Farmer/Rancher Response to Drought in the West

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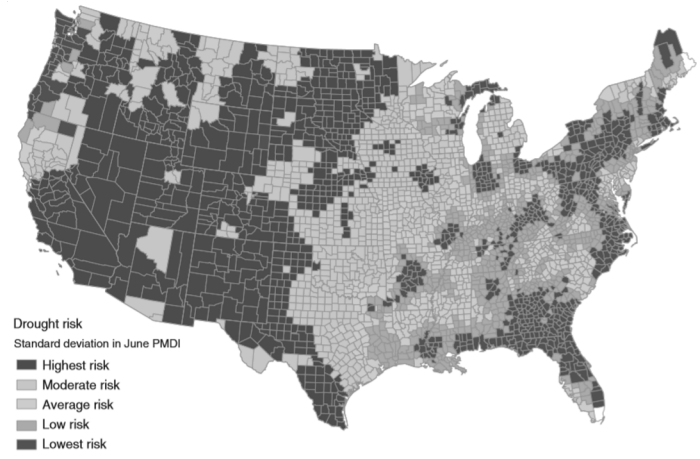
Background

Drought risk in the continental U.S. measured by the Palmer Modified Drought Index



- Drought risk is calculated as the standard deviation in natural soil moisture over the past century, using June data each year.
- Source: Wallander et al., 2013, using data from NOAA.

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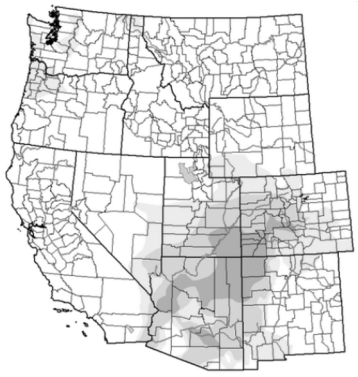
Background

- Drought in the Western U.S. – current (map) and past



Drought Conditions (Percent Area)

Week	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current 10/08/2019	69.63%	30.37%	16.07%	5.31%	0.00%	0.00%
Last Week 10/01/2019	68.40%	31.60%	16.32%	3.16%	0.00%	0.00%
Three Months Ago 7/09/2019	85.38%	14.62%	5.68%	1.26%	0.00%	0.00%
Start of Calendar Year 1/01/2019	28.03%	71.97%	53.25%	27.22%	8.35%	2.88%
Start of Water Year 10/01/2019	68.40%	31.60%	16.32%	3.16%	0.00%	0.00%
One Year Ago 10/09/2018	19.10%	80.90%	57.31%	34.65%	14.13%	3.67%

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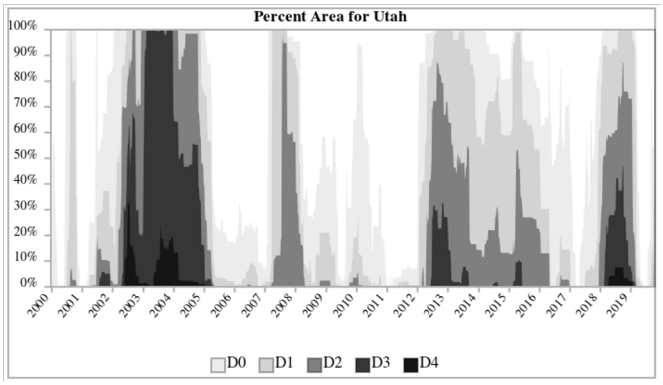
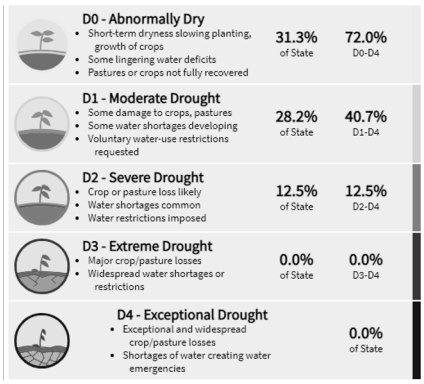
Background

