scale of 1 to 5 where 1 = Strongly Disagree and 5 = Strongly Agree. Also, participants from the U.S. and India responded to a questionnaire in English[1], those from Japan responded to a questionnaire in Japanese, and those from Spain received a Spanish version. The questionnaires were translated by native speakers and tested for conceptual accuracy.

Results

Comparing Cooperation in the U.S. Across Studies 2 and 3

To ensure replicability of results, the percent of participants who cooperated by condition for the U.S. only were compared across Studies 2 and 3. Specifically, the percent of people who cooperated in the normal rainfall (χ^2(1, 219) = 0.03; p = .86), flood (χ^2[1, 216] = 0.11; p = .75), and drought (χ^2[1, 225] = 0.004; p = .95) conditions showed no statistical difference across the two studies. Furthermore, these results suggest that independent of country and as in previous studies, participants in Study 3 may also have experienced the drought condition as one of certain loss, the normal rainfall condition as one of certain gain, and the flood condition as one of uncertainty.

Testing for H1A and H1B

We began by testing whether H1A and H1B were true independent of country. On average, 39% of the participants in the drought (certain loss) condition and 65% in the normal rainfall (certain gain) condition cooperated, which was a significant difference (χ^2(1, 853) = 54.65; $p < .001$) that supports H1A. Subsequently, whether or not a participant cooperated was regressed on condition (as a categorical variable with base = normal rainfall) using a binary logistic regression (*-2 Log Likelihood* = 1699.40, *Nagelkerke* R^2 = .06), and the flood (β = -0.52, $p < .001$) as well as drought (β = -1.04, $p < .001$) conditions were both significant negative predictors of cooperation, further supporting H1A.

Additionally, and as shown in Figure 2, the percent of participants who cooperated were not significantly different by country (χ^2[3, 416] = 5.67; p = .129) in the normal rainfall condition, but they were different by country in the drought condition (χ^2[3, 437] = 21.42; $p < .001$), with Spain driving that difference, which we return to later. There were also significant differences in the percent of participants who cooperated by country in the flood condition (χ^2[3, 414] = 35.47; $p < .001$). Further exploration of the flood condition revealed that the percent of participants who cooperated were similar in the U.S. and Japan, but different in India and Spain. Specifically, cooperation in the flood condition were similar to that in the normal rainfall condition in Japan (χ^2[1, 88] = 2.55; p = .110) and the U.S. (χ^2[1, 235] = 1.20; p = .27). However, percent of people who cooperated were similar in the flood and drought conditions in India (χ^2[1, 242] = 18.40; $p < .001$) and Spain (χ^2[1, 265] = 6.62; p = .010). Thus, the experience of uncertainty (flood) appears to result in similar choices as the experience of a certain gain (normal rainfall) in the U.S. and Japan, while in India and Spain it results in choices similar to those made when a certain loss (droughts) is experienced.

Collectively, cooperation patterns support H1A independent of country such that cooperation levels are always higher in the normal rainfall condition compared to the drought condition. H1B, however, is only partially supported by these results (for the U.S. and Japan), which further suggests that H1B may have a culture-specific component. We return to the implications of this pattern of results in the general discussion.

