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Research Report: Producer Response to Drought Policy in the West

Kynda R. Curtis,[a]Φ Tatiana Drugova,[b] and Ruby Ward[c]

[a]*Professor, Department of Applied Economics,*
Utah State University, 4835 Old Main Hill,
Logan, UT 84322 USA

[b]*Postdoctoral Fellow, Department of Applied Economics,*
Utah State University, 4835 Old Main Hill,
Logan, UT 84322 USA

[c]*Professor, Department of Applied Economics,*
Utah State University, 4835 Old Main Hill,
Logan, UT 84322 USA

Abstract

The study assesses Utah producers' preferred drought management strategies, the level of drought at which producers adopt specific management strategies, and the level at which they exit farming/ranching. Results show that preferred strategies differ across producer groups. Fresh produce growers prefer adopting a water-saving technology, hay growers prefer switching to a more efficient irrigation system, and cattle producers prefer purchasing feed or reducing the herd. Producers would only exit farming in dire circumstances, such as no water availability. Policies aimed at assisting with drought adaptation should focus on preferred strategies.

Keywords: drought management, experimental economics, producer adoption, Utah

ΦCorresponding author: Tel: (435) 797-0444
Email: kynda.curtis@usu.edu

Introduction

Agricultural production is responsible for approximately 80% of all consumptive water use in the United States (U.S. Department of Agriculture, 2019). Persistent drought negatively impacts agricultural production, often leading to severe economic consequences in agriculture-based communities (Lal et al., 2012; Howitt et al., 2017). Drought is especially problematic in arid and semi-arid regions in the Western United States. Previous studies have confirmed the negative impacts of climate change and drought on agriculture in terms of reduced yields (Fisher et al., 2012; Kuwayama et al., 2018). In response to drought, producers were found to increase their adoption of water-conservation technologies, fallowing land with low-value crops, groundwater pumping (Zilberman et al., 2002), and conservation tillage (Ding, Schoengold, and Tadesse, 2009).

In this study, we examine producers' preferred drought management strategies in the southwest United States, specifically in Utah, where 65% of the state experienced dry conditions between 2000 and 2019 (National Integrated Drought Information System (NIDIS), 2019a). Utah is the second-driest state in the nation; in 2018–2019, 40.7% of the state suffered moderate to severe drought (NIDIS, 2019b). This level of drought damages pastures and crops and leads to economic losses in agriculture. Water shortages are common, especially in late summer, and water restrictions are often imposed. Agriculture is one of Utah's top five industries contributing to state gross domestic product (GDP); maintaining agricultural production and adapting to drought is important to the Utah economy.

Livestock, hay, and fresh produce are Utah's primary agricultural commodities in terms of sales. Livestock production is the most important agricultural sector, with 70% of all agricultural sales or $1,278 million/year (U.S. Department of Agriculture, 2017). Hay, a high-water-use crop and one of the primary feed sources for livestock, generated $182 million in sales in Utah in 2017 (Utah Department of Agriculture and Food (UDAF), 2018), not including the value of hay grown and consumed by the same operation. Fresh produce is a high-value crop and is very important to the Utah economy, especially on the Wasatch Front, with $56 million in sales annually (U.S. Department of Agriculture, 2017). Fresh produce is grown on smaller farms (< 100 acres) that often use water-conserving irrigation systems.

Production processes for livestock, hay/forage, and fresh produce differ in their water resource needs and likely face distinct challenges in the presence of drought. The objectives of this study are to examine preferred drought management strategies in each of these producer groups, the drought conditions under which they are willing to adopt a particular strategy, and the point at which they would exit farming/ranching. Our findings can inform policies needed to improve the ability of growers and producers to prevent or mitigate the negative effects of drought.

Data

The data for the study were collected separately for fresh produce growers ($N = 26$), hay/forage growers ($N = 88$), and livestock producers ($N = 64$) at producer meetings in 2019. The majority of respondents indicated their farm is located in Utah (91%), and the remainder in Idaho (5%),

Table 1. Selected Grower/Producer Characteristics

	Fresh Produce Growers		Hay/Forage Growers		Livestock Producers	
Characteristic	**Class**	**Count (% share)**	**Class**	**Count (% share)**	**Class**	**Count (% share)**
Acres farmed/animals managed	≤ 10	19 (79)	n/a	4 (6)	< 50	8 (24)
	11–25	2 (8)	≤ 100	14 (23)	51–200	16 (48)
	26–100	0 (0)	101–300	17 (27)	201–400	7 (21)
	> 100	3 (13)	301–1,000	15 (24)	401–700	0 (0)
			> 1,000	12 (19)	> 700	2 (6)
Primary crop/livestock type	Veggies	22 (85)	Hay	37 (61)	Calf/cattle	43 (81)
	Tree fruit	2 (8)	Cattle	16 (26)	Sheep/lamb	4 (8)
	Other	2 (8)	Other	8 (13)	Poultry/eggs	1 (2)
					Dairy/milk	1 (2)
					Other	4 (8)
Irrigation system used	n/a	0 (0)	n/a	2 (3)	–	–
	Flood	3 (12)	Flood	14 (23)		
	Wheel	0 (0)	Wheel	20 (33)		
	Pivot	1 (4)	Pivot	24 (39)		
	Drip	17 (65)	Drip	1 (2)		
	Other	5 (19)	Other	0 (0)		
What is a large % of crop loss/grazing efficiency reduction to you?	100%	0 (0)	100%	0 (0)	100%	0 (0)
	80%–99%	0 (0)	80%–99%	3 (7)	80%–99%	1 (4)
	60%–79%	3 (13)	60%–79%	15 (36)	60%–79%	6 (25)
	40%–59%	11 (46)	40%–59%	11 (26)	40%–59%	9 (38)
	20%–39%	7 (29)	20%–39%	12 (29)	20%–39%	6 (25)
	< 20%	3 (13)	< 20%	1 (2)	< 20%	2 (8)

Arizona (2%), Nevada (2%), Colorado (1%), and Oregon (1%). Table 1 provides an overview of selected producer characteristics. The sampled fresh produce growers farm on less than 10 acres of land (79%), grow vegetables as their primary crop (85%), and use drip as their primary irrigation system (65%). The largest portion of hay/forage growers manage 101–300 acres of cropland (27%), hay is their primary crop (61%), and they use pivot irrigation (39%). Among sampled livestock producers, 48% manage 51–200 animals, and their primary livestock type is calf/cattle (81%).

Methods

We employed choice experiments to examine how reductions in crop harvested and grazing efficiency, as a result of drought, affected producer preferences for drought management strategies. Fresh produce and hay/forage growers were asked whether they would adopt a particular strategy (= 1 if yes, = 0 otherwise) given the percentage of crop harvested, which was varied at 40%, 60%, and 80% for three strategies that varied across grower groups. In total, growers answered nine choice questions. The analysis for each grower group was completed using binary logit models, estimated using a penalized maximum likelihood estimation (PMLE) procedure.[1]

Livestock producers were asked which one of several strategies they preferred most (= 1 if the strategy is chosen, = 0 otherwise) given the percentage reduction of grazing efficiency. The reduction was varied at 20%, 40%, 60%, and 80% across the questions, while the offered strategies remained the same and consisted of "change livestock type," "purchase feed or rent additional grazing area," "reduce the herd," and "transition out of livestock." In total, producers answered four choice questions. Their choices were analyzed using multinomial logit models.

The utility of producer *n* from choosing strategy *i* is (Train, 2009)

$$U_{nit} = \alpha_i + \beta_i X_t + \varepsilon_{nit}, \quad (1)$$

where X_t is the percentage of crop harvested (growers) or reduction of grazing efficiency (livestock producers) in choice scenario t, β_i represents marginal effect of X_t on the utility, constant α_i represents effect of unobserved factors, and ε_{nit} is an *i.i.d.* type I extreme value. For growers, we can calculate the percentage of crop harvested at which the grower is indifferent between adopting and not adopting the strategy i as

$$WTA_i = -\frac{\alpha_i}{\beta_i} \times 100\%, \quad (2)$$

which represents the minimum crop harvested for which the grower is willing to adopt strategy i instead of not adopting; thus, it is a measure of willingness to adopt (WTA). It is important to note that a lower WTA_i value represents higher willingness to adopt and vice versa. We can also compare the minimum percentage of crop harvested necessary for different strategies to examine growers' preferences for the strategies: If $WTA_i < WTA_j$ for strategies i, j, then strategy i is said

[1] PMLE has been found to improve the MLE estimates by reducing the variance and bias, in particular in smaller samples (Rainey and McCaskey, 2015), which is the case in this study.

to be preferred over strategy j. For livestock producers, equation (2) calculates the percentage reduction of grazing efficiency for which the producer is indifferent between adopting strategy i and base strategy j; efficiency reduction greater than this value will result in strategy i being preferred over base strategy j.

In addition to the choice experiments, we also asked growers/producers directly which one of the offered drought management strategies they preferred most to avoid a large loss of crop/grazing efficiency reduction, not specifying the percentage of crop harvested/grazing efficiency reduction. We also asked them an open-ended question about the drought circumstances under which they would exit ranching/farming.

Results

Tables 2–4 report the results of logit models. For each grower group, the strategies are presented in the column headers, and they follow in the order of preference from most preferred (1) to least preferred (3), based on the calculated WTA_i values. For growers, the analysis is performed using two datasets: dataset A, which contains all collected data, and dataset B, which contains only responses from growers who answered at least one question related to each strategy. Overall, the results are consistent across the two datasets, and we focus on the results from dataset B.

Fresh produce growers (Table 2) are the most willing to adopt a new water-saving technology, followed by switching to a drought-resistant variety and sacrificing lower value crops. The minimum calculated percentage of crop harvested (WTA) for adopting a water-saving technology is 36%, which means that vegetable producers would be willing to adopt a water-saving technology if they can harvest at least 36% of their crop. Hay/forage growers (Table 3) prefer to switch to a more efficient irrigation system rather than adopt a water-saving technology or switch to a low water-use crop.

Table 2. Results for Fresh Produce Growers

Strategy	**(1) Adopt a Water-Saving Technology**		**(2) Switch to a Drought-Resistant Variety**		**(3) Sacrifice Lower-Value Crops**	
Dataset	**A**	**B**	**A**	**B**	**A**	**B**
Intercept α_i	−2.89**	−3.26**	−3.11***	−3.26***	−4.95***	−5.84***
	(1.41)	(1.62)	(1.07)	(1.12)	(1.29)	(1.49)
Percentage of crop harvested β_i	8.32***	9.05***	5.88***	6.11***	9.22***	10.31***
	(2.87)	(3.35)	(1.82)	(1.89)	(2.22)	(2.52)
WTA_i	34.7%**	36.0%**	52.9%***	53.3%***	53.7%***	56.6%***
No. of obs.	72	59	64	60	66	59
Log-likelihood	−25.48	−20.45	−36.47	−33.57	−30.56	−26.08
Wald χ^2	8.39***	7.29***	10.38***	10.49***	17.20***	16.71***

Note: Single, double, and triple asterisks (*, **, ***) denote significance at the 10%, 5%, and 1% levels. Standard errors are in parentheses. WTA_i is calculated as $-(\alpha_i/\beta_i) \times 100\%$. Confidence intervals for WTA are determined using the Krinsky–Robb method with 10,000 replications.

Table 3. Results for Hay/Forage Growers

Strategy	**(1) Switch to a More Efficient Irrigation System**		**(2) Adopt a Water-Saving Technology**		**(3) Switch to a Low-Water-Use Crop**	
Dataset	**A**	**B**	**A**	**B**	**A**	**B**
Intercept α_i	−1.53**	−1.67**	−3.34***	−3.23***	−3.57***	−3.00***
	(0.69)	(0.78)	(0.83)	(0.86)	(0.80)	(0.85)
Percentage of crop harvested β_i	3.81***	4.02***	6.90***	6.72***	6.62***	5.95***
	(1.16)	(1.34)	(1.47)	(1.53)	(1.34)	(1.45)
WTA_i	40.1%**	41.5%**	48.5%***	48.0%***	53.9%***	50.4%***
No. of obs.	143	110	120	109	124	104
Log-likelihood	−83.09	−63.92	−62.21	−56.87	−67.66	−57.82
Wald χ^2	10.76***	9.03***	22.01***	19.36***	24.33***	16.86***

Note: Single, double, and triple asterisks (*, **, ***) denote significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses. WTA_i is calculated as $-(\alpha_i/\beta_i) \times 100\%$. Confidence intervals for *WTA* are determined using the Krinsky–Robb method with 10,000 replications.

Table 4 presents results for livestock producers. Statistically insignificant coefficients β_i mean that a reduction in grazing efficiency does not have an impact on the likelihood of choosing each strategy relative to the base strategy (i.e., purchase feed/rent additional area). A herd reduction strategy is similarly preferred as the base strategy, while the remaining two strategies ("change livestock type" and "transition out of livestock production") are less likely to be chosen. In summary, livestock producers prefer to take actions that are less costly to implement and would keep them in business. In fact, even if grazing efficiency were reduced by 80%, we find that only 3 out of 47 livestock producers would sell off all their livestock and 21 producers would prefer to purchase more feed.

Table 4. Results for Livestock Producers (*N* = 162)

Strategy		**Estimate**	**Std. Error**
Reduce the herd	Intercept α_i	−0.82	0.50
	Grazing efficiency reduction β_i	0.48	0.80
Change livestock type	Intercept α_i	−3.94**	1.58
	Grazing efficiency reduction β_i	3.25	2.29
Transition out of livestock production	Intercept α_i	−3.20**	1.48
	Grazing efficiency reduction β_i	1.16	2.25
Purchase feed/rent additional area (base outcome)	Intercept α_i	–	–
	Grazing efficiency reduction β_i	–	–
Log-likelihood		−162.59	
Wald χ^2		2.62	

Note: Single, double, and triple asterisks (*, **, ***) denote significance at 1%, 5%, and 10% levels, respectively.

Table 5 summarizes shares of producers selecting each strategy as their most preferred to avoid a large (unspecified) loss of crop/grazing efficiency reduction. First, across all groups, "moving out of farming"/"transitioning out of production" is selected as most preferred by a relatively small group of respondents, ranging from 0% (fresh produce growers) to 12% (hay growers). "Adoption of a water saving technology" is the most preferred strategy among fresh produce growers (40% share), in line with our findings based on the logit models. For the remaining strategies, growers' preferences vary somewhat depending on whether they have been given information on the percentage of crop harvested and whether they are evaluating the strategies directly against each other. Hay growers most prefer to switch to a low water-use crop when they are not provided with information on the harvested crop, but this strategy is least preferred for low levels of harvested crop.

Table 5. Share of Respondents Selecting Each Strategy as Most Preferred

Order	Fresh Produce Growers	Hay/Forage Growers	Livestock Producers
#1	Water-saving technology (40%)	Low-water-use crop (35%)	Purchase feed/rent additional area (50%)
#2	More water-efficient irrigation system (25%); Sacrifice lower value crops (25%)	Water-saving technology (31%)	Reduce the herd (38%)
#3	Change to a drought-resistant crop (10%)	More water-efficient irrigation system (22%)	Change livestock type (8%)
#4	Move out of farming (0%)	Move out of farming (12%)	Transition out of livestock production (4%)
#5	–	–	Other (0%)
No. of obs.	20	51	26

Finally, "purchase of feed/renting additional area" is the most preferred strategy for 50% of livestock producers, followed by "reducing the herd" (38%). The remaining options are most preferred by much smaller groups. The preferences when the reduction of grazing efficiency is not specified (Table 5) are very similar to the preferences identified using the logit model (Table 4), which is not surprising given that reducing grazing efficiency was found to not affect preferences. In addition, livestock producers (unlike growers) evaluated the strategies directly against one another in both cases.

Conclusions

In this study, we examine preferred drought management strategies among different groups of producers. We find that, while drought would have to be very serious and long-term for the producers to exit farming/ranching in general, the preferred drought strategies varied among groups. Thus, policies to improve uptake of drought management strategies need to be commodity-specific and target the most preferred options to be successful. Policies also need to compensate producers for the costs of adopting these strategies, but the costs associated with each drought management strategy are different and thus need to be identified. Future work will also examine the applicability of these findings to producers in other regions.

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