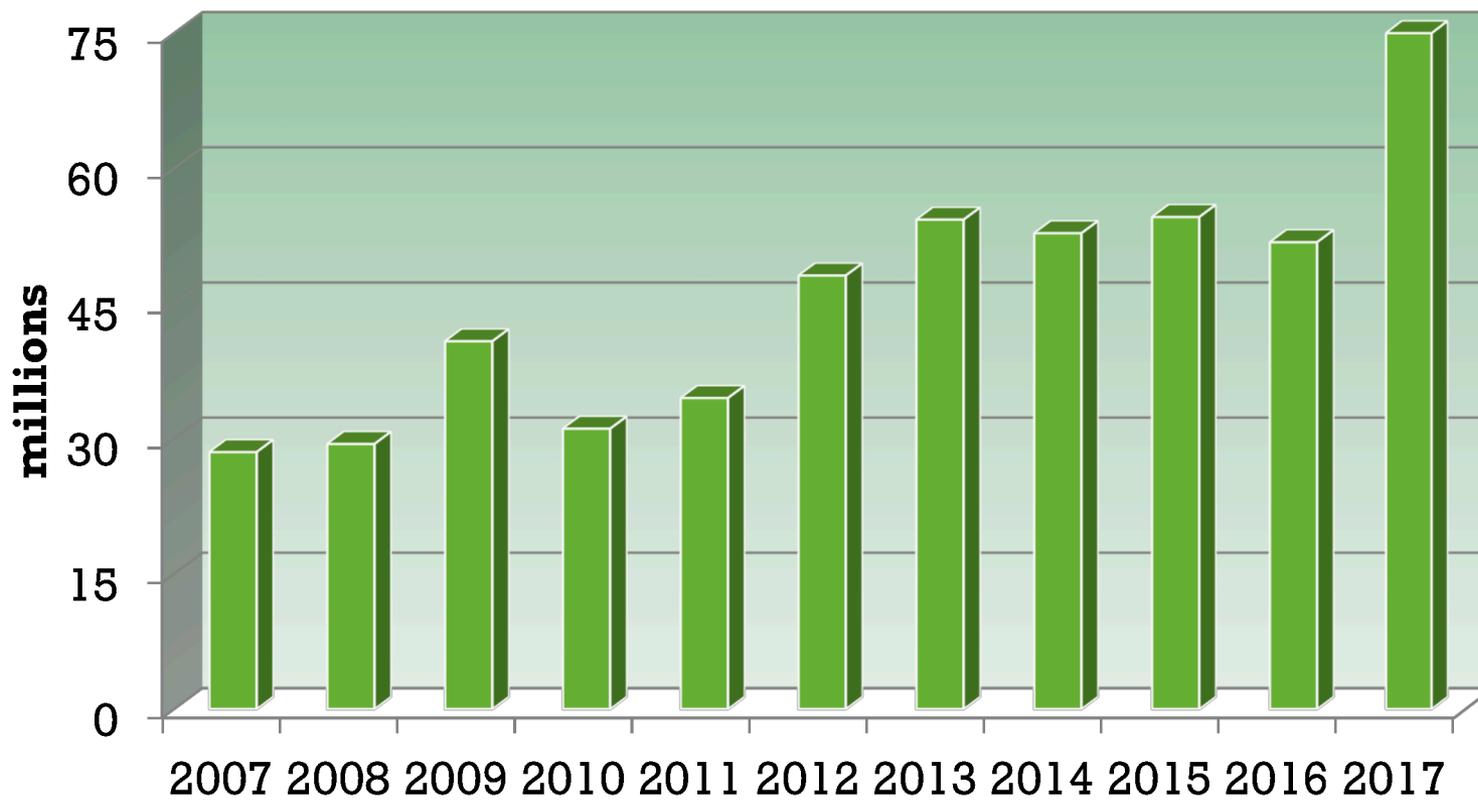
- Rainfall and hay yields are positively correlated at the state and county levels
- Possible to construct a portfolio with PRF intervals as decision set
- Optimal portfolio is “close” to equally-weighted interval loadings
- Variance reduction possible by weighting critical periods more heavily