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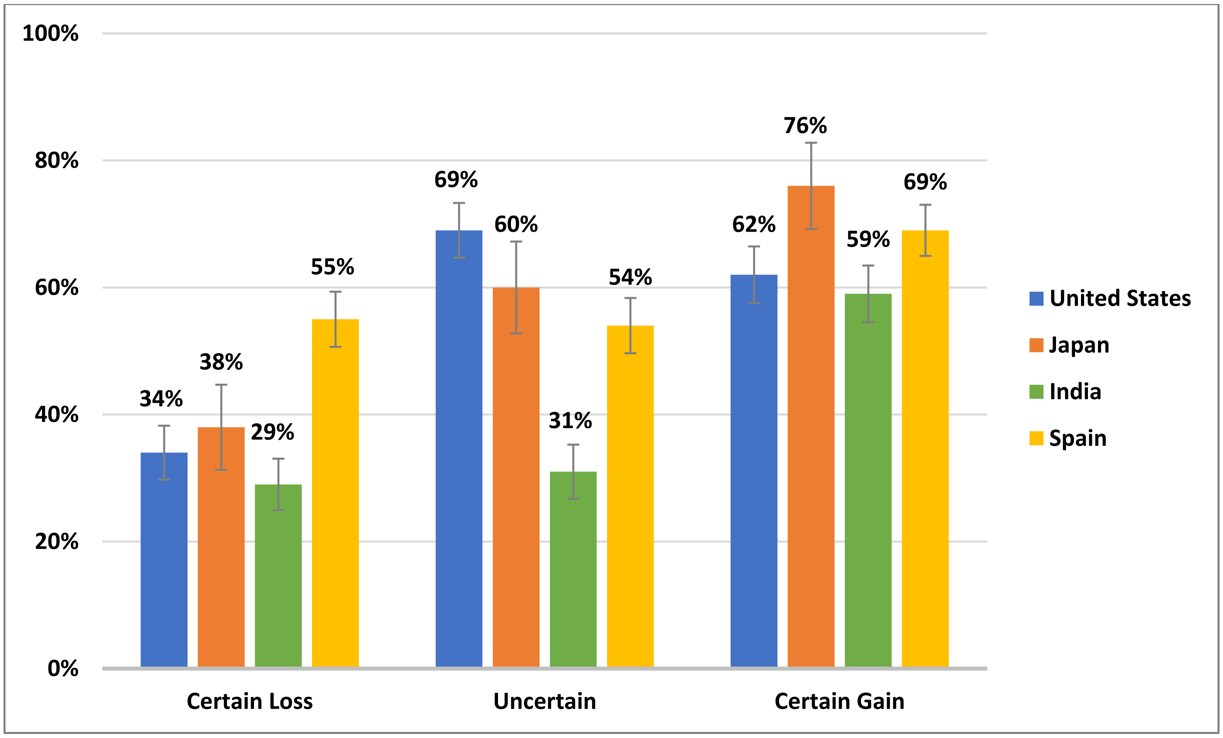
[1] Participants from India answered the questionnaire after completing English fluency questions as has been previously used with considerable success (Boyles & Arora, 2015).

Figure 2

Percentage of Cooperation by Economic Condition in Study 3. Error Bars are 95% CI.



The Influence of Local vs. Global Trust

Data were also collected on local trust. An ANOVA with local trust as the dependent variable (DV) and country as the independent variable (IV) revealed a significant difference [F[3, 1266] = 27.60, $p < .001$] in the average level of local trust by country: U.S. (M = 3.68, SD = 0.87); Spain (M = 3.41, SD = 0.83); Japan (M = 3.33, SD = 0.77); and India (M = 3.11, SD = 0.87). These self-reported results follow the general pattern of global trust in the World Values Survey for the U.S., Japan, and India, but not for Spain. We discuss this difference later.

Since differences in trust are being considered post-hoc, we test for these accordingly. As a first step we conducted a Levene's test of variance, which revealed unequal variances of local trust (F[3,1266] = 1.26, p = .288) (Shingala & Rajyaguru, 2015). The suggested post hoc analysis to assess differences amongst countries for unequal differences in variance is the Games-Howell test (Field, 2013). Pairwise comparisons among the four countries (see Table 2), showed significantly higher levels of local trust in the U.S. compared with Spain ($p < .001$), India ($p < .001$), and Japan ($p < .001$). Both Spain and Japan reported significantly higher levels of local trust than India ($p < .001$) but there was no significant difference between Spain and Japan (p = .682).

Interestingly, self-reports of local trust levels in Spain among our participants were consistently higher than those reported by the World Values Survey. This may have been due to the nature of the question–participants were asked about trust in a neighbor. World Values Survey data regarding trust in neighbors in Spain is much higher than overall global trust and similar to levels observed in this study (79% of participants responded they completely or somewhat trust people in their neighborhood in Spain, compared with 72% in the U.S. and 56% in Japan). Thus, this self-reported trust measure appeared to replicate the trend for neighbors in Spain, which may also explain the higher percentage of cooperation in the certain loss condition. Similarly, trust levels in Japan were lower than global trust but consistent with reported values for trust in neighbor based on the World Values Survey. This might also be due in part to the comparatively smaller sample size for Japan (*N* = 142).