- Drought in Utah

2000-2019



As of October 10, 2019



Source: U.S. Drought Portal

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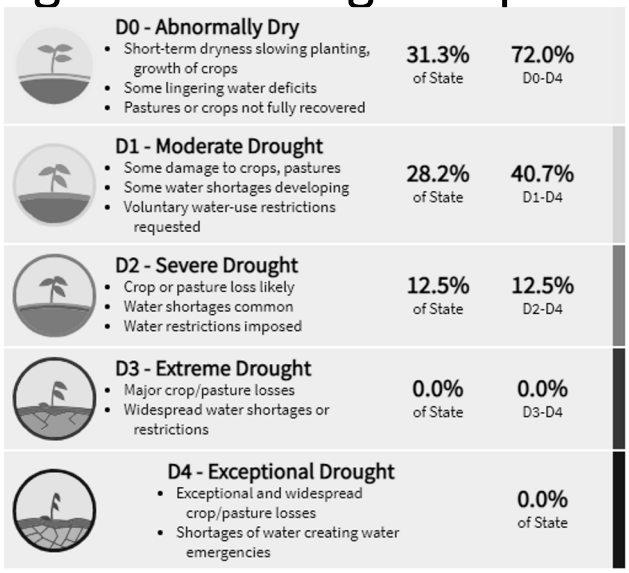
Background: Drought Impacts to Ag.



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Background: Ag. Production Important to Economy

- Livestock production
  - Around 70% of Utah's agricultural income (USDA 2017 Ag. Census)
- Hay and onions
  - High water-use crops
  - Sales in Utah: $176-260 mil./year for hay
  - Sales in Utah: $6.6-$7.4 mil. for onions (UDAF 2018 Annual Report)
- Vegetables and fruits
  - High value crops – important source of income for growers
  - Sales in Utah: $30 mil. for vegetables, $26 mil. for fruits (USDA 2017 Ag. Census)

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Study to Understand

- What drought management strategies do growers/producers prefer
- At what drought levels will growers/producers adopt specific management strategies
- At what drought levels will growers/producers exit farming/ranching

- Inform policy to better assist agriculture to adapt to drought and other climate change factors
  - Legislation, policies, incentives, support, etc.

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Methodology

- Sessions with growers at producer/association meetings in February 2019
  - Hay/forage growers, fresh produce growers, onion growers, and livestock producers
- Growers/producers asked directly :
  - Under what drought circumstances would they exit farming/ranching: open-ended question
  - Which strategy they prefer most among given options: multiple choice question
    - Trade-offs between the offered strategies, but the impact of crop loss/grazing efficiency reduction not examined
  - What percentage of available water loss they consider extreme drought
- Choice experiment (multiple questions) employed to examine the impact of crop loss/grazing efficiency reduction on the preferences
  - Three or four drought management strategies at three levels of drought, 12 choices

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Methodology

- Choice experiment – growers:
  - Asked whether they would adopt a strategy (Y=1) or not (Y=0) given % of crop harvested (varied at 40%, 60%, 80%)
  - Strategies evaluated individually, and they varied across grower groups
  - 2 options – binomial logit model (estimated using Penalized MLE)
- Choice experiment – livestock producers:
  - Asked which one of four strategies they would choose given % reduction of grazing efficiency
  - Strategies evaluated against each other
  - 4 options – multinomial logit model (estimated using MLE)

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Example Experiment Question

- You have 250 acres, where you grow a hay/forage
- Due to drought you could loose a large percentage of your crop
- If you switch to a low water-use crop/variety you will still harvest at least 60% of your crop
- Do you switch, yes or no?
- Do not discuss anything with your neighbor

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Data

Group	N – total	N – usable	Data collection method
Livestock producers	64	48	Producer meeting 2/2019, online spring 2019
Hay/forage growers	28	8	Grower meeting 2/2019
Onion growers	18	13	Grower meeting 2/2019
Vegetable growers	26	21	Online spring 2019

- Analysis done individually for four groups of producers/growers

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Potential Responses to Water Availability & Timing – Ag only

- Concentrate water use on most fertile areas
  - Reduce overall irrigated acres
- Produce high-value crops (price per unit higher)
  - Fresh produce vs. grains, etc.
  - Food grade crops vs. livestock feed
- Produce low water-use crops/varieties (drought or heat resistant)
- Implement water saving irrigation methods
  - Drip vs. flood or sprinkler vs. flood
- Produce annual crops to reduce risk
  - Teff vs. alfalfa (perennial with 5-8 year stand life)

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Other Potential Responses to Climate Change Impacts – Ag only

- Introduce drought resistant grasses to fallow and range areas for livestock feed
  - Alleviate erosion, low to no water needed other than rainfall, provide feed for cattle
- Expand tourism activities around agriculture and food (agritourism, food or cultural tourism)
  - Food and cultural tourism very popular
- Use technology to protect against temperature change, pests, etc.
  - Use of hoop houses (with shade), row covers, netting, etc.
  - Monitor soil moisture and deliver water as needed

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Water Availability – Institutional Reponses

- Tap new water sources
- Reuse/recycle water
- Desalinization
- Change water allocation (rights) to higher valued uses
- Water banking and other delivery structure systems
- Water markets and secondary sales
- Land tenure changes

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Crop Production: What is your best option?

- You have 250 acres, where you grow your current primary crop
- Due to drought you could loose a large percentage of your crop
- Which of the following is your most preferred option?
  - Change to a low-water use crop/variety
  - Change to a more water efficient irrigation system
  - Move out of farming/fallow land
  - Adopt a water saving technology such as low/zero till, cover crop, manure application, etc.

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Most Preferred Strategies

Order	Livestock Producers	Hay Growers	Onion Growers	Vegetable Growers
#1	Purchase feed/lease additional grazing (50%)	More water efficient irrigation system (33%)	More water efficient irrigation system (50%)	Water saving technology (40%)
#2	Reduce the herd (38%)	Low water-use crop (33%)	Stretch out irrigation events (33%)	More water efficient irrigation system (25%); Sacrifice lower value crops (25%)
#3	Change livestock type (8%)	Water saving technology (17%)	Move out of farming (8%); Low water-use crop (8%)	Change to a drought resistant crop (10%)
#4	Transition out of livestock production (4%)	Move out of farming (17%)	Finish the crop early (0%)	Move out of farming (0%)
#5	Other (0%)	-	-	-

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Sample Stats

Characteristic	Vegetable growers		Onion growers		Hay growers		Livestock producers	
Acres farmed (growers)/animals managed (livestock producers)	<=10 11-25 26-100 >100	79% (19) 8% (2) 0% (0) 13% (3)	NA <50 51-100 101-300	47% (8) 24% (4) 24% (4) 6% (1)	NA 0-300 301-1000 >1000	18% (4) 23% (5) 18% (4) 41% (9)	<50 51-200 201-400 401-700 >700	24% (8) 48% (16) 21% (7) 0% (0) 6% (2)
Primary crop/livestock type (secondary crop for onion growers)	Veggies Tree fruit Other	85% (22) 8% (2) 8% (2)	None Corn Wheat Veggies Other	27% (4) 7% (1) 13% (2) 47% (7) 7% (1)	Hay Cattle Other	85% (17) 5% (1) 10% (2)	Calf/cattle Sheep/Lamb Poultry/Eggs Dairy/Milk Other	81% (43) 8% (4) 2% (1) 2% (1) 8% (4)
Irrigation system used primarily (growers only)	NA Flood Wheel Pivot Drip Other	0% (0) 12% (3) 0% (0) 4% (1) 65% (17) 19% (5)	NA Flood Furrow Drip Other	27% (4) 33% (5) 7% (1) 27% (4) 7% (1)	NA Flood Wheel Pivot Drip Other	10% (2) 14% (3) 29% (6) 43% (9) 5% (1) 0% (0)	-	-

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Sample Stats

Characteristic	Categories	Vegetable growers	Onion growers	Hay growers	Livestock producers
Specify what is a large % of crop loss/grazing efficiency reduction to you	100%	0% (0)	9% (1)	0% (0)	0% (0)
	80-99%	0% (0)	9% (1)	11% (1)	4% (1)
	60-79%	13% (3)	27% (3)	44% (4)	25% (6)
	40-59%	46% (11)	36% (4)	11% (1)	38% (9)
	20-39%	29% (7)	18% (2)	33% (3)	25% (6)
	<20%	13% (3)	0% (0)	0% (0)	8% (2)

- Vegetable growers appear most sensitive to crop loss
- Onion growers appear the least sensitive to crop loss

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Results: Vegetable Growers

Strategy	(1) Adopt a water-saving technology		(2) Switch to a drought-resistant variety		(3) Sacrifice lower value crops	
N of obs.	72	59	64	60	66	59
WTA	34.7%**	36.0%**	52.9%***	53.3%***	53.7%***	56.6%***
Wald χ^2	8.39***	7.29***	10.38***	10.49***	17.20***	16.71***

Notes: *** and ** denote significance at 1% and 5% level, respectively. $WTA = -(\alpha_i/\beta_i) * 100\%$.
Confidence intervals for WTA determined using Krinsky & Robb method with 10,000 replications.

- Same conclusion regardless of the number of observations
- Water-saving technology– growers are willing to do so if they harvest at least 36% of crop
- The other two strategies are similarly preferred (minimum crop harvested 53-57%)

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Results: Vegetable Growers

- Switch to a drought-resistant variety
  - Those farming on 11-25 acres significantly less willing (WTA = 102%) than those on 10 acres or less (47%)
  - Those with 5 varieties or less significantly less willing (WTA = 84%) than those with 6-50 varieties (48%)
- Sacrifice lower value crops
  - Those who think <20% is a large crop reduction significantly more willing (WTA = 24%) than those who think 20-39% (59%) or 40-59% (57%) is a large reduction

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Results: Livestock Producers

Strategy	Coefficient	Est.	S.E.
Reduce the herd	Constant α	-0.82	0.50
	Grazing efficiency red. β	0.48	0.80
Change livestock type	Constant α	-3.94**	1.58
	Grazing efficiency red. β	3.25	2.29
Transition out of livestock production	Constant α	-3.20**	1.48
	Grazing efficiency red. β	1.16	2.25
Purchase feed/rent grazing area (base option)	Constant α	-	-
	Grazing efficiency red. β	-	-
N of obs.		162	
Log-Likelihood		-162.59	
Wald χ^2		2.62	

Notes: ** denote significance at 5% level.

- Insignificant β – grazing efficiency reduction does not affect preferences
- Significant and negative α – strategies are preferred less relative to the base
- WTA not reported (all highly insignificant)

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Results: Livestock Producers

- Producer characteristics affect preferences
- Number of animals
  - Those with >200 animals prefer most to purchase additional feed, and are less likely to reduce herd and change livestock type relative to those with <200 animals
- Primary livestock type
  - Those with cattle are relatively less likely to change livestock type but more likely to transition out of livestock production than those with other than cattle
- Grazing efficiency reduction perceived to be large
  - Those who think that 0-39% is a large reduction are more likely to change the livestock type than others, but they are relatively less likely to transition out of livestock production

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Results: Hay/Forage Growers

Strategy	(1) Switch to a low water-use crop		(2) Adopt a water-saving technology		(3) Switch to a more efficient irrigation system	
N of obs.	27	22	26	23	32	24
WTA	58.8%***	58.9%**	63.1%**	61.9%**	68.5%***	72.7%***
Wald χ^2	7.50***	5.79**	4.57**	3.33*	6.86***	5.74**

Notes: ***, **, and * denote significance at 1%, 5%, and 10% level, respectively. $WTA = -(\alpha_i/\beta_i) * 100\%$. Confidence intervals for WTA determined using Krinsky & Robb method with 10,000 replications.

- Similar conclusion regardless of the number of observations
- Growers willing to switch to a more efficient irrigation system if they harvest at least 73% of crop
- Similar preferences for the other two strategies

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Results: Hay/Forage Growers

- Adopt a water-saving technology
  - Those managing 200-400 animals significantly more willing (WTA = 21%) than those managing <200 animals (86%)
- Switch to a more efficient irrigation system
  - Least preferred overall
  - But those using flood as primary irrigation significantly more willing (WTA = 30%) than those using wheel line (75%) or pivot (77%)
  - Those who did not use cover crops more willing (WTA = 47%) than those who did (83%)

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Results: Onion Growers

Strategy	(1) Switch to a more efficient irrigation system		(2) Finish the crop early	
N of obs.	35	34	37	36
WTA	61.3%**	59.4%***	69.5%***	70.3%***
Wald χ^2	5.14**	6.09**	8.79***	8.07***

Notes: *** and ** denote significance at 1% and 5% level, respectively. $WTA = -(\alpha_i/\beta_i) * 100\%$. Confidence intervals for WTA determined using Krinsky & Robb method with 10,000 replications.

- Same conclusion regardless of the number of observations
- Onion growers prefer switching to a more efficient irrigation system (at least 59% harvested crop needed) to finishing the crop early (70% harvested crop needed)

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Results: Onion Growers

- Switch to a more efficient irrigation system
  - Those with 101-300 acres significantly less willing (WTA = 104%) than those with 51-100 acres (47%)
  - Those growing vegetables significantly less willing (WTA = 77%) than those with “other” crop (29%), no additional crop (40%) and wheat (50%)
- Finish crop early
  - Those using flood significantly less willing (WTA = 80%) than those selecting “not applicable” (50%) and “other” (50%)

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Results: Conditions for Exiting Farming or Ranching

- Livestock producers (N=25):
  - no or minimal grazing/pasture/forage (N=9);
  - no water/irrigation (N=4);
  - multi-year drought (N=3);
  - high feed cost (N=3);
  - would not sell herd under any circumstances (N=3)
- Onion growers (N=10):
  - not enough water/snow or dry spring (N=4);
  - no water/snow at all (N=2);
  - financial concerns (N=2)
- Vegetable growers (N=19):
  - no water at all (N=8); high water costs (N=6);
  - not enough water (N=4);
  - would not stop under any circumstances (N=3)

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Overview of Results

- Choice of a preferred strategy varies among growers/producers and depends on their characteristics
- The drought would have to be very serious and long-term for growers/producers to exit farming
- Each drought management strategy entails a different cost
  - Those costs need to be identified
- Policies to improve uptake of drought management strategies need to be commodity specific focused and target the most preferred options and compensate growers for costs to be successful

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Round Table Discussion

- Overall question

What types of policy, program assistance, information, tools, or formats, timing, etc. will improve your ability to adapt to drought and other climate change effects?

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1. How have recent droughts affected your operation?

30

2. Were changes in agricultural practices necessary (temporary/permanent), if so what changes were made?

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3. Is increased variability in water supplies a major concern (economically, socially, etc.) for agriculture in the future?

32

4. What is the outlook for this year?

33

5. What other climate effects have you noticed, such as changes in growing degree days, temperatures, etc.?

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6. Are these climate change effects a major concern (economically, socially, etc.)?

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7. Will permanent changes in agricultural practices need to be made, if so, what types of changes do you foresee?

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8. What is your interest in the following?

- Alternative low-water use crops
- High-value food crops
- Irrigation and other water-saving technologies
- Hoop houses and other “protective” technologies
- Financial management/cost reduction strategies
- Marketing and/or market type assessment
- Agronomic strategies (seeding timing, zero/low tillage, stubble retention, integrated pest management, manure applications, cover crops, etc.)

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9. What types of policy or governmental programs (subsidies, USDA programs, etc.) would be most helpful to you in managing climate change effects?

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10. What types of information would be most helpful to you in managing climate change effects?

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11. What methods of information delivery would work best?

- Workshops
- Videos
- Factsheets
- Farm demos/field days
- On-farm trials
- Other???

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What final questions do you have regarding adopting drought management strategies?

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