2017 Acres Insured with PRF



**U.S. Total:
75.0 mil.**

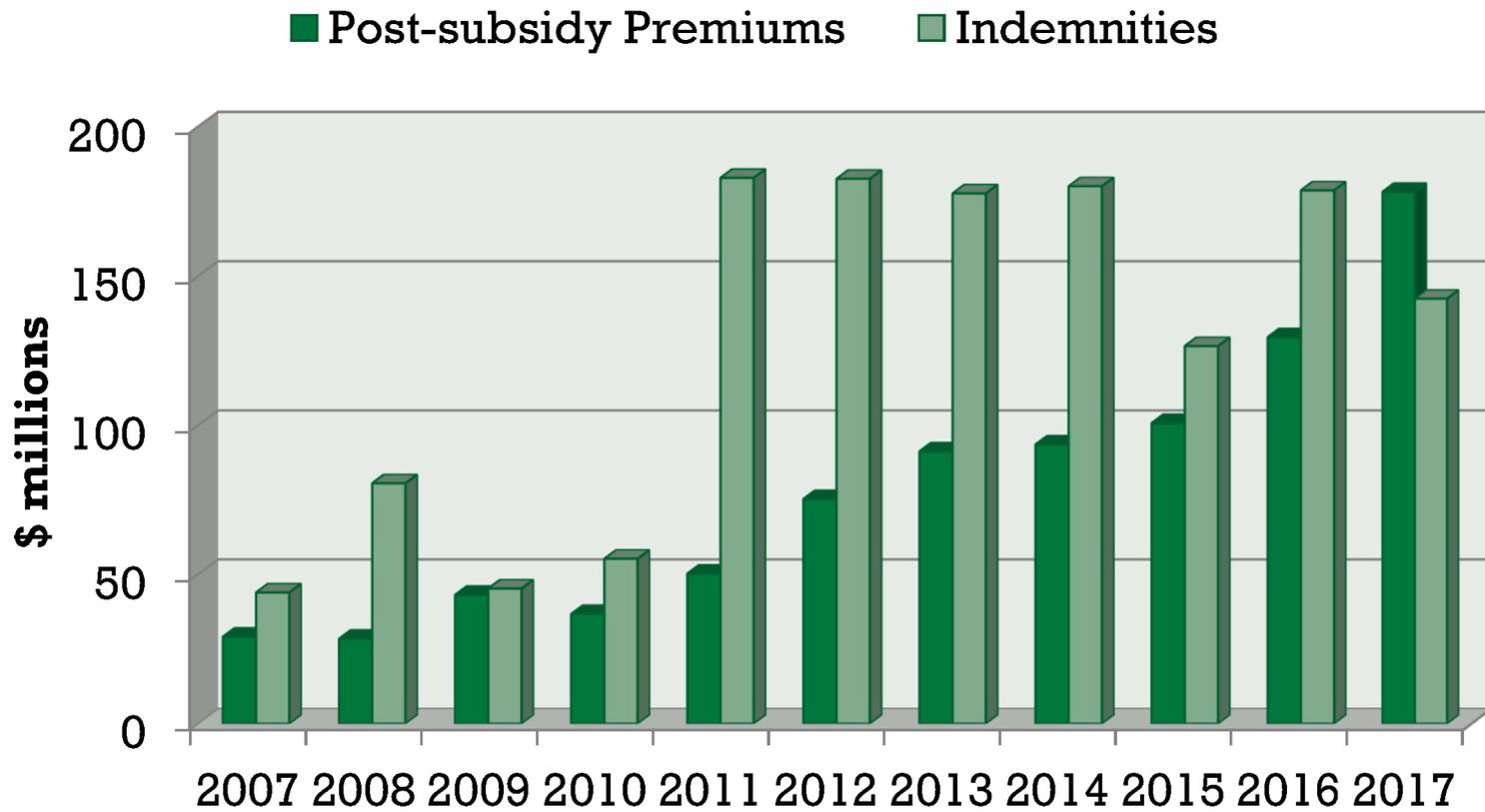
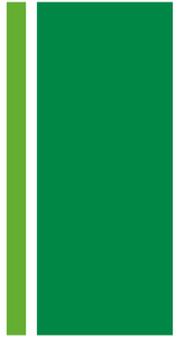
U.S. Acres Insured with PRF



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

U.S. PRF Loss Summary



Accommodating, Complex Choice



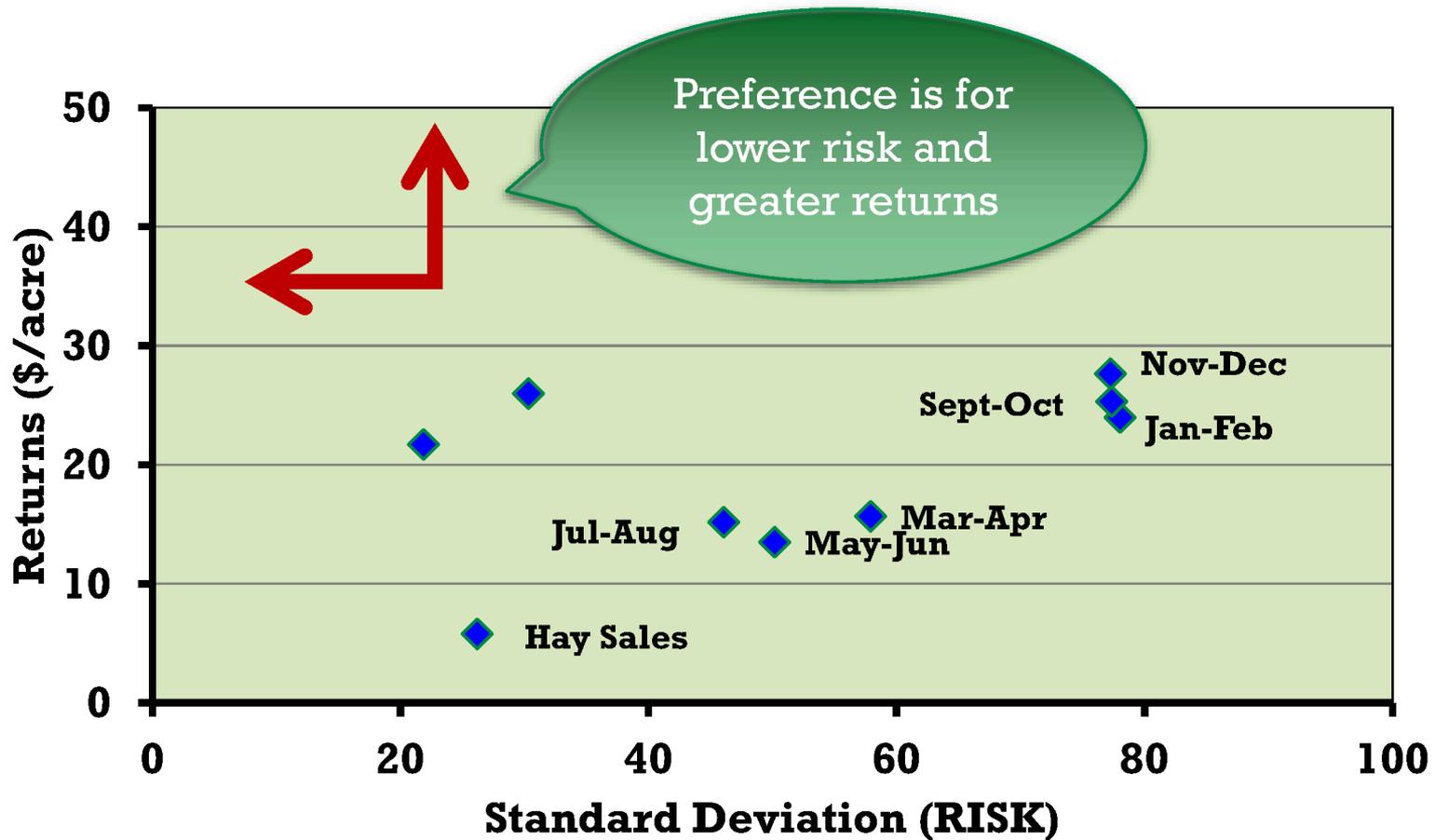
Example 1. A portion of eligible acres is spread equally across several intervals.