Table 2

ANOVA Comparisons of Local Trust Across Four Countries

				Games-Howell Comparison		
Country	*N*	*M*	*SD*	Spain	India	Japan
Spain	397	3.413	0.832			
India	369	3.112	0.872	.000		
Japan	142	3.327	0.770	.682	.034	
United States	362	3.680	0.874	.000	.000	.000

The role of local trust as a possible influence and mechanism for cooperation was tested using a binary logistic regression (*-2 Log Likelihood* = 493.22, *Nagelkerke* R^2 = .23) where global trust (coded as a dichotomous variable – high- or low-trust) and trust in the neighbor (local or specific trust) were used to predict cooperation. Global trust was not a significant predictor (β = -0.07, p = .59) while local trust was a significant predictor (β = 0.98, $p < .001$). Replacing the dichotomous variable for global trust with the exact data from the World Values Survey yielded the same results. Interestingly, although trust influences cooperation independent of the condition (drought, flood, normal rainfall) or country, local trust directly predicts cooperation in our Study.

To better examine the collective model, we ran a binary logistic regression with local trust, condition, and country as our predictors of cooperation. Both condition (base = normal rainfall) and country (base = U.S.) were included as categorical variables. As shown in Table 3, the resulting model was highly significant (*-2 Log Likelihood* = 1489.03, *Nagelkerke* R^2 = .25). Notably and in support of H2, there is a strong main effect for local trust. Furthermore, also as expected, there is a main effect of condition (supporting H1) where cooperation is always lower in the drought condition than in the normal rainfall condition independent of country or local trust (supporting H1A).

Table 3

Logistic Regression with Specific Trust, Country Code, and Economic Condition

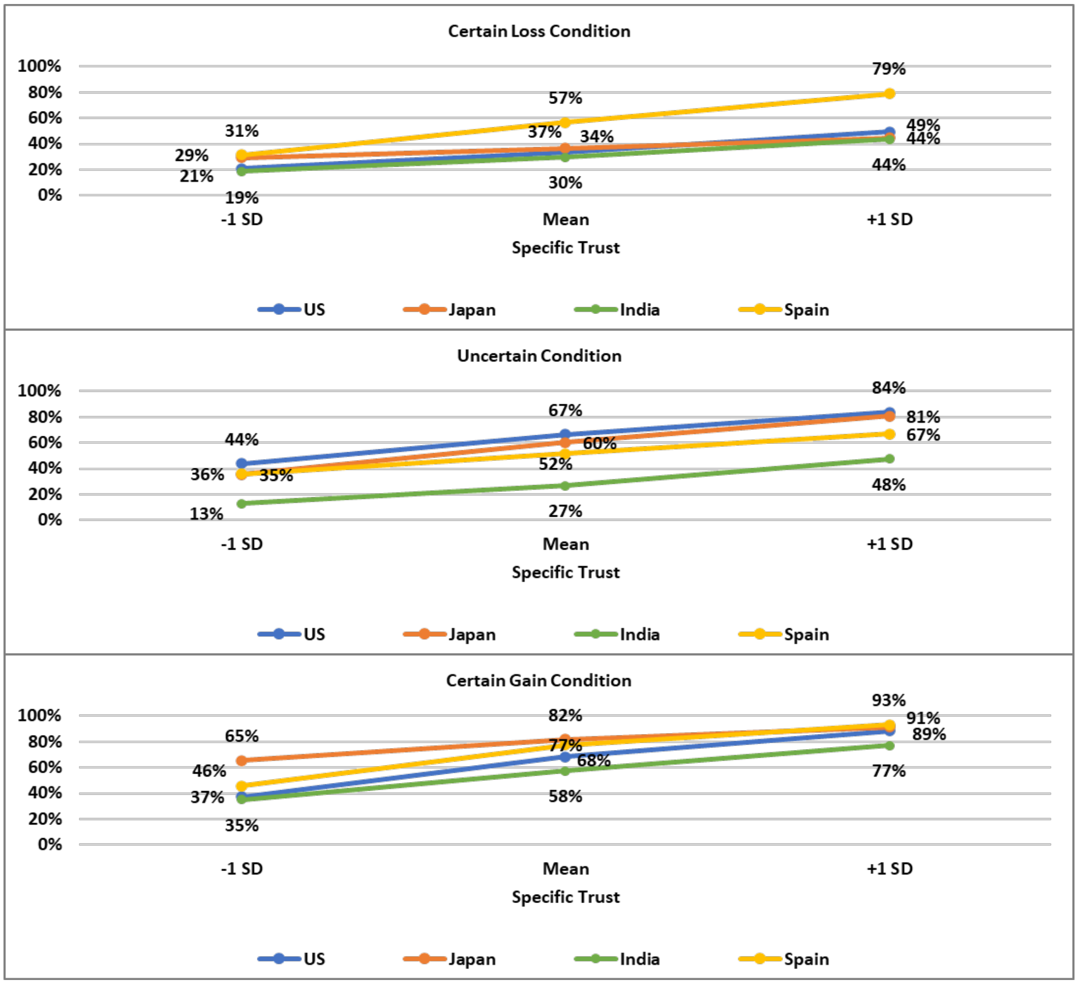
Variable	β	SE β	*p*
Constant	-2.870	0.330	.000
Specific Trust	1.025	0.086	.000
Country Code {United States}	NA	NA	.000
Country Code (1) {Japan vs. United States}	0.454	0.219	.038
Country Code (2) {India vs. United States}	-0.179	0.169	.290
Country Code (3) {Spain vs. United States}	0.486	0.163	.003
Condition {Certain Gain}	NA	NA	.000
Condition (1) {Uncertain vs. Certain Gain}	-0.791	0.157	.000
Condition (2) {Certain Loss vs. Certain Gain}	-1.219	0.156	.000

Exploratory Analysis

Cross-cultural differences in cooperation were explored while controlling for individual differences in trust. To allow for direct comparisons, we considered cooperation at three standardized levels of local trust (mean and ± 1 SD). Figure 3 shows the percent of participants who cooperated as a function of country and level of local trust. Although the percent of people who cooperated varied by level of local trust, they appeared to follow similar patterns for droughts and normal years independent of country. Cooperation in the flood condition, however, appeared to vary by country. Specifically, H1B, or cooperation should be higher during floods than during droughts, is supported for the U.S. and Japan, but not for India and Spain. Perhaps cooperation under uncertainty is influenced by country/culture. To further explore this possible interaction, we used Model 1 (a standard moderation model) in PROCESS macro version 3.4 in SPSS 26 (Hayes, 2013), with condition as the predictor, country as the moderator, cooperation as the DV, and local trust as a covariate variable (*-2 Log Likelihood* = 1461.96, *Nagelkerke* R^2 = .28, p < .001). This allowed an examination of the impact of culture on condition while controlling for the main effect of local trust. Both country and condition were entered as categorial variables with the U.S. and certain gain as the base case.

Figure 3

Predicted Percentage of Cooperation by Country and Level of Specific Trust in Study 3.



General Discussion and Limitations

The structure of social dilemmas incentivizes individuals to act non-cooperatively, valuing short-term self-interest over long-term collective benefit. The context of a dilemma in the real-world, however, can exert considerable influence on an individual's cooperative choice, especially when the outcome itself is uncertain. While there is some research on environmental dilemmas showing uncertainty of resource reduces cooperation rates (Anderson, 1981; Budescu et al., 1990; Messick et al., 1988), there is little to no prior work that directly addresses choices given the certainty effect or when the outcome itself is uncertain. We investigated this in the context of real-world dilemmas where droughts, floods, and normal rainfall levels effectively result in the experience of certain loss, uