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PREFERENCE AND WILLINGNESS TO PAY FOR DROUGHT ASSISTANCE IN CALIFORNIA'S CENTRAL VALLEY

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Abstract

The study uses conjoint-analysis and a contingent valuation method to estimate Central California farmers' willingness-to-pay (WTP) for various attributes of drought assistance programs. It focuses on farmers' valuations about each attribute and the combinations of attributes in a hypothetical environment, and analyzes their rankings of choices when groundwater availability is declining; the current situation for agricultural irrigation in the valley. The online survey with farmers in spring 2019 shows that WTP estimation for drought assistance changes with the type of crop grown: 1) tree-nut growers have the highest, positive WTP; 2) fruit growers have a negative WTP; and 3) other food producers have the lowest, negative WTP. Thus, differentiating between crop growers and planning for assistance accordingly may increase awareness and improve participation of state and federal funded drought assistance programs in Central California.
Keywords: *Drought Assistance, California's Central Valley, WTP, Drought Resistance, Drought Stress.*
JEL Codes: *Q18*

1. Introduction

California's production agriculture uses about four times as much water as its cities (Mount et al., 2015). Over the years, in response to sinking groundwater levels and dwindling rainfall amounts, farmers either switched to crops that generate higher revenue per water use or fallowed crop land. However, producing alternative crops did not improve California's overall output nor did it help with building drought resilience at the farm level (Mount et al. 2015). Moreover, high-revenue generating nut, fruit, and vine crops have little flexibility in water requirements and make land fallow less of an option due to the substantial long-term investment. Only about five percent of land planted to lower-revenue crops was fallowed statewide in 2015. This small-scale, drought-caused fallow led to an economic loss of about $2 billion, and job losses of 17,000 full and part-time farm workers alone (Mount et al. 2015).

California is in urgent need to strengthen the state's ability to withstand drought and support curtailment of water use through drought assistance programs. This includes programs that invest in better water tracking, more accurate water flow measurements, and improved management of water quality, storage and discharges. At the farm level, programs to improve adoption of new water-saving technologies such as remote sensing and improved hydrologic models are critical to help reduce the impact of drought. The State Water Resources Control Board is working with the Department of Water Resources and the legislature to enact meaningful reforms in water use management to enhance the adoption of new programs. With additional funding, studies to understand farmers' preferences and acceptance towards these programs are of paramount importance to support suitable water assistance strategies. Moreover, farm level response is vital in California's water management system to help improve efficiency of water allocation and to mitigate ongoing economic losses. This study identifies farm-level adoption preferences for the Central Valley's agricultural system in order to propose meaningful policy interventions for different crop types based on their water requirements and vulnerabilities to droughts.

The study uses conjoint-analysis and a contingent valuation method to estimate farmers' willingness-to-pay (WTP) for various attributes of drought assistance programs. It focuses on farmers' valuations about each attribute and the combinations of attributes in a hypothetical environment, and analyzes their rankings of choices when groundwater availability is declining; the current situation for agricultural irrigation in the valley. Attributes were selected based on an extensive review of existing drought assistance programs in California. Even though farmers' WTP for irrigation water has been studied (Knapp et al. 2018), little if any research has looked at farmers' preferences for drought induced public assistance. California farmers have expressed strong concerns about groundwater allocation inefficiency throughout the state but traditional drought assistance tends to solely emphasize financial support and overlooks the need for technological help, thus failing to resolve ongoing difficulties. This study examines the economic impacts of drought assistance programs by looking at the perceived benefits and costs of financial and technological assistance for tree-nut, fruit, and other food growers. This allows for a more accurate and nuanced evaluation of drought assistance for the agricultural sector, and is more suitable for the support of effective policy interventions.

2. Agricultural Water Use in the Central Valley

The Central Valley is a vast, flat area that is about 450 miles long and 50 miles wide, located at the geographic center of California. The climate is hot and dry in the summer, and foggy with limited rain in the winter; annual rainfall ranges from a low of 5 inches to a high of 25 inches (Climate Commons, 2019). Agriculture dominates land use in the Valley and the industry has experienced dramatic water shortages, a critical resource to support the nation's largest production of tree nuts, table and wine grapes, dairy and other foods. Reoccurring droughts have pushed producers to rely heavily on groundwater to meet their irrigation needs. Tulare Country, an important study area, approved 3,684 drilling permits for wells since 2014, causing gradual subsidence and increasing the risk that groundwater aquifers permanently lose their ability to recharge (U.S. Climate and Health Alliance, 2017). Given groundwater aquifer subsidence and decreased snowpack in the Sierra Nevada mountain range, which is an important storage source of water for Central California, water availability will continue to decline thus threatening the production of irrigated crops (Fulton et al. 2019).

Irrigation is vital to the sustainability of tree-nut production in California. For example, the Central Valley produces 80 percent of the worlds' almonds. With 450 thousand hectares, the almond industry contributed $21.5 billion to California's economy in 2014 and $5.1 billion to the state's farm exports in 2015. However, each nut requires a gallon of water to grow and the almond industry accounts for 10 percent of the state's annual agricultural water use (Philpott and Lurie, 2015). Water use inefficiency caused the industry to use 81 percent more water than what was used a decade ago and spurred the industry to practice new water-saving technologies and to reduce water waste (Fulton et al. 2019, California Board of Almonds, 2018). However, recently published food research has linked water use efficiency to the nutritional elements generated, rather than just considering the water used per unit of food produced. These studies have applied a new measurement to understand nutritional water productivity calculated as the nutritional elements of energy, protein, calcium, fat, vitamins, and iron generated per unit of water input (Renaut and Wallender, 2000; Fulton et al. 2019). In the case of California's almond production, another method was applied to compute the water footprint of almonds which includes the water consumption from managed sources and effective precipitation. The study shows the water footprint for almonds in California is lower than the global average of water used in almond growing, concluding California almond production is water efficient. Also, when nutritional contributions and market value are considered, almond production was more water efficient than most other foods produced in the region (Fulton et al. 2019). Comparatively, the water footprint for wine and table grapes was higher, indicating less water efficiency when growing grapes.

Published research on droughts in California emphasizes scientific methods of improving soil moisture and water efficiency for different crops but pays little attention to perceived economic losses and how droughts depress the farming community (Lackstrom et al., 2013; Kallis, 2008; Greene, 2018). Using interview data gathered from California farmworkers and local residents, Greene (2018) demonstrates that drought is a source of anxiety that depresses agricultural communities, increases food prices, contributes to unemployment, adds to food insecurity, and hurts the economic stability of the farming region (Greene, 2018). The study reveals that if fruit and tree nut production increases before a drought, farmworkers tend to be more vulnerable economically due to reduced employment opportunities after the drought. The intensification of tree nut and fruit production during a drought induces food insecurity and the redistributed risks of drought from agriculture to surrounding communities lead to reduced quality of living (Greene, 2018).

3. Existing Drought Assistance Programs in California

The United States Department of Agriculture (USDA), as a federal funding source, takes steps to help farmers combat droughts by offering conservation and livestock assistance, crop insurance assistance, credit assistance, and Farm Service Agency disaster designations programs. In 2019, 14 of California's counties were designated disaster areas and 8 counties were contiguous to a designated county. As part of the USDA's Secretarial Disaster Designations Program, farmers in the primary and contiguous counties were eligible to receive emergency loans to help reduce losses (USDA, Disaster Assistance, 2017). For many California growers, the disaster designation program is most widely used with an expedited payment process that can be made within days or hours of the initial request.

Under drought conditions that do not trigger immediate payment, the Disaster Designation Program requires a 30 percent production loss of at least one crop to qualify for emergency funding. The USDA's Farm Service Agency also provides emergency loans to help producers recover from production and physical losses caused by droughts (USDA FSA, 2019). The emergency loans can be used to restore farm operations and cover family living expenses to a maximum amount of $500,000. The Noninsured Crop Disaster Assistance Program (NAP) provides financial assistance to producers of non-insurable crops when low yield, loss of inventory, or prevention of planting occur due to droughts. This Market Risk Management Program provides coverage equal to 50 percent of the approved yield and 55 percent of the average market price, and producers are given the option to buy-up coverage to receive 100 percent of the average market price.

Another funding source of the USDA are the Natural Resources Conservation Service programs that offer technical and financial assistance to eligible agricultural producers (USDA NRCS, 2019). Specifically, the drought-related conservation practice program focuses on improving irrigation systems to ensure farmers are losing the least amount of water due to evaporation, percolation, and runoff. For example, technological help is offered to build drip irrigation, improve soil infiltration, and increase the amount of water directly applied to crop roots. This program allocated $21 million to mitigate the short- and long-term effects of droughts.

With regard to California's Central Valley, the 114th Congress passed H.R.2898 in July 2015 titled *Western Water and American Food Security Act of 2015*. A goal of the bill is to maximize Central Valley Project (CVP) and State Water Project (SWP) water deliveries. The bill was a result of an emergency drought declaration by state officials in 2014, which was preceded by the lowest-ever recorded annual precipitation in 2013 (Congress. Gov. 2019). The bill specified the importance of protecting agricultural production during droughts and allowed the USDA to provide arrangements to offset the negative effects on threatened species such as the Delta Smelt. In April 2017, the governor-assigned Natural Resources Subcommittee in California announced the termination of the 2014 Drought State of Emergency for all counties in California except the counties of Fresno, Kings, Tulare and Tuolumne (California Water Board, 2017), where most of the data for this current study is gathered.

4. Methods

A questionnaire was developed and pre-tested with randomly selected farmers to ensure readability and comprehension of the questions, as well as the ability to hold respondents' attention and interest throughout the questionnaire. Feedback from selected pre-testers was used to refine questions and the response options, and to adjust the number of conjoint analysis questions (choice sets) to answer. A pilot test with more farmers resulted in dropping a few questions that were confusing, further rewording of question response options to communicate meanings more clearly, and reducing the number of conjoint analysis choice sets from six to four for each participant in the online survey. The final questionnaire included 23 questions and was administered online using the Qualtrics Survey Software and required 10-15 minutes to complete. When starting the survey, participants were shown a cover page explaining: 1) the purpose of the study; 2) the potential risks and benefits involved; 3) the confidentiality and voluntary participation terms; and 4) information about the researcher and the primary contact of the university's Internal Review Board. Agribusiness students at California State University, Fresno helped advertise the survey to local farmers. A total of 432 invitations were sent and 97 farmers responded, a response rate of 22.4 percent. The final sample used in this study includes 63 complete observations. The sampling procedure is believed to be appropriate and the resulting sample is unbiased and representative of Central Valley farmers.

Table 1. A Sample Choice Card

Choices	Crop type	Reduced drought impact as % of land area	Length of program period	Level of fee to be paid	Financial support received during droughts	Provided assistance to build drought resistance
1	Fruits	20%	3 years	$3,000	No	A lot
2	Nuts	30%	3 years	$9,000	Yes	A lot
3	Other	10%	3 years	$9,000	Yes	No
4	None of the above options.					

The first section of the questionnaire inquiries about farm products, geographic location using zip code, and farmers' perceived impacts of drought on crop and animal production. The second section asked about drought induced farm-level economic losses, farmers' opinions about the impact of drought, and their willingness to pay for proposed drought assistance. A sample choice set is shown in Table 1. The third section includes farmers' demographic profiles.

This study applies the Choice-based Conjoint (CBC) analysis technique and Lancaster's random utility theory (Lancaster, 1996). We assume that farmers' choice of drought assistance is affected by a bundle of pre-determined program features (i.e., program attributes and attribute levels). The CBC framework is appropriate since it estimates the trade-offs between selected attributes and levels, and thus allows for the computation of dollar values associated with preferred program features. Studies have shown that CBC predicts the probability of one attribute being picked from among a given competing set of attributes, and this framework can mimic a real-world choice situation (McFadden, 1970; Knapp et al. 2018). In this study, we assume groundwater and natural precipitation are scarce resources. In each choice set, farmers are given access to four hypothetical options of drought assistance and they have no access to other water use assistance.

The CBC framework applies the random utility theory and defines the utility of the *ith* farmer U_i ($i=1,\ldots,I$) derived from the *jth* alternative (out of a choice set of *C*) as a function of the selected attributes associated with the choice alternative of *j*:

$$U_{ij} = \beta x_{ij} + \varepsilon_{ij} \quad (1)$$

Where β is a vector of unknown parameters of interest, *x* is a vector of selected attributes in the drought assistant program for choice alternative *j* selected by farmer *i*, and $\mathcal{E}$ is a stochastic error term resulting from measurement errors.

According to McFadden (1974), the probability P_{ij} that individual farmer *i* chooses alternative *j* from choice set *C* is the probability that the utility associated with choice *j* is greater than the utility associated with all other *k* choices in the same set. Thus,

$$P_{ij} = P[(\varepsilon_{ij} - \varepsilon_{ik}) > (\beta x_{ij} - \beta x_{ik}); j \neq k \in c \quad (2)$$

It is assumed the error terms a $\mathcal{E}$ are independent and identically distributed with the Weibull (Gnedenko, extreme value) distribution (McFadden 1974) and that independence of irrelevant alternatives (IIA) is controlled. Thus, the probability of individual respondent *i* choosing alternative *j* is (P_{ij}):

$$P_{ij}(j) = \int \frac{\exp(\beta x_{ij})}{\sum_{k=1}^{J} \exp(\beta x_{ik})} \delta(\beta) d\beta \quad (3)$$

It is further assumed that farmers are cost-sensitive to drought assistance programs such that an expensive program is less likely to be accepted than a similar program that is cost effective:

$$\frac{\partial U}{\partial p} < 0 \quad (4)$$

Where *U* is the estimated utility from equation (1) and *p* represents the estimated coefficients of price, which in this study is the *fee* variable. Willingness to pay (WTP) can be estimated using (Mayen et al. 2007; Xu et al. 2012; Hole 2013):

$$WTP_j \frac{\beta_{j=1} - \beta_{j=0}}{-\beta_{price}} \quad (5)$$

In this instance, WTP denotes the amount of money an individual farmer is willing to give up in exchange for the utility associated with a specific attribute (or feature) of a drought assistance program. The WTP estimate is expected to be positive when changing from the least preferred level to the most preferred level. For all attributes with base levels,
the base level is set to zero ($\beta_{j=0} = 0$) (=0) meaning the farmer would choose the opt-out option. The estimated utility framework is:

$$Utility = \beta_1(nuts) + \beta_2(fruits) + \beta_3(other) + \beta_4(reduce10\%) + \beta_5(reduce20\%) \\ +\beta_6(1\ year) + \beta_7(2\ years) + \beta_8(fee) + \beta_9(support) \\ + \beta_{10}(assistantsome) + \beta_{11}(assistantlot)$$

5. Results

Participating farmers' demographic information is presented in Table 2. These farmers are from 59 zip codes in central California, with 55 percent of them growing tree-nuts (almonds 44%, pistachios 8%and walnuts 3%). The average land size owned by tree-nut growers is 392 acres. Table and wine grape growers make up 21 percent of the sample and own a relatively smaller average land size of 204 acres. The remaining 24 percent of the respondents are livestock related, including meat and milk producers, with an even smaller average land size of 106 acres. Fifty-two percent of participating farms are diversified, defined as producing more than one farm output, with 29 percent producing more than four products. The mean age of participating growers is approximately 33, with 59 percent between 19 and 30 years old. More male (74 percent) growers participated than females and the mean household size count is 3.7 people. The average net household income generated from agricultural activities is $164,000 and that from non-farm activities is $89,000, indicating the importance of agriculture in the region.

Table 2. Participating Farms and their Owners' Information

	Frequency	**Percentage**
Most important farm products		
Almonds	28	44%
Pistachios	5	8%
Walnuts	2	3%
Fruits	13	21%
Other	15	24%
Total	63	100%
Farm diversification		
Grow 1 product	30	48%
Grow 2 products	11	17%
Grow 3 products	4	6%
Grow 4 products and more	18	29%
Total	63	100%
Farm owner's age		
19-30	37	59%
31-40	2	3%
41-50	12	19%
51 and older	12	19%
Total	63	100%
Farm owner's gender		

Male	46	74%
Female	16	26%
Total	62	100%
Net income from agricultural activities		
$0-59,999	12	20%
$60,000-99,999	15	25%
$100,000-159,999	6	10%
$160,000-209,999	7	11%
$210,000-259,999	8	13%
$260,000-309,999	4	7%
$310,000-359,999	3	5%
$360,000-401,999	1	2%
$402,000 and above	5	8%
Total	61	100%
Net income from non-agricultural activities		
$0-59,999	27	44%
$60,000-99,999	14	23%
$100,000-159,999	12	20%
$160,000-209,999	3	5%
$210,000-259,999	3	5%
$260,000-309,999	1	2%
$310,000-359,999	0	0%
$360,000-401,999	1	2%
Total	61	100%
Household head count		
1	2	3%
2	13	21%
3	11	17%
4	19	30%
5	12	19%
6	5	8%
7	1	2%
Total	63	100%
Land size		
Less than 100 acres	30	48%
100-200 acres	11	17%
201-300 acres	5	8%
More than 300 acres	17	27%
Total	63	100%
Farm access to financial services		
Yes	54	86%
No	9	14%
Total	63	100%

Given the sample includes tree-nut growers and growers of other food, the reported impact of droughts on farm activities for the two groups is compared (Table 3). Three types of impacts are differentiated: 1) land area; 2) length of time; and 3) economic loss. The results demonstrate tree-nut growers have a larger land area impacted, are impacted for a longer time, and experience larger economic damage. The more severe drought impacts on high-revenue seeking tree-nut farms may be caused by their larger land size, which makes it more difficult and expensive for drought resilience practices. This may predict the decline of tree-nut farming if droughts are persistent in this area.

Table 3. Reported Impact of Droughts on Farm

Land area impact	Tree nuts growers	Growers of other food
10% or less	8	7
10-20%	5	7
20-30%	12	7
30-40%	4	5
40-50%	4	0
More than 50%	2	2
Counts	35	28
Mean impact	5.833	4.667
Length of time impact	Tree nuts growers	Growers of other food
1 year	5	8
2 years	11	11
3 years	7	4
4 years	4	0
5 years	2	3
More than 5 years	5	2
Counts	34	28
Mean impact	5.667	4.667
Economic loss impact	Tree nuts growers	Growers of other food
10% or less	8	8
10-20%	9	9
20-30%	8	7
30-40%	5	2
40-50%	4	2
More than 50%	1	0
Counts	35	28
Mean impact	5.833	4.667

Table 4 summarizes the estimated coefficients and marginal effects from the conditional logit model. The model's goodness-of-fit is reported using Prob > Chi^2 and log likelihood statistics. The log likelihood of the null model is the one without predictors, which in this study is -368.09. When the 11 independent predictors are included, the log likelihood increases in order to maximize the log likelihood function. This model converges at the second interaction because successive interaction does not add more to the function. The final log likelihood statistic of -425.27 is used to compare efficiency of the nested models and shows that the selected predictors are effective in explaining the dependent variable of choice made. The Prob > Chi^2 statistics report the probability of obtaining the Chi-square statistics when the null hypothesis is true. Given the value for this study is approaching 0, the model is statistically significantly better than the null model in explaining farmers' selection of the best program out of the four alternatives.