	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					

Hughes County Portfolio



RMA Grid ID Locator

The screenshot shows the RMA Grid ID Locator web application. At the top left is the logo for "Grid Locator" with the subtitle "Pasture, Rangeland, Forage". To the right is a search bar with the text "Find a Location:" and a "Search" button. Below the search bar is a prompt: "Enter name, address, or latitude/longitude values. [More Info](#)".

On the left side, there is a "Current Location" section with the following details:
Grid ID: 30707
Latitude: 45° 30' 54.03" N
Longitude: 103° 17' 56.22" W
County: Harding
State: South Dakota
Address: Unnamed Road, Buffalo, SD 57720, USA

Below this is a "Grid Tools" section with four links: "Decision Support Tool", "Historical Rainfall Indices", "View Actuarial Info", and "View Cost Estimator".

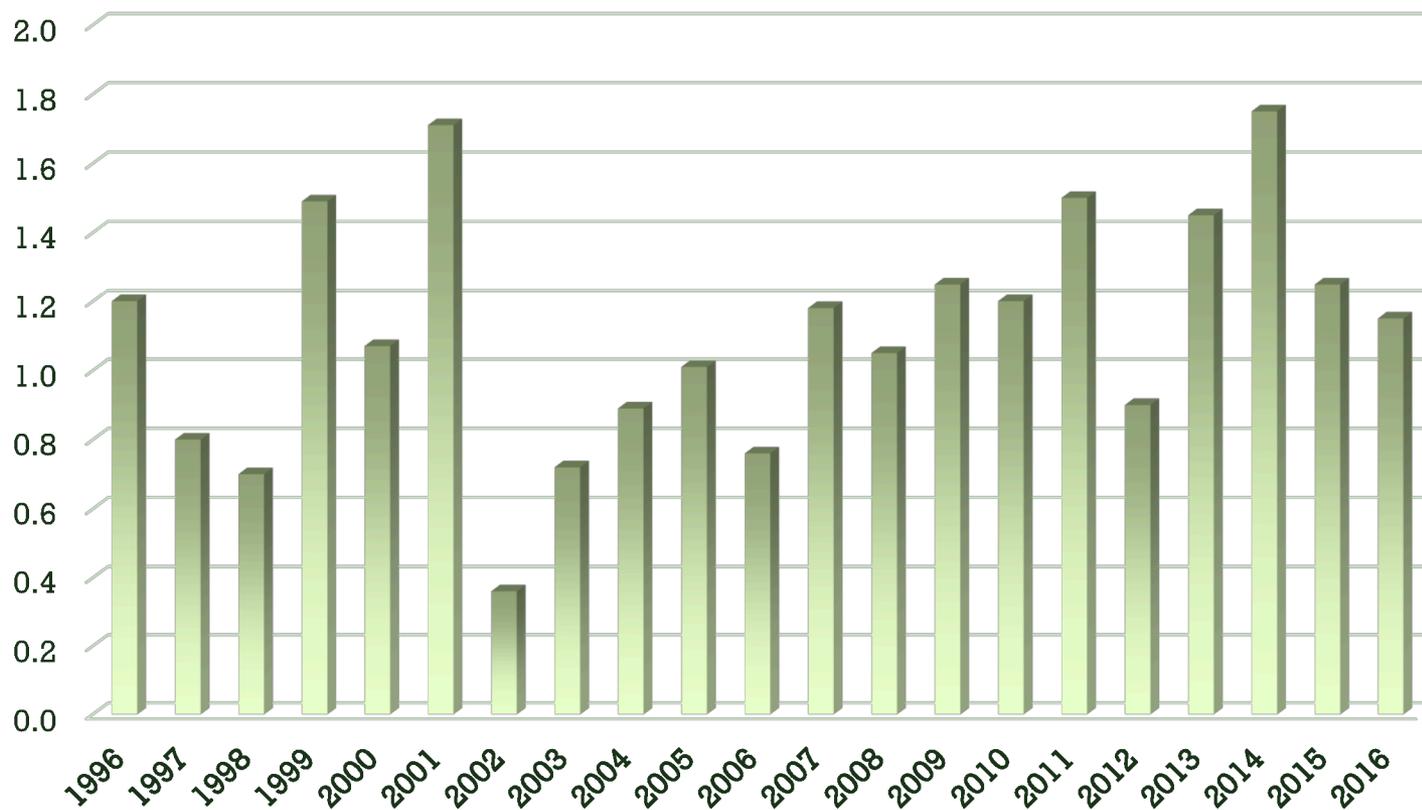
At the bottom left, there is a "Steps" section with a numbered list:
1. Enter nearest town or address
2. Click Search
3. Navigate to property
4. Click a point on property
5. Print view for records
6. Note the Grid ID
7. Choose grid tool to view data

The main area is a map showing a grid overlay. The map includes labels for "Vegetation" and "Rainfall". There are navigation controls: "Map", "Satellite", a location pin icon, a red location pin icon, a print icon, and a "Clear All" button. A "Zoom to Grids" button is also present. In the top right corner of the map area, there are checkboxes for "Grids" (checked), "Counties", "Marker Info", "Labels", and radio buttons for "Degrees" (selected) and "Dec".

A popup window is displayed over the map, showing the following information:
Grid ID: 30707
Latitude: 45° 30' 54.03" N
Longitude: 103° 17' 56.22" W
County: Harding
State: South Dakota

The popup is positioned over a green marker on the map labeled "State Experiment Farm and Antelope...". The map shows a grid of red lines and yellow roads, with "Buffalo" labeled near the center.

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



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

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

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						
NPV₂₁						

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
NPV₂₁	140.23	32.3	141.71	-17.90	1.36	154.62

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)

Expected Returns & Risk



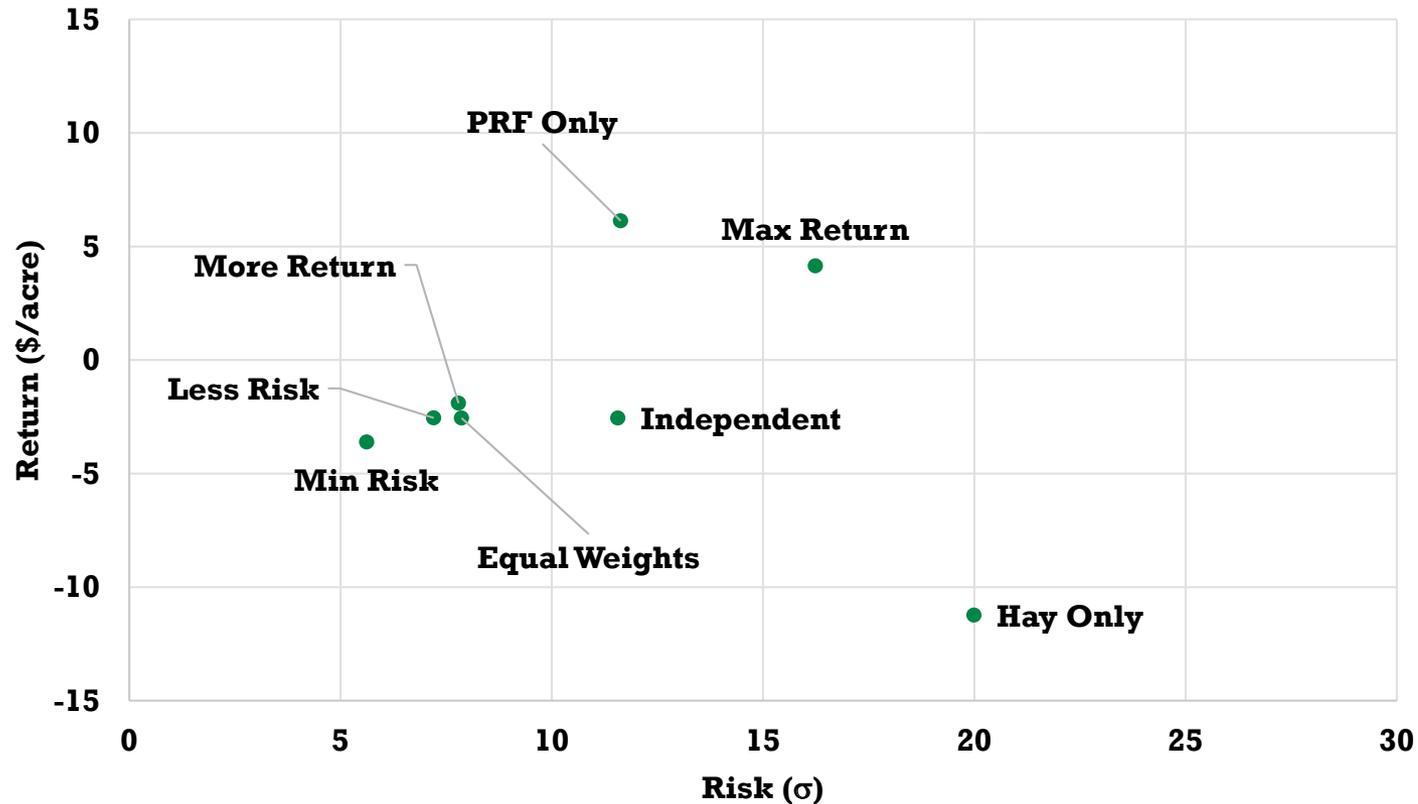
$$\text{Max } \sum_t [-PE(Y - C\bar{Y}) + \varphi bE[(R_1 - C)S_1 + \dots +$$

Modeling

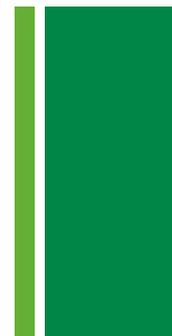


- Used Excel solver to back test portfolios with equal weights and those on the frontier with $C=0.90$
- Used county hay yields (NASS) and rainfall data from 1996 to 2016 (RMA)
- Used 2018 base prices and premiums (assumes historic yield losses occur at current costs)

Antelope Station Portfolios



Antelope Station Weights



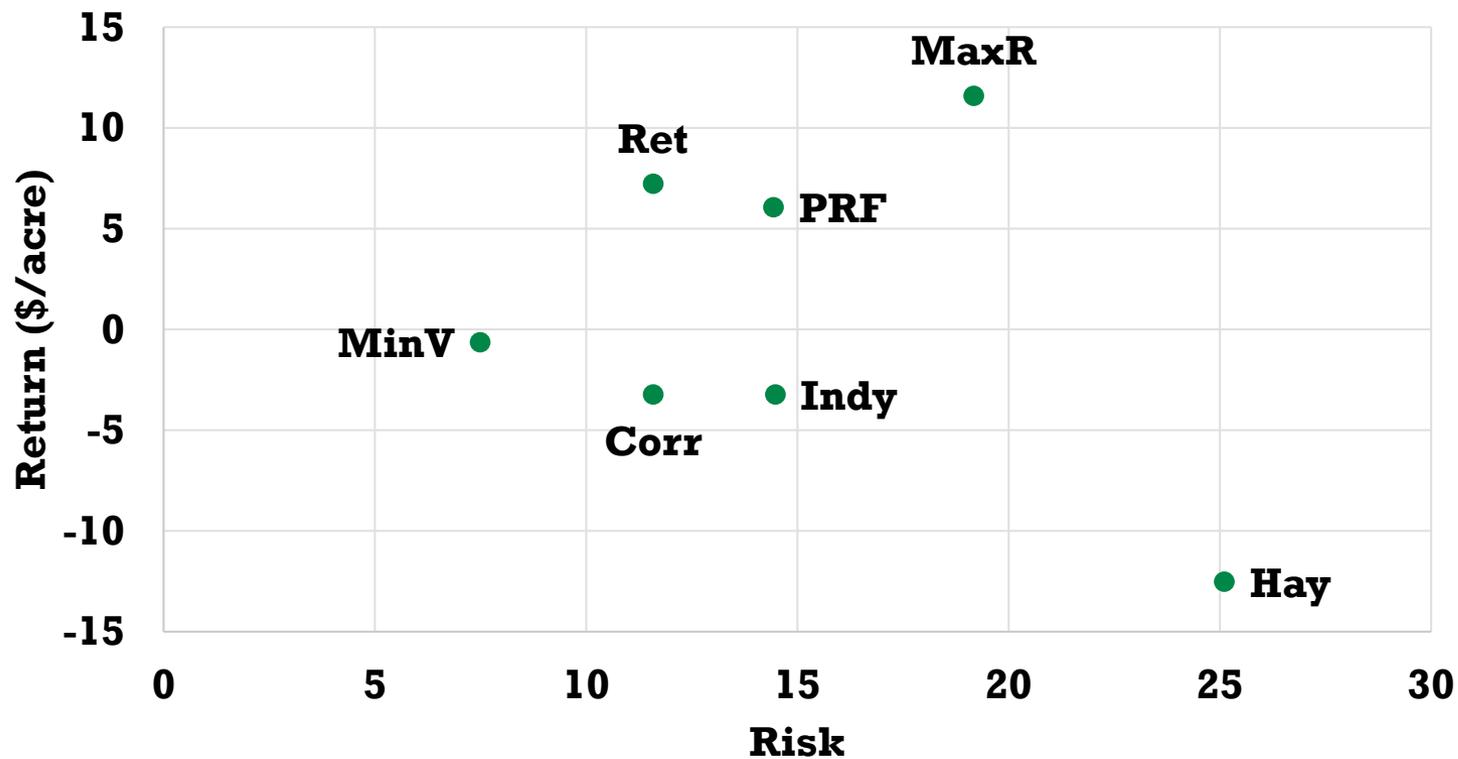
	(% Acres per Interval)					
	J-F	M-A	M-J	J-A	S-O	N-D
Equal Shares (-.62)	17%	17%	17%	17%	17%	17%
Correlation	0.24	-0.45	-0.34	-0.37	-0.43	-0.44
Less Risk (-.69)	0%	39%	0%	27%	0%	43%
Min. Risk (-.83)	0%	35%	0%	37%	18%	10%
More Return (-.65)	0%	38%	0%	20%	0%	43%
Max. Return (-.37)	30%	0%	0%	0%	0%	70%

PRF Implications

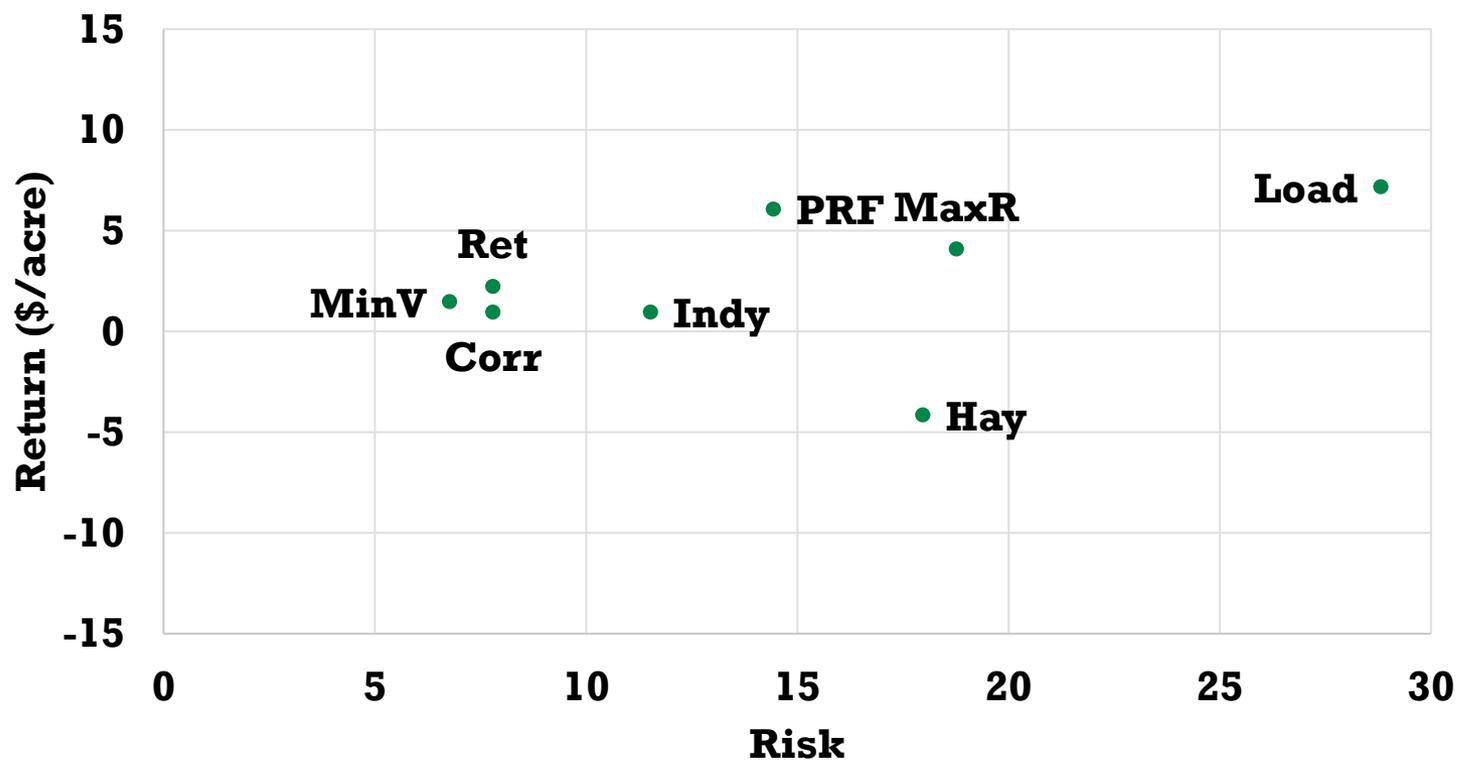


- Draws from any single interval may:
 - Lead to very long lags in indemnities
- Payoffs from an inclusive portfolio capitalizes on covariance across intervals
 - Premium of \$11.22, $E(NPV) = \$100.77$, $NPV_{21} = \$75.39$
- Inclusive portfolio is unlikely to need other equity or financing to sustain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

Tripp County Portfolios



Marshall County Portfolios





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