Drought adaptation decision models and tools: Range livestock production

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A collaboration of WWA, NIDIS, and Earth Lab
w/ assistance from the USDA Northern Great Plains Climate Hub

NIDIS Webinar
May 31, 2017

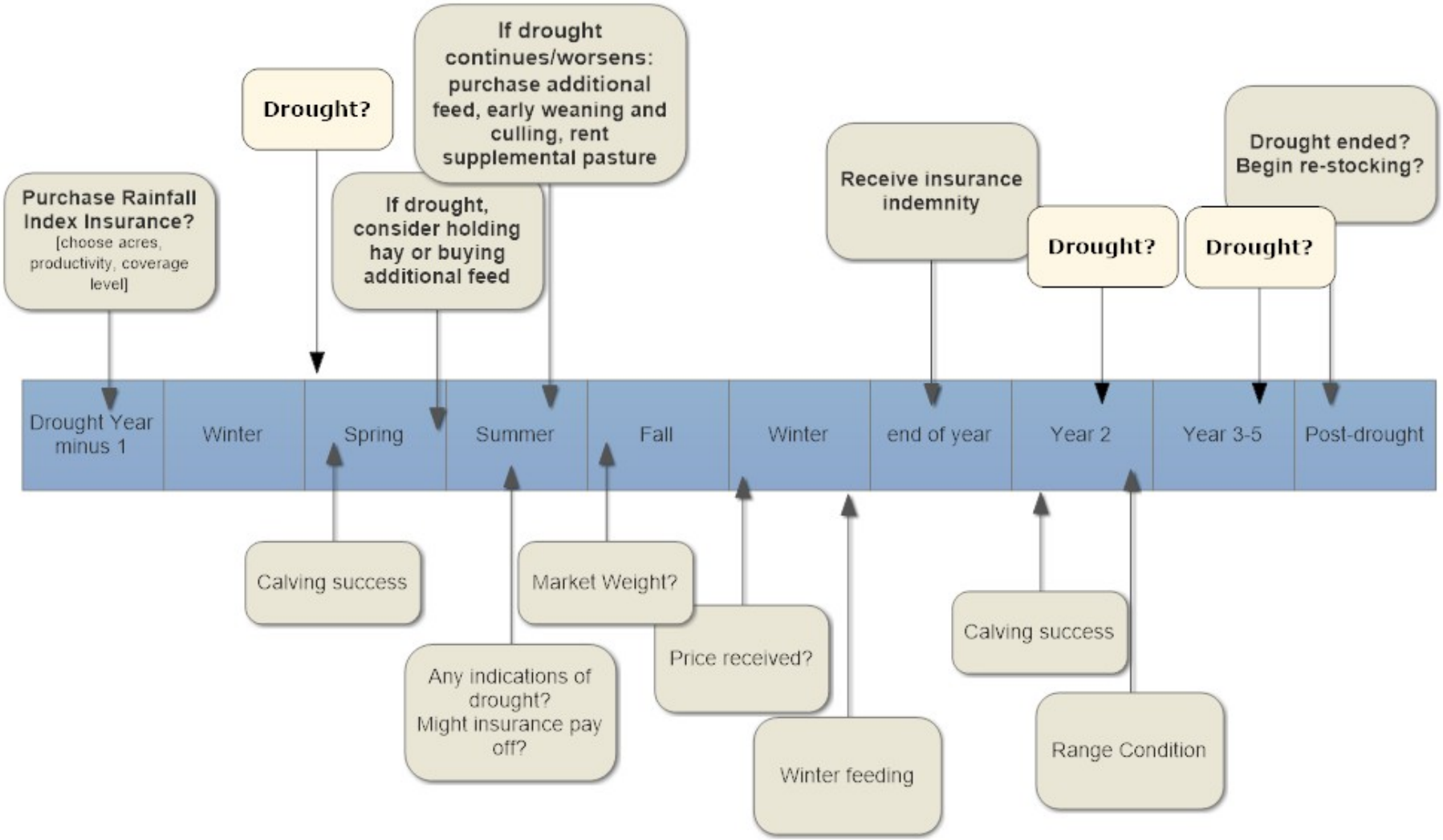
Today's Webinar Roadmap

1. Problem: The challenge of ranching decision-making during drought
2. Analysis: The role of decision modeling
3. Policy: USDA's rain-index insurance
4. Tools: Test drive an online ranch-drought decision model
5. Next steps:
   - Estimating the value of drought early warning
   - Testing alternative drought indices for decision-making and insurance.

1. The Problem:

Sequential Decision-Making Under Uncertainty in Ranching

Ranching:
Complex, sequential decision making under uncertainty



Each decision has financial, management and land implications, and different sensitivity to drought information; we explore those through decision modeling.

Drought decision making on the ranch

Some factors include:

- Recent and current drought conditions
- Expectations about future drought conditions: What's the forecast? What about next year?
- What options are available?
- What will other ranchers will do?
- Potential insurance payments (e.g., USDA RMA)
- Current market conditions, net worth, financial plan, and potential market response to drought

Plenty of good advice is available from ranch and range management experts

Managing your ranch during drought:
Implications from long- and short-run analyses

Managing Drought Risk on the Ranch

A Planning Guide for Great Plains Ranchers

University of Nebraska - Lincoln
National Drought Mitigation Center

Available Online at:
www.drought.unl.edu/ranchplan

Christopher T. Bastian, W. Marshall Frasier, Micha

Western Beef Resource Committee — Third Edition

Cattle Producer's Handbook

Drought and Other Natural Disasters Section 1130

Drought Management Strategies for Beef Cattle

John Paterson, Rick Funston, and Ron Carlstrom, Montana State University
Greg Lardy, North Dakota State University

Drought develops progressively over time. Management of the ranch during a drought depends on the balance between stocking density and the availability of feed and water.

In the long run, you can help protect your interests by sound planning to make your ranch decisions less sensitive to drought. Early decisions need to be based on what relief measures are potentially available on the ranch. Among the important factors are:

- Guessing the expected duration of the drought,
- The current water and feed inventories,
- The body condition of the cowherd, and
- Financial resources available.

During drought, decisions may often be made on emotion rather than logic. The main goal is to make objective decisions and get skilled help when necessary from your extension educator, beef specialist, range specialist, or agricultural consultant.

Effect of Drought on Range Plants and Management

Drought is a serious obstacle to successful range livestock management. Producers must understand how drought affects plants, grazing animals, and livestock management, and what options exist. Forage production is decreased dramatically, but reductions are less on range in good and excellent ecological condition.

The ability of perennial plants to recover after drought is closely related to their vigor before and during the drought. Excessive grazing (more than 60 percent of current year's growth) decreases the ability of some plants to recover. Moderate use (25 to 55 percent) does not seem to affect the recovery rate.

A drought may require that livestock numbers be reduced according to forage supply. Retaining a rotational grazing system during drought is recommended over continuous grazing because periodic rest helps plants maintain vigor. Concentrating more animals into a single herd is recommended over having several smaller herds because by having more animals in a pasture, the entire pasture will be grazed more uniformly, and more use will be made of the less-preferred plants. Other options include grazing Crested wheat grass earlier and longer than normal, because it is one of the plants most tolerant of grazing.

Another option is keeping cattle on irrigated or subirrigated sites longer than usual. Fertilizer could be used to increase forage production on many of these sites. Fertilizer is a cash cost, however, and soils should be tested before fertilizer is applied. Fertilizer needs moisture to be available to the plant, and in times of extreme drought, this may not happen.

Initial Questions

The producers who survive best during drought are those who adopt sound management and financial plans and review them regularly. They make firm decisions, and act quickly and early.

Keep alert for opportunities such as leasing land instead of buying feed. Four factors that affect risk management during a drought include:

1. The total population of cattle in relation to feed availability,
2. How widespread the drought-area is,
3. The time of year and the likelihood of rain and return to adequate feed supplies in your area, and
4. Evaluation of cash flow needs (borrowing your way through a drought to maintain traditional herd size may inhibit long term profitability).

Most Common Advice: Decide Early

- Make decisions early during drought,
- Adopt more adaptive herd management and land use, and
- Reduce pressure on the range—which is good for the enterprise *and* range ecology.

What can help ranchers make this choice (earlier) in a drought?

- Timely drought information (drought early warning and monitoring)
- Efficient decisions and risk management (decision support)
- Risk mitigation tools (e.g., insurance)

2. Analysis:

Decision modeling

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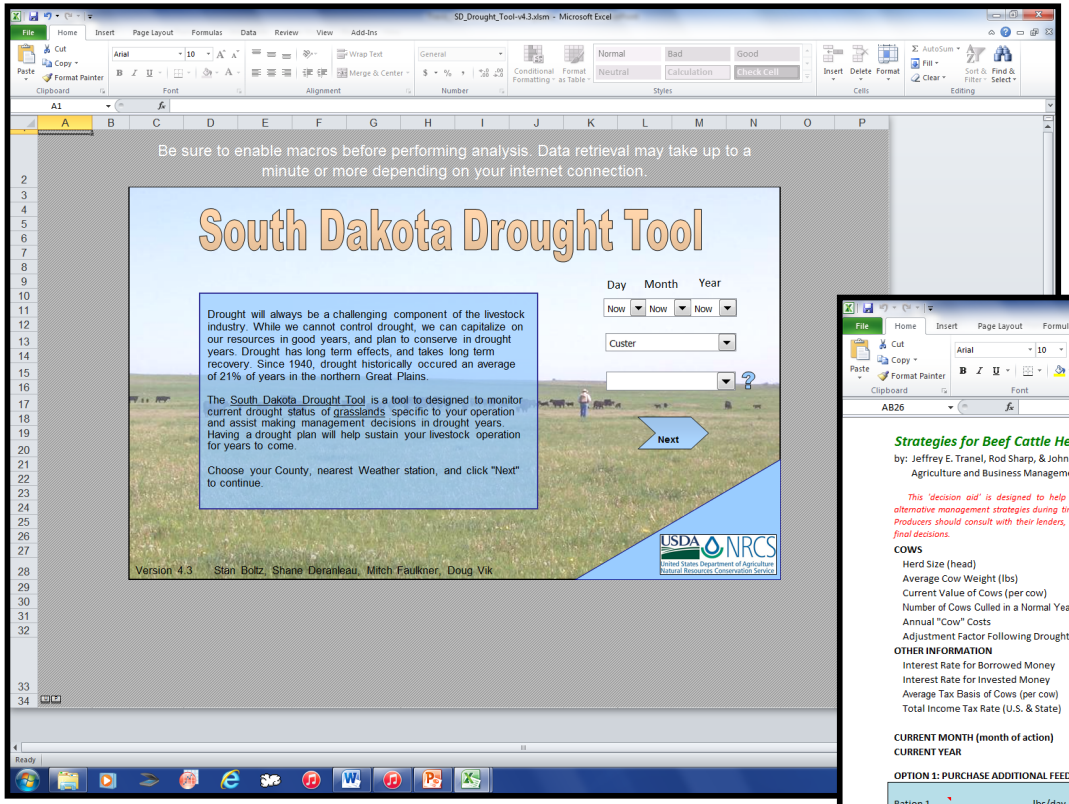
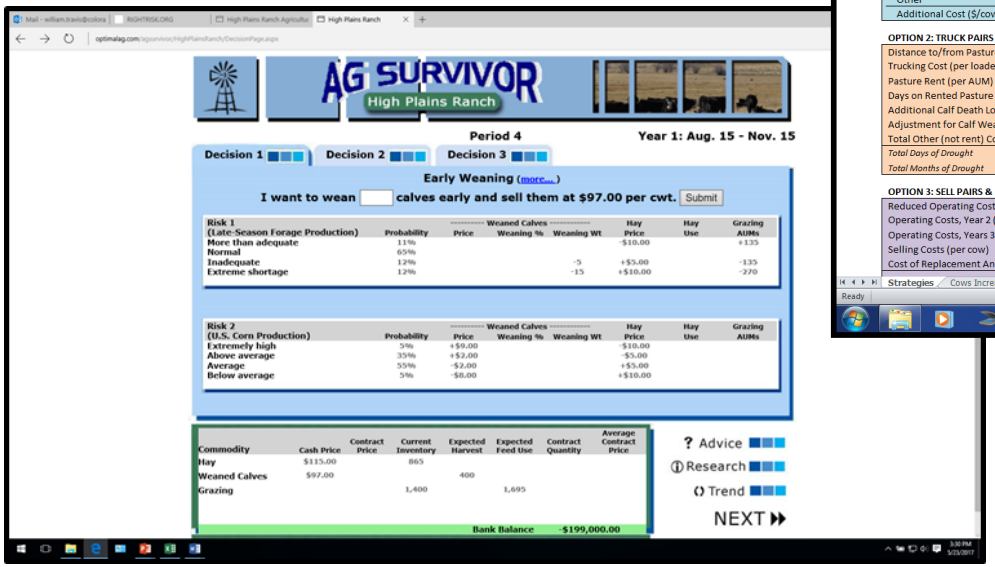
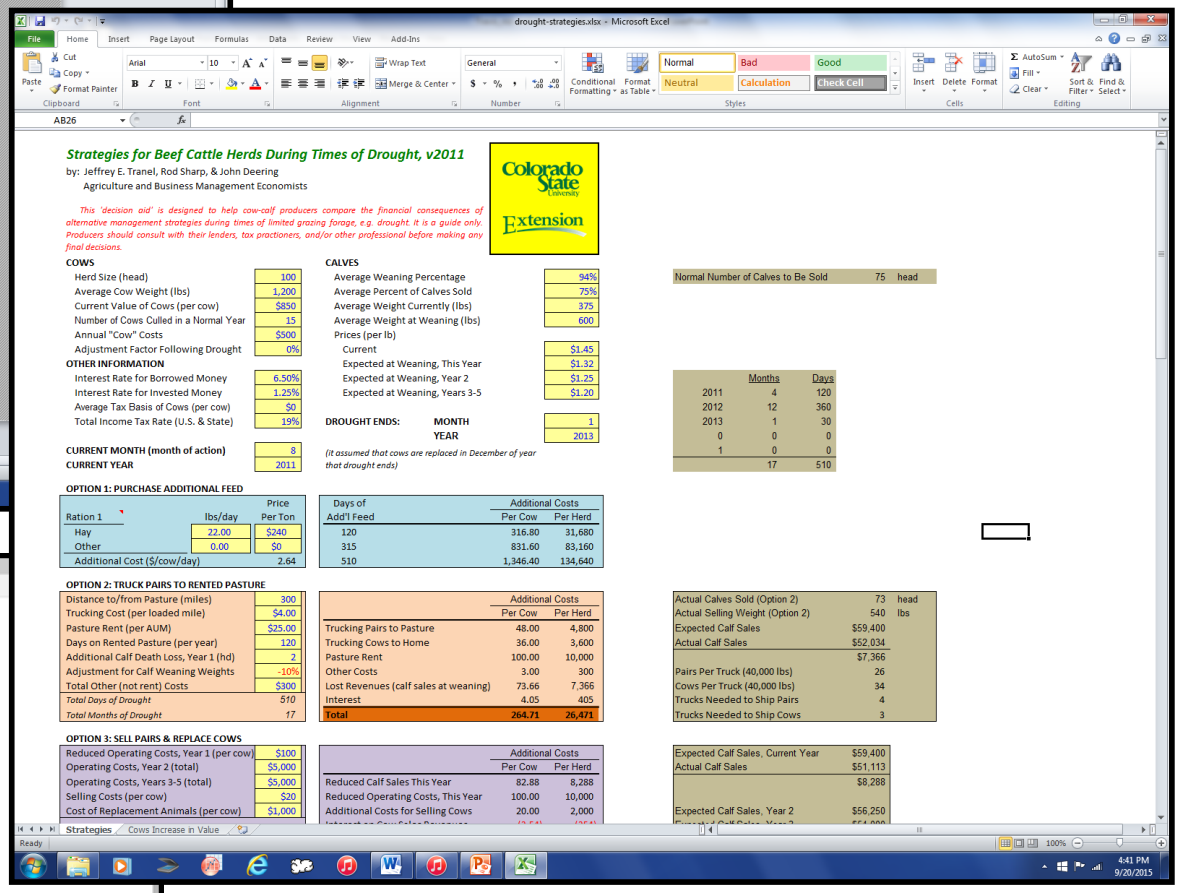
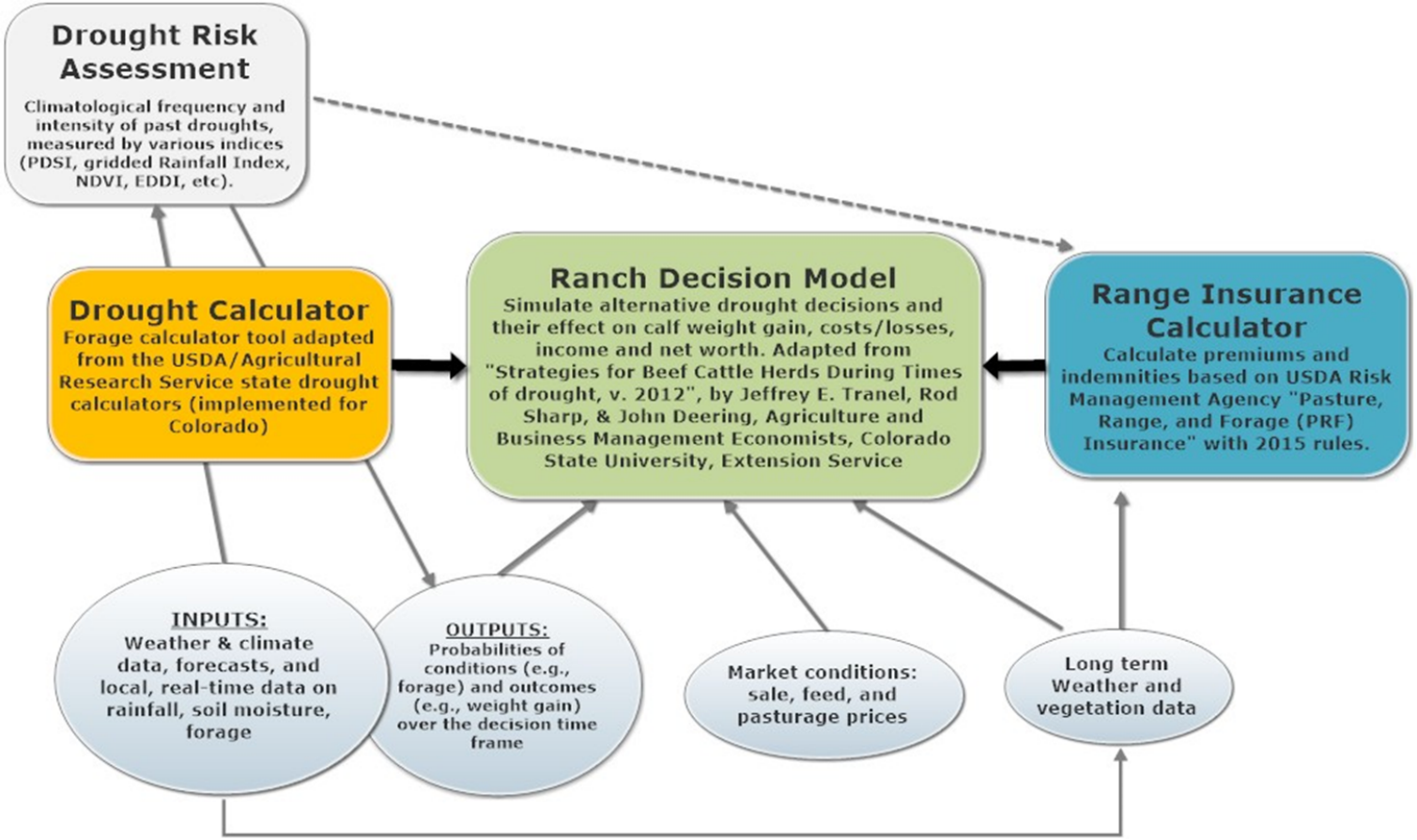
Drought-oriented ranching decision models and other tools can help….







http://www.rightrisk.org/



Our Goal: Create a decision model that combines:

1. Drought
2. Ranch management
3. Insurance

3. Policy:

USDA's Rain-Index Insurance for Pasture, Range, and Forage (PRF)

The USDA's Pasture, Range, and Forage (PRF) insurance program (rainfall index)

http://www.rma.usda.gov/policies/pasturerangeforage/archives.html

USDA Risk Management Agency
United States Department of Agriculture

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You are: Home / Crop Policies and Pilots / PRF Archives

Popular Topics

- Appendix III/M-13
- Bulletins and Handbooks
- Crop Policies and Pilots
- Federal Crop Insurance Corp
- Field Offices: ROs | COs
- Frequently Asked Questions
- Information Browser
- Laws and Regulations
- Livestock Policies
- Reinsurance Agreements

PRF Archives

2015

Rainfall Index

- County Availability (PDF): Map | Text
- Basic Provisions (PDF) See mandatory Ineligibility Amendment, Farm Bill Amendment, and footnotes.
  - Ineligibility Amendment (15-Ineligibility)
  - Farm Bill Amendment (15-RIVI-Farm Bill)
- Policy Provisions (PDF)
- Insurance Standards Handbook (PDF) (Revised Apr 2013)
- Grid ID Locator, Decision Support Tool, Historical Indices

Vegetation Index

- County Availability (PDF): Map | Text
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  - Ineligibility Amendment (15-Ineligibility)
  - Farm Bill Amendment (15-RIVI-Farm Bill)
- Policy Provisions (PDF)
- Insurance Standards Handbook (PDF) (Revised Apr 2013)
- Grid ID Locator, Decision Support Tool, Historical Indices
- Downloadable Interactive PRF Spreadsheet - Total Loss Factor: XLS | PDF

Ineligibility Amendment (15-Ineligibility) modifies the Rainfall and Vegetation Index Plan of Insurance Basic Provisions for the 2015 and succeeding crop years.

Farm Bill Amendment (15-RIVI-Farm Bill) modifies the Rainfall and Vegetation Index Plan of Insurance Basic Provisions for the 2015 and succeeding crop years.

2013

Rainfall Index

- Basic Provisions (PDF) See mandatory Ineligibility Amendment, Farm Bill Amendment, and footnotes.
- Insurance Standards Handbook (PDF) (Revised Apr 2013)
- Insurance Standards Handbook (PDF)
- Policy Provisions (PDF)

http://www.rma.usda.gov/policies/2015/15ineligibility.pdf

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http://maps.agforceusa.com/prf/ri/ | PRF Grid Locator | PRF Decision Support Tool

Home | Help

Grid Locator

Pasture, Rangeland, Forage

Find a Location: Search

Enter name, address, or latitude/longitude values. More Info

Vegetation | Rainfall

Grids: ☑ Labels: ☑ Counties: ☐ Labels: ☑ Marker Info: ☐ Degrees ○ Decimal Google Maps Print

Current Location

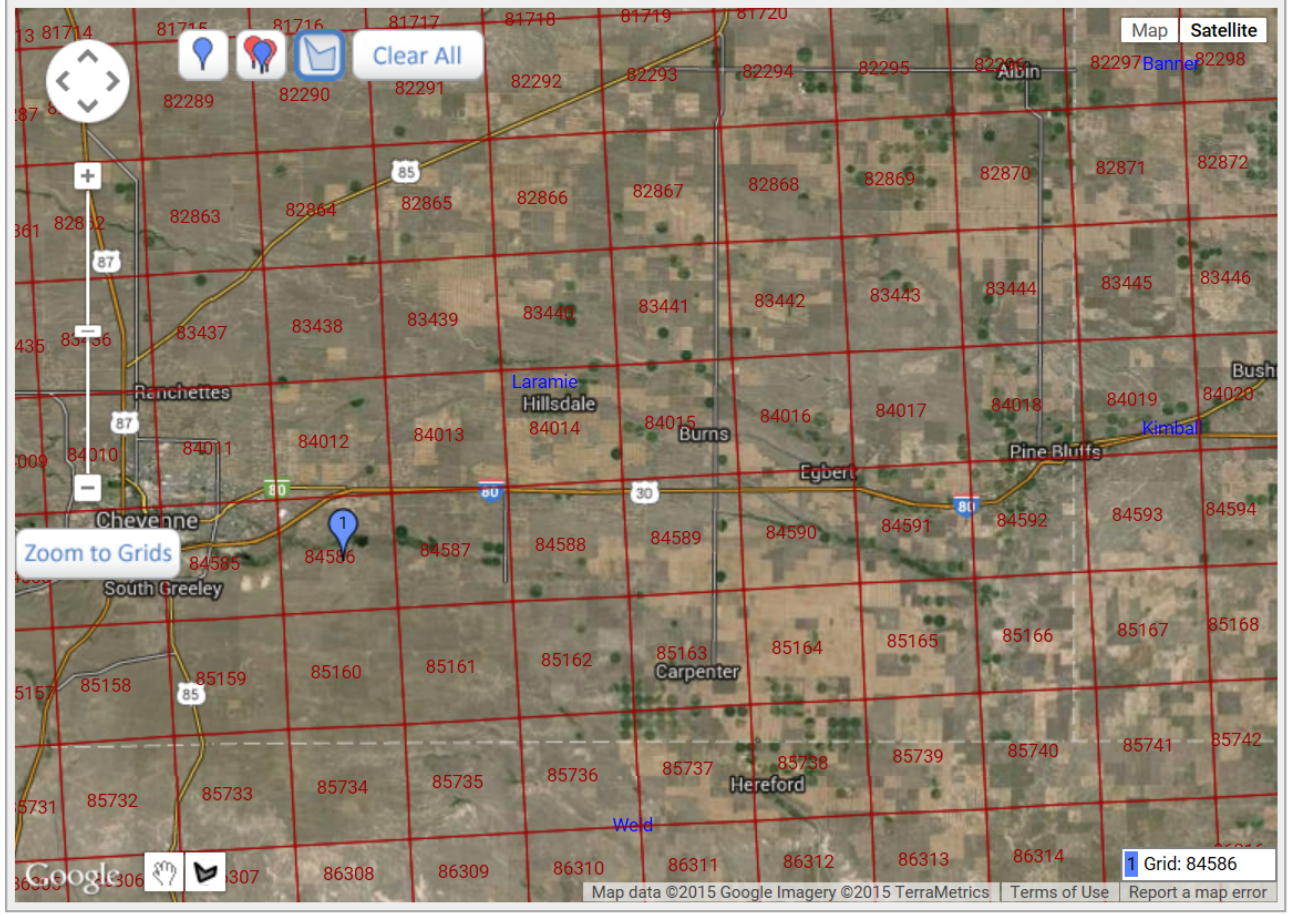
Grid ID: **84586**
Latitude: 41° 6' 48.61" N
Longitude: 104° 39' 25.69" W
County: Laramie
State: Wyoming
Address: 3359 Campstool Road, Cheyenne, WY 82007, USA

Grid Tools:

- Decision Support Tool
- Historical Vegetation Indices
- View Actuarial Info
- View Cost Estimator

Steps

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



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Decision Support Tool

Pasture, Rangeland, Forage

This tool is for illustration purposes only. Your actual information may differ.
For additional information, please click here.

Rainfall | Vegetation

Please Select a Location: State: Wyoming | County: Laramie | Grid: 84587 | Grid Locator | Print

Protection Information

Intended Use: Grazing

Coverage Level (%): 70

Productivity Factor (%): 100

Insurable Interest (%): 100

Insured Acres: 2000

Sample Year: 1989

Graph

Type:

Index Values | Estimated Indemnities

Range:

Start 1989 End 2015

Intervals:

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

Table | Graph

Index Interval	Percent of Value (%)	Policy Protection per Unit	Premium Rate per $100	Total Premium	Premium Subsidy	Producer Premium	Actual Index Value	Indemnity
Jan-Mar	Interval not valid for selected county.							
Feb-Apr	Interval not valid for selected county.							
Mar-May	Interval not valid for selected county.							
Apr-Jun	100	$11,144	7.58	$845	$498	$347	52.9	$4,764
May-Jul	N/A	$0	10.89	$0	$0	$0	51.6	$0
Jun-Aug	N/A	$0	15.52	$0	$0	$0	53.6	$0
Jul-Sep		$0	18.10	$0	$0	$0	60.1	$0
Aug-Oct		$0	17.35	$0	$0	$0	70.0	$0
Sep-Nov	Interval not valid for selected county.							
Oct-Dec	Interval not valid for selected county.							
Per Acre	N/A	N/A	N/A	$0.42	$0.25	$0.17	N/A	$2.38
Policy Total	2,000	$11,144	N/A	$845	$498	$347	N/A	$4,764

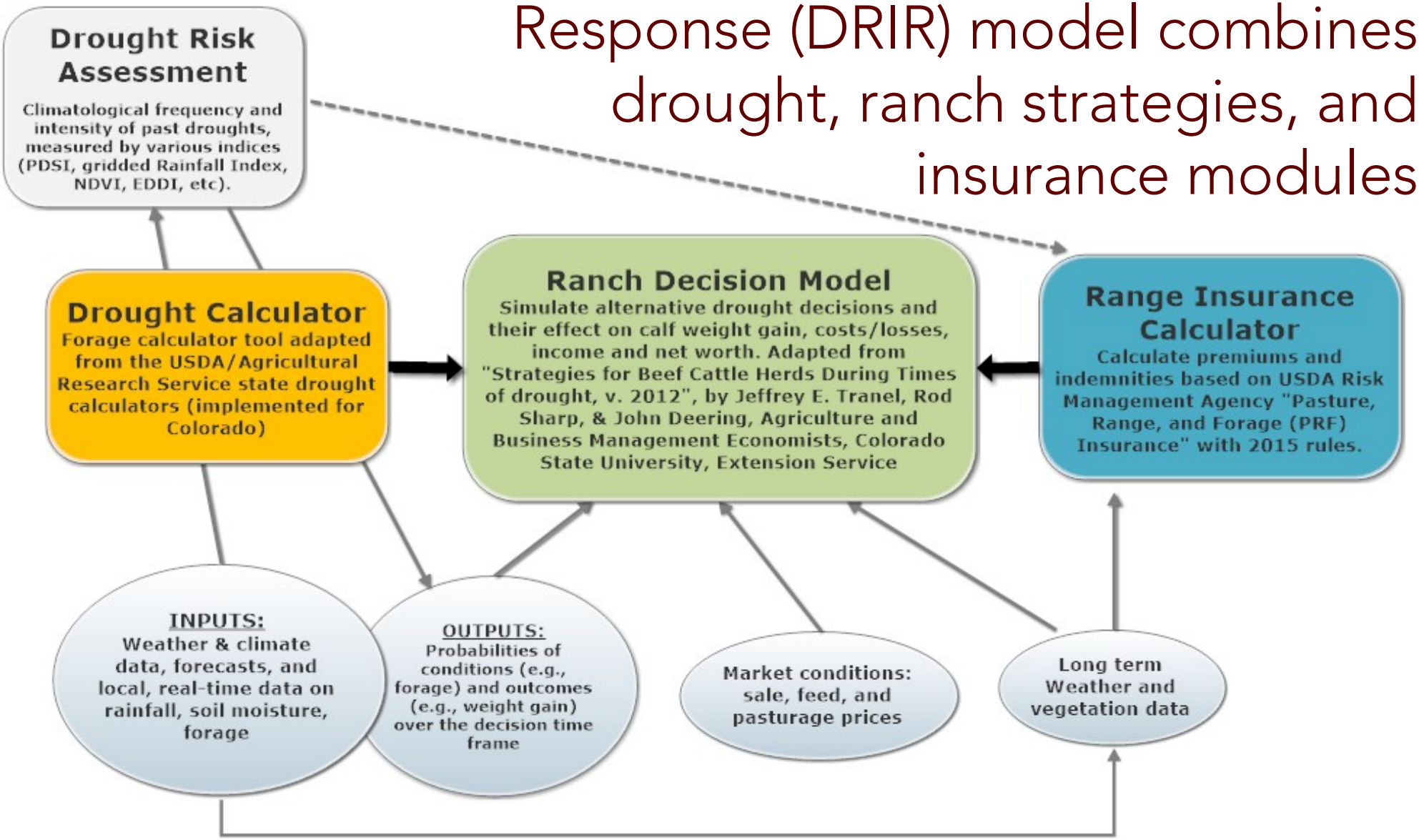
County Base Value	$7.96
Dollar Amount of Protection	$5.57
Total Insured Acres	2,000
Total Policy Protection	$11,144
Subsidy Level	59.0%

Calculate

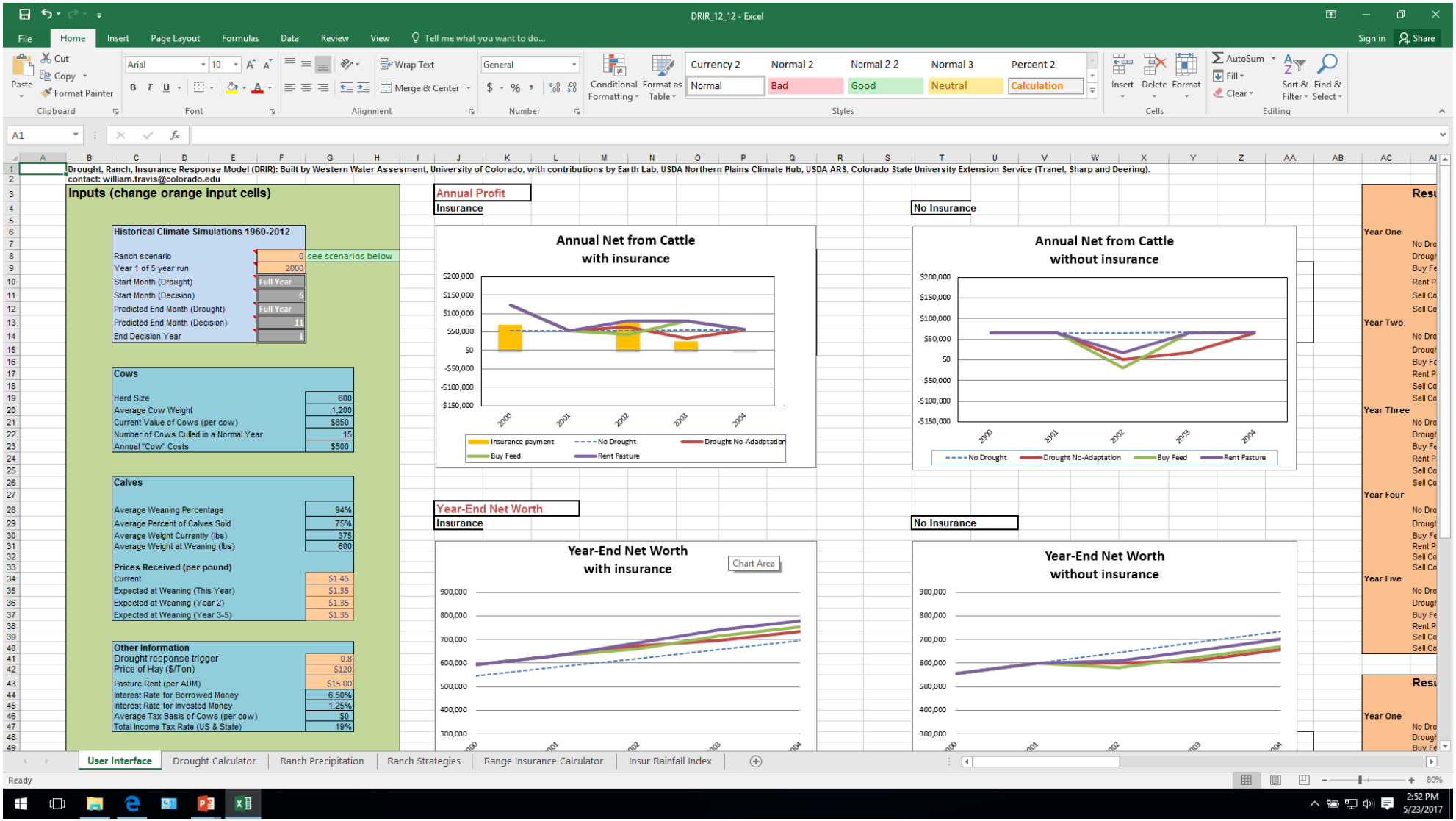
4. New Tools:

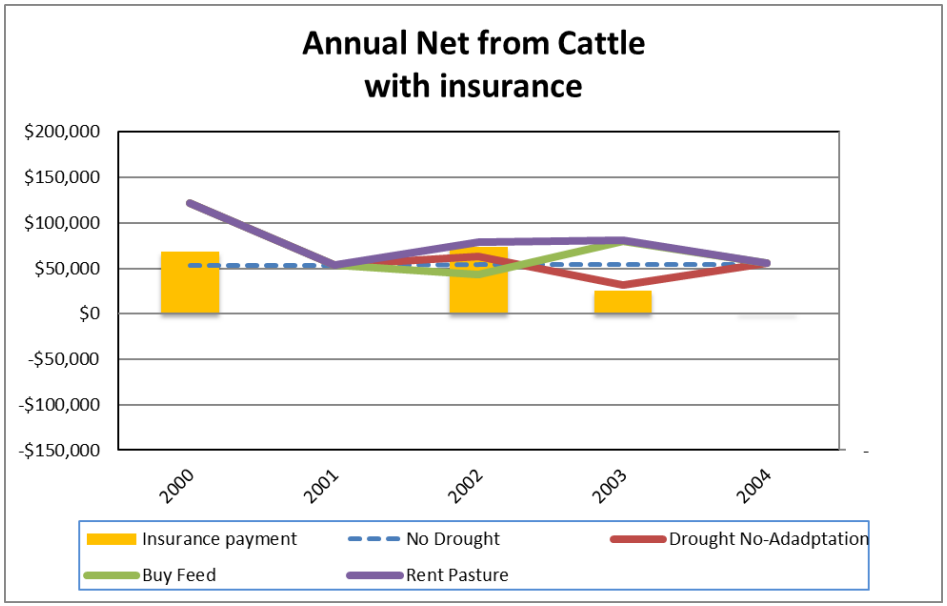
The Drought, Ranching, Insurance Response (DRIR) Model

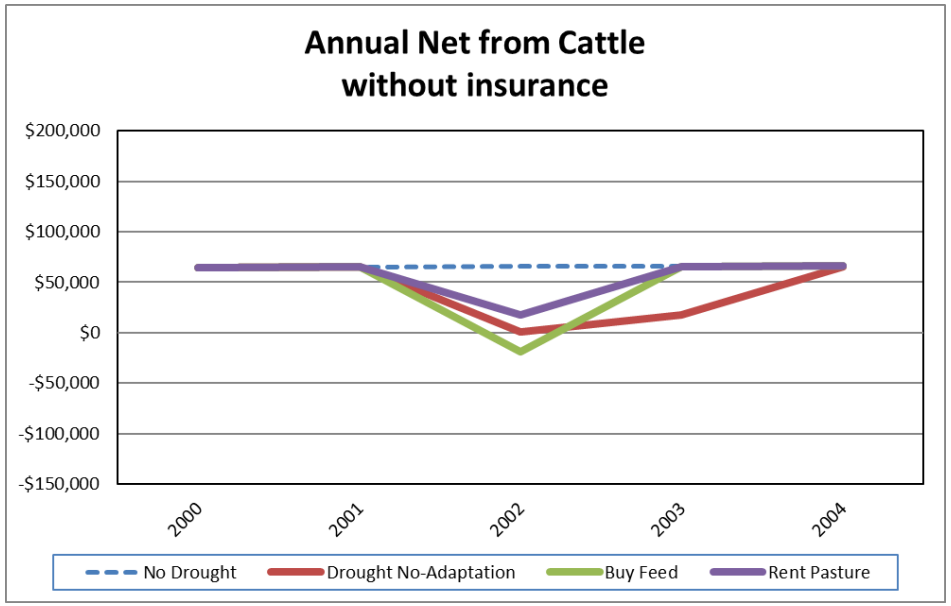
The Drought Ranch Insurance Response (DRIR) model combines drought, ranch strategies, and insurance modules

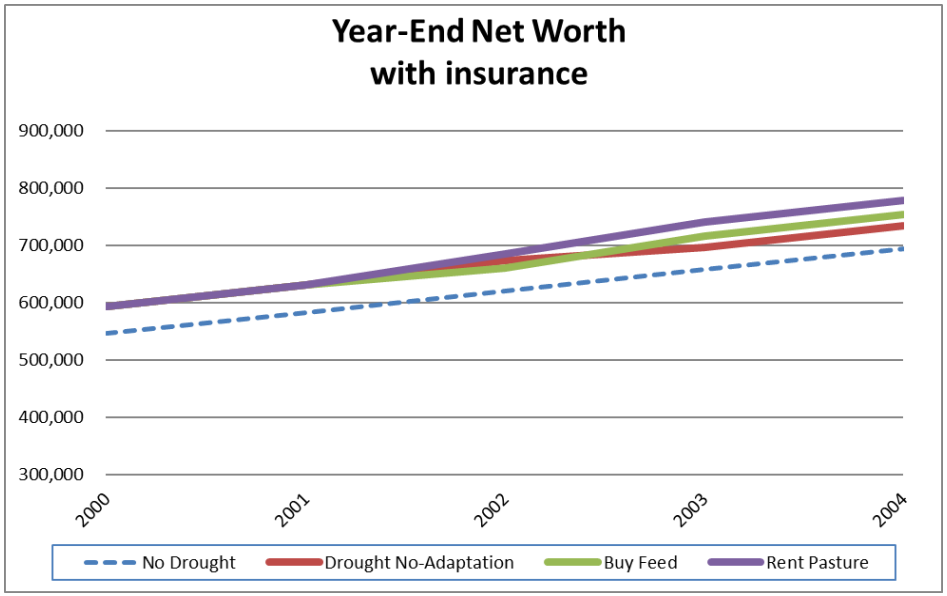


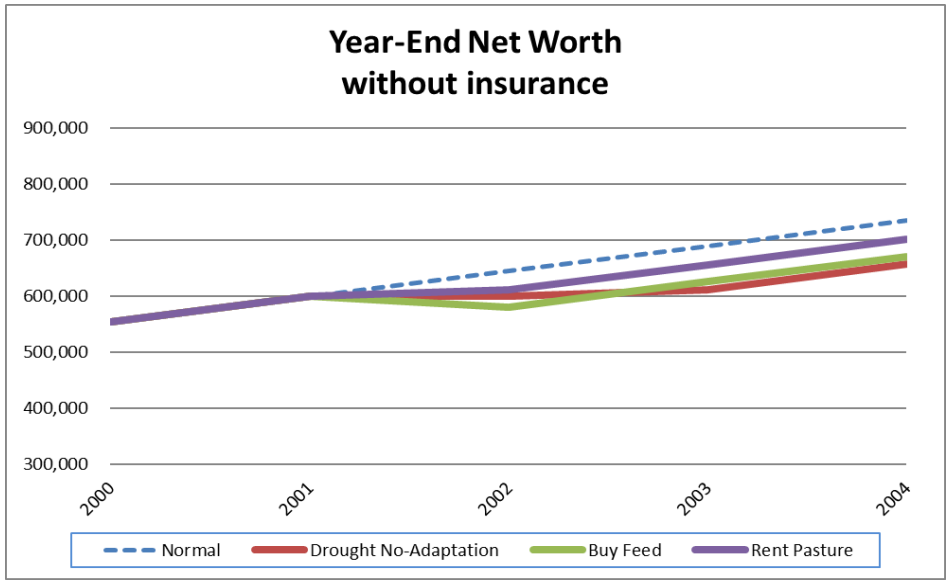
DRIR is written in Excel, built on Jeff Tranel, Rod Sharp, and John Deering's "Strategies for beef cattle herds during times of drought"











Five-year runs for a 600-head cow-calf operation accessing 8,000 acres in eastern Colorado with and without PRF insurance

The DRIR-R Model

- Builds upon the DRIR model
- Written in "R" programming language, with an app for web use
- Extensions on the DRIR model:
  - Dynamic effects on forage potential: Overgrazing reduces future productivity
  - Cow-calf reproduction rates depend on how well fed cows are in the years leading up to reproduction
  - Simplifies drought adaptation: choose intensity of investment, not type of investment
  - Drought adaptation investment is linear, not binary

Ready for a tour?

Link:
https://earthlab.shinyapps.io/drought_decision_model_053117/

Code for insurance treatment: 1234567

Code for no insurance treatment: 2345678

Hypothesis Testing with Randomized Control Experiments

What we will test:

- Does insurance affect the intensity of grazing through larger herds? (upcoming)
- Does insurance affect investment in drought adaptation? (upcoming)
- How does early drought warning information affect investment in drought adaptation? (future/potential experiments)

4. Next Steps:

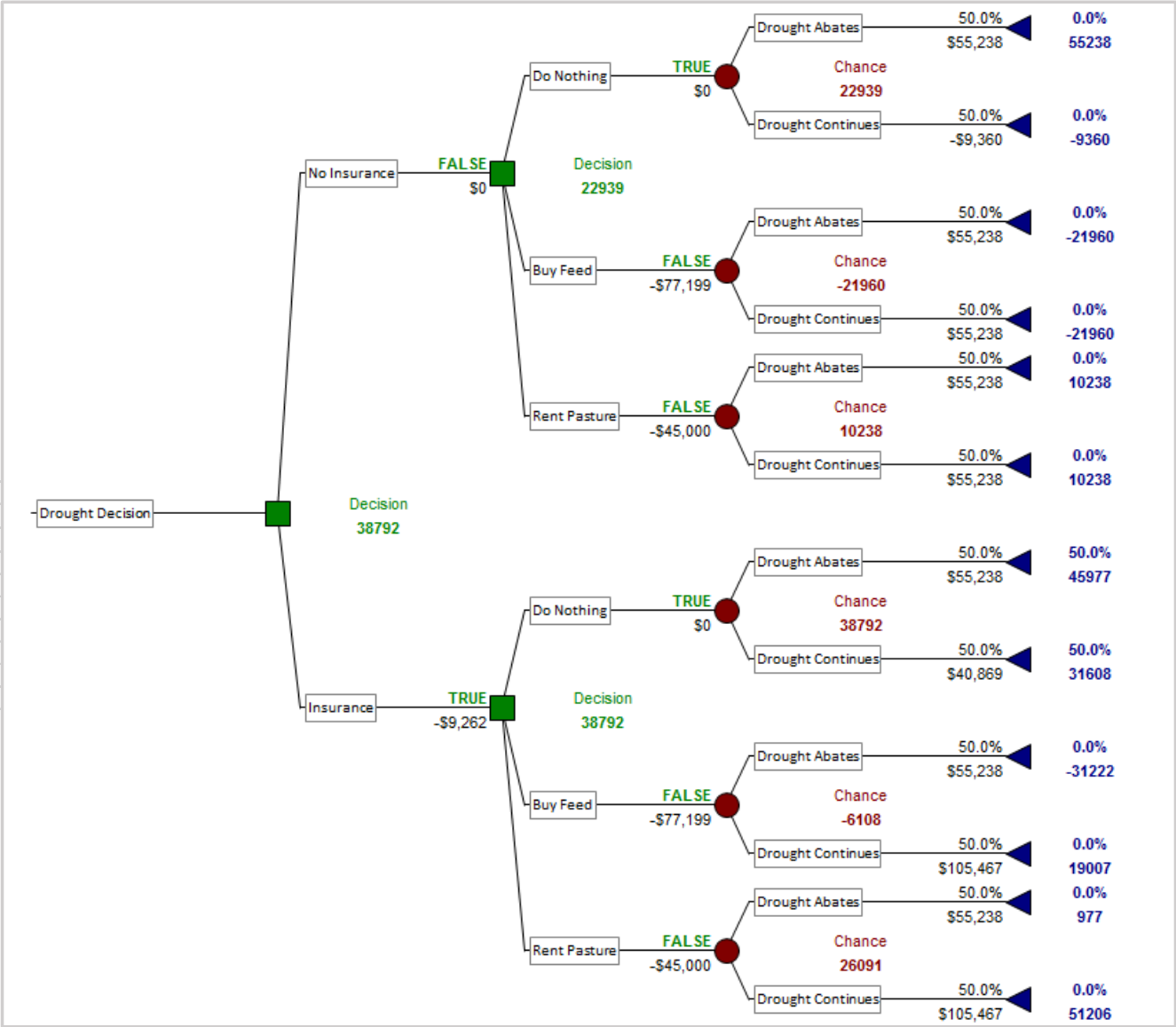
The Value of Drought Early Warning & Testing Drought Indices

Ongoing and future directions

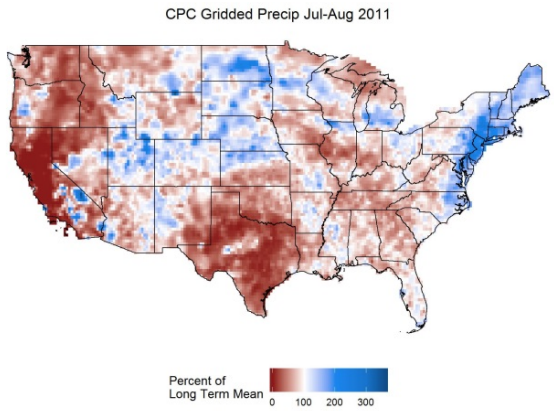
- Examine the value of additional information (VAI) in decision-making (SDO & other forecasts, alternative drought indices)
- Assess ranch outcomes when the RMA PRF insurance payouts are pegged to different drought indices (USDM, EDDI, NDVI, etc.)
- Invite ranchers and policy makers to participate in simulation experiments online and in Earth Lab's visualization and decision studio

Testing the value of drought forecast with a decision tree linked to the DRIR model

2002		
Ranch Strategies Outcomes		
		P drought continuing
Costs of insurance	$ 9,262	
Insurance indemnity	$ 50,229	
Costs of feeding	$ 77,199	
costs of renting pasture	$ 45,000	
non-dr ops costs	$ (309,262)	
drought/no adapt revenue	$ 299,902	
no drought OR adap revenue	$ 364,500	



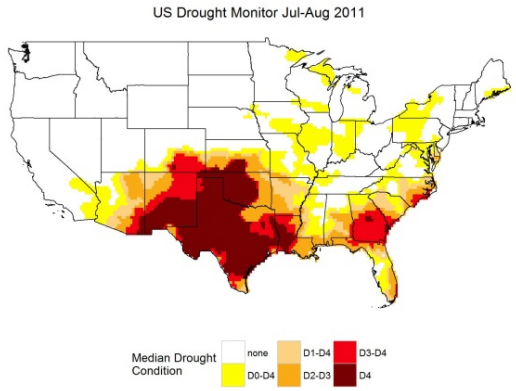
Comparing different drought measures



Gridded Precipitation

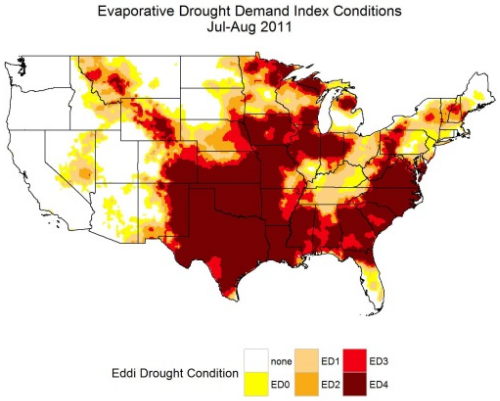
NOAA/CPC's gadded precipitation data set (1948-present), often as monthly totals or percent on long-term means (above), can be used to assess drought risk. The index is from station data interpolated onto a continuous grid over the U.S. at .25 X .25 degrees (about 27 X 23 km) located (NOAA ESRL product description). The precipitation amount for each grid cell is calculated using a distance weighted optimal interpolation of the four nearest reporting stations for that day, summed to monthly values, and normalized against the mean to an index that ranges form 0-200, with 100 being normal.

The USDA Pasture, Forage and Range insurance program uses the index to calculate drought pay-outs on its policies.



U.S. Drought Monitor's Drought intensity levels

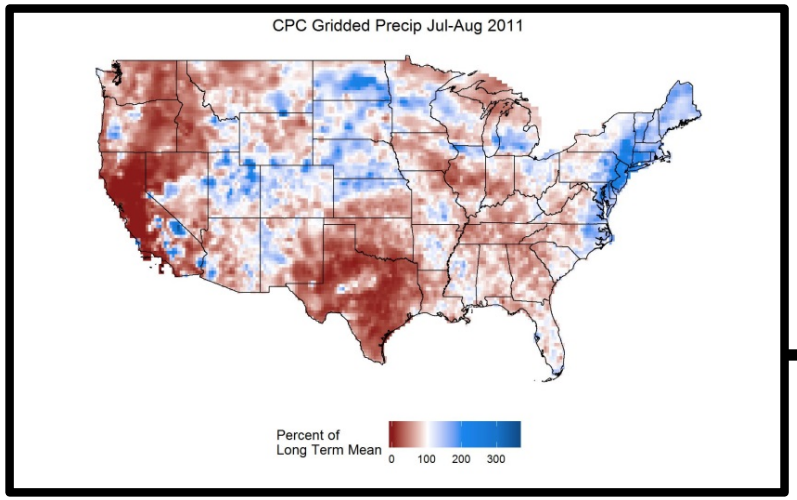
We also use the weekly "U.S. drought Monitor" (NIDIS U.S. Drought Monitor), a combination of meteorological, hydrological, and impacts report that is in wide use. The drought Monitor is mapped in iso-lines of drought intensity, but can also be used as a gridded data via shapefile data from the National Drought Mitigation Center.

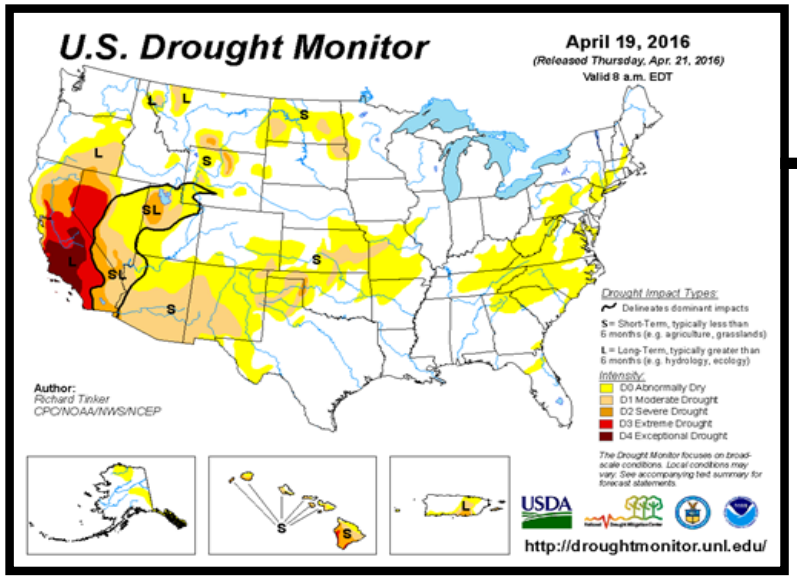


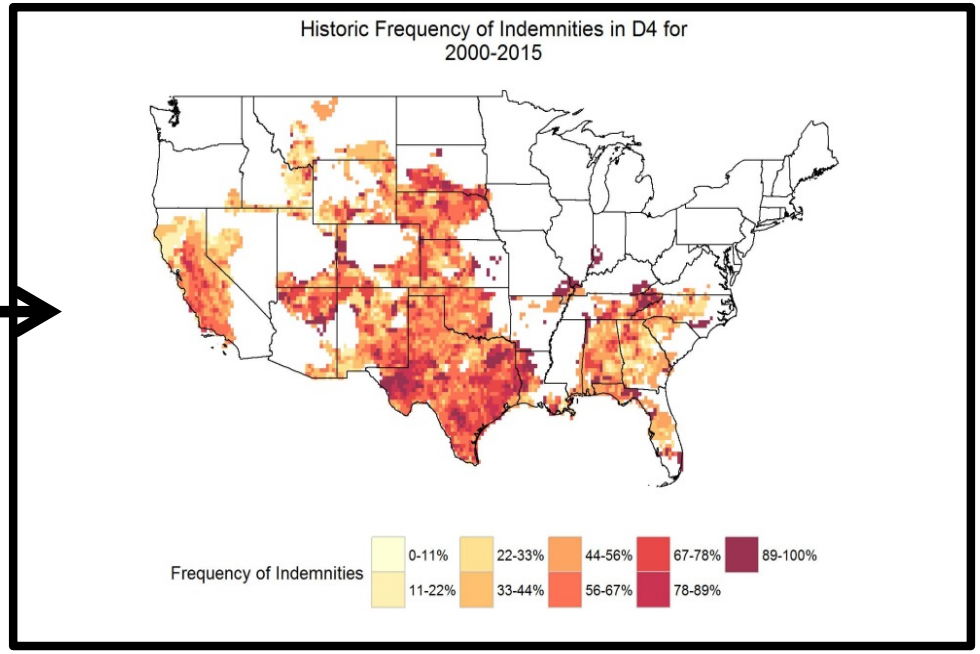
Evaporative Demand Drought Index (EDDI)

EDDI is an experimental drought index under development at NOAA/ESRL to measure drought via evaporative demand or the "thirst of the atmosphere" EDDI 2-pager. EDDI is calculated by comparing the current E_0 to climatology, and is one of several new and experimental products that aim both to measure current drought as well as act as leading indicators. NOAA considers EDDI experimental and the data is not publically available.

How do rainfall-index payments compare to the USDM levels?

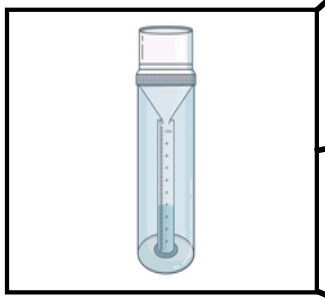


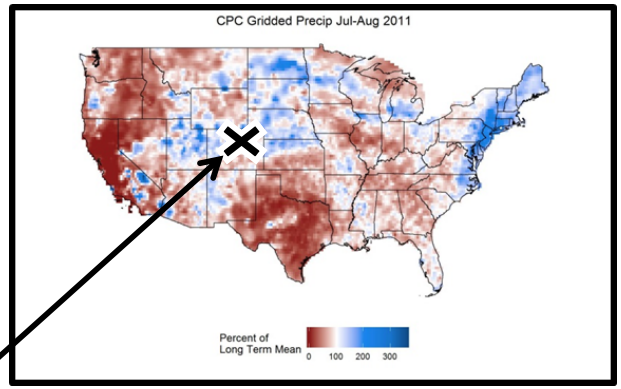


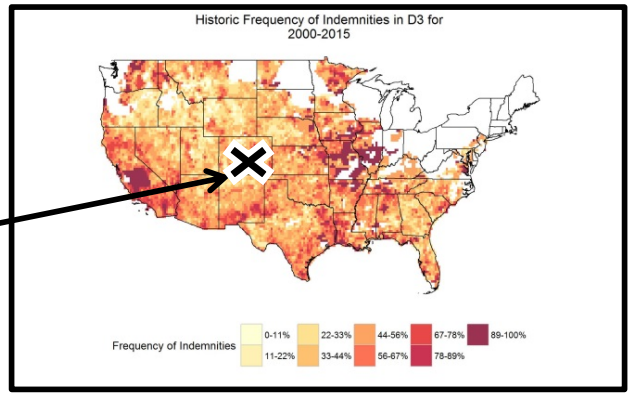


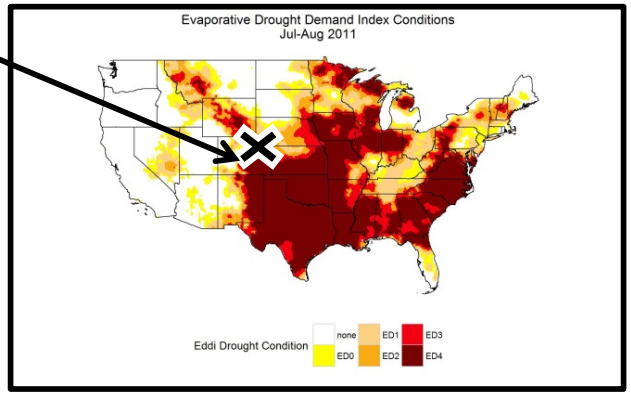
Testing how a ranch rain gauge reflects the PRF gridded rainfall

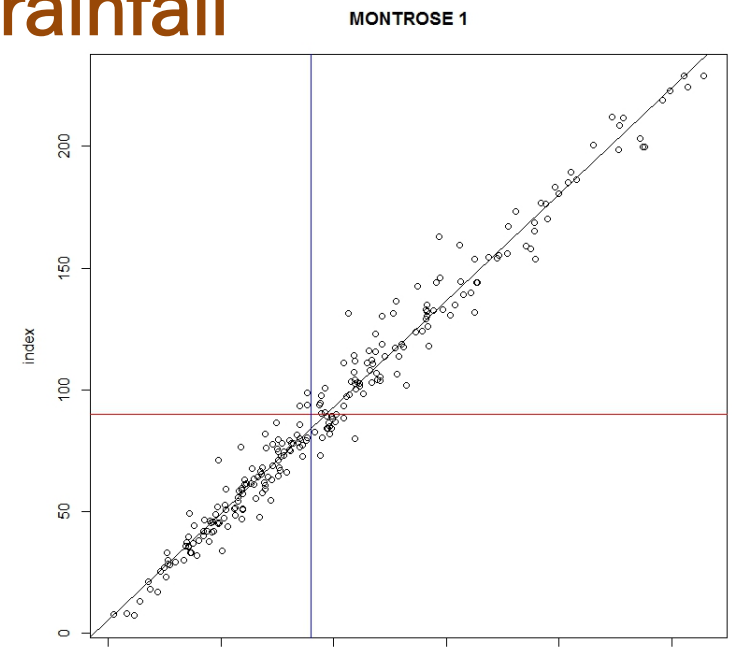
How does a single station, like a rancher's personal rain gage, relate to gridded precipitation, insurance payout, Drought Monitor?

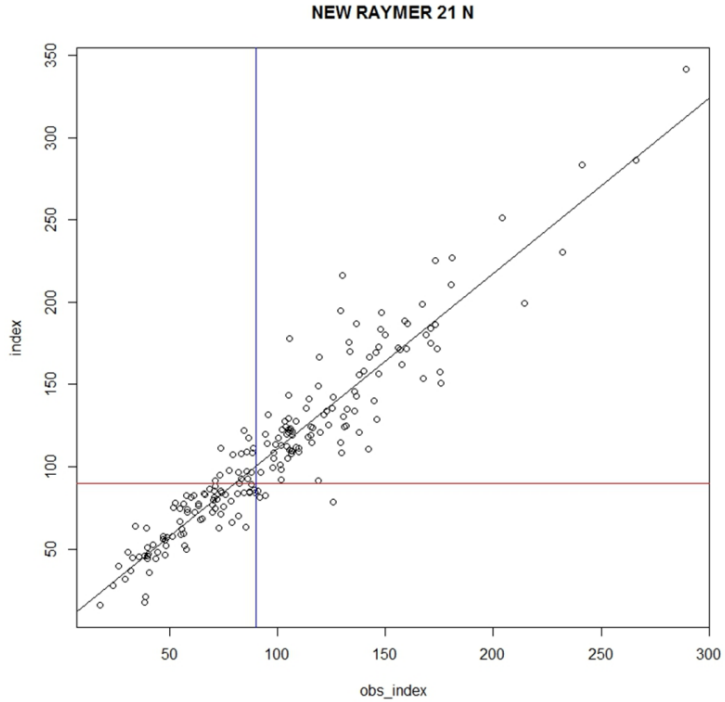












Main Takeaways

1. Ranching provides a testing ground for key theoretical questions on decision-making under uncertainty
2. Models and decision-making tools can help inform policy and stakeholders
3. Randomized controlled experiments powered by decision models can identify key places in drought response where intervention and information can lead to better decisions.

This and other applications of decision models to weather and climate adaptation on WWA website:

- http://wwa.colorado.edu/themes/projects/drought_decision_analysis.html
- http://wwa.colorado.edu/resources/tools/decision_models/index.html

Feedback on the models appreciated:

- william.travis@colorado.edu
- trisha.shrum@colorado.edu

Thanks for your attention!

And a special thank you to:

Justin Derner, Danelle Peck, John Ritten, John Hewlett, Adam McCurdy, Evan Lih, Max Roland, Joe Tuccillo, and Travis Williams