Table 4. Estimated Coefficients And Marginal Effects from Conditional Logit Model

Variables	**Coding**	**Coefficient**	**z**	**Marginal Effects at Means**	**z**
Tree nuts	1 if tree nut, 0 otherwise	1.01***	2.71	0.23	2.88
Fruits	1 if fruits, 0 otherwise	0.18	0.47	0.04	0.48
Other products	1 if other products, 0 otherwise	0.13	0.34	0.03	0.34
Reduced drought impact as 10% of land area	Yes=1, No=0	0.06	0.3	0.01	0.30
Reduced drought impact as 20% of land area	Yes=1, No=0	-0.04	-0.21	-0.01	-0.21
1-year program	Yes=1, No=0	-0.03	-0.14	-0.01	-0.14
2-year program	Yes=1, No=0	-0.17	-0.81	-0.04	-0.81
Fees paid (continuous variable)	1=$3,000, 2=$6000, 3=$9,000	0.00	-1.33	0.00	-1.33
Financial support received	Yes=1, No=0	0.66***	3.86	0.15	3.76
Provided a lot of assistance to build drought resistance	Yes=1, No=0	0.49**	2.27	0.11	2.25
Provided some assistance to build drought resistance or not	Yes=1, No=0	0.74***	3.55	0.17	3.47
Log likelihood	-425.27				
Prob > Chi2	0.00				

The only product-specific variable that is statistically significant is the *Tree-nuts* variable (alpha < 5 percent). The estimated parameter for *Tree-nuts* (1.01) is significantly higher than the *fruits* parameter (0.18), which was very similar to that of *other products* (0.13), affirming the finding that tree-nut growers need drought assistance more severely than none tree-nut growers. The marginal effects estimated at the mean level show that tree-nut growers are 23 percent more likely to choose drought assistance than choosing the opt-out option. Whereas, fruit growers are only 4 percent more likely to choose drought assistance than the opt-out alternative. Tree-nut growers also place the highest dollar value on drought assistance and are willing to pay about $21,815 to access the program (Table 5), whereas WTP drops to $3, 921 for fruit growers and $2,846 for growers of other food.

The coefficient for the *financial support* variable is significant (alpha < 1 percent), demonstrating farmers' desire for a program that provides financial assistance. The marginal effect shows that a program with financial support is 15 percent more likely to be selected than one without financial assistance. Since the sign of the coefficient is positive, this indicates a positive relationship between financial support and choice made, and hence the positive willingness to receive. The estimate shows that farmers will expect an average of $14,185 being provided by the program (Table 5). Linking the large and positive WTP valuation from tree-nut growers ($21,815) and the average compensation request of $14,185 as financial assistance, tree-nut growers are only willing to incorporate the difference of $7,630 into their cost of drought mitigation. Nevertheless, the positive WTP means a willingness to absorb a portion of the cost to build drought assistance, which may reflect tree-nut growers' concerns about the rising production cost caused by droughts. Anecdotal evidence shows that tree-nut growers have experienced further reductions in agricultural water allocations due to competing water use by other stakeholders, which forces them to pay a higher price for water. Indeed, compared to many years ago when the cost of water was the cost of the energy needed to pump groundwater from the aquifer, now the expensive price of water adds to the rising cost of land, labor, seed, and machinery, making it more difficult for tree-nut farming to stay profitable.

Table 5. Estimated WTP

Variables	**WTP**	**Upper Bound**	**Lower Bound**
Tree nuts	21,815.34	-5,719.29	49,349.97
Fruits	3,921.82	-10,397.32	18,240.96
Other products	2,846.27	-12,026.17	17,718.71
Reduced drought impact as 10% of land area	1,301.82	-7,468.10	10,071.73
Reduced drought impact as 20% of land area	-940.77	-9,853.90	7,972.37
1-year program	-621.42	-9,269.85	8,027.01
2-year program	-3,562.38	-13,486.23	6,361.47
Financial support received	14,185.04	-7,407.20	35,777.28
Provided a lot of assistance to build drought resistance	10,526.16	-7,224.74	28,277.05
Provided some assistance to build drought resistance or not	15,834.98	-8,661.39	40,331.34

In contrast, fruit and other food growers are less willing to pay out of pocket to support the programs. Fruit growers' WPT is $3,921 and their average request of financial support is $14,185, which results in a negative WTP of $10,264. This means that on average fruit growers demand compensation of $10,264 from the program. Other food producers also request $11,338 of compensation. Thus, fruit and other food growers do not value drought assistance and demonstrate negative WTP for the program. In fact, these growers switch to less water demanding crops such as persimmons to alleviate the impact of drought on economic loss. Further, the marginal effect of 15 percent for financial assistance indicates that a program that offers financial support is 15 percent more likely to be chosen than one without.

The two technological assistance variables are both statistically significant (alpha < 1% and alpha < 5%) meaning that farmers need a program that offers this type of help. If the program provides some technological assistance, the chance of the program being selected is 17 percent higher than one without such assistance. If the program offers a lot of technological help, the chance of being selected will increase by an additional 11 percent. Thus, a program that offers technological assistance is more likely to be selected than one that does not. Farm scale irrigation in central California is inefficient due to the lack of technology to mitigate the impact of droughts. Technologies are needed to: 1) help with irrigating at night; 2) aid in matching water applications to water use targets; 3) increase soil water holding capacity with compost; and 4) store rain runoff during winter. Our sample shows that a program offering some technological assistance results in a WTP of $15,834 and the one offering a lot of technological assistance results in an additional WTP of $10,526.

The dollar estimates of the preference heterogeneity across selected variables provides evidence to agricultural policy makers to help with identification of factors that cause positive and large magnitudes of WTP. Financial support and technological assistance are the two factors that best explain variations about the mean level of choice preference for this sample. This result is within expectation because farming in central California has long been plagued by continuous water shortages. A drought assistance program that only offers short-term help or only reduces the impact of drought on a small scale is considered insufficient to help farmers' vulnerability to water related production risk.

6. Conclusion

California's persistent and severe droughts have caused groundwater level declines and shortages of surface water, which have heavily impacted its agricultural industry. The wide-ranging impact of droughts have put tree-nut, fruit and other food growers under financial stress and created uncertainty for the stability of production outputs. Coping with the rising price of water and adapting to low water availability are of great concern to agricultural producers and policy planners in the Central Valley. Over the years, policy interventions at the local, state and federal levels have mitigated some of the impacts of the water shortage, impacts that would have been much worse without intervention. However, farmers' preferences for drought assistance programs and the features of such programs are overlooked. Identifying elements that have predictive power for influencing producers' WTP for drought assistance are critical for understanding the economic viability of these programs. Understanding farm level WTP valuations have the potential to improve adoption of existing programs and aid in construction of new assistance programs, and both will contribute to the economic viability of agriculture during droughts.

This study demonstrates that WTP estimation for drought assistance changes with the type of crop grown: 1) tree-nut growers have the highest, positive WTP; 2) fruit growers have a negative WTP; and 3) other food producers have the lowest, negative WTP. Grower awareness of ground and surface water scarcity, along with reduced precipitation, may explain the WTP variation. According to Knapp et al. 2018, higher awareness can predict increases in WTP such that tree-nut growers believe water scarcity is a bigger problem which directly affects their farm's economic efficiency, and this is reflected in their positive WTP. However, fruit and other food growers, who may more easily switch to other crops at lower cost, seem to relate smaller WTP to drought assistance. Thus, differentiating between crop growers and planning for assistance accordingly may increase awareness and improve program participation. For high-revenue generating crops like tree-nuts, droughts may predict a higher retail price and thus higher profit margin, making it economically viable to invest in drought assistance rather than switching to other crops. For fruit and other food producers, providing information about market opportunities and helping farmers switch to alternative crops may be necessary to help offset the impact of droughts.

Conjoint analysis indicates that tree-nut growers are willing to incorporate part of the drought related costs into their farm-level expenses, while fruit and other food growers perceive drought related costs as purely the responsibility of government funding. This perception difference may intensify over time, as the impact of droughts become more significant and switching crops more common, further stressing economically irrigated tree-nut, fruit and other food growers. However, less help will be extended from the agricultural policy system because: 1) there is pressure to cut funding; 2) it is difficult to achieve systematic coordination among all stakeholders; and 3) numerous institutions in charge of policy planning will make it more challenging to create effective drought assistance. Thus, the integration of self-support and government funding will be a viable solution to reduce drought sensitivity and increase the agricultural industry's resilience to future droughts.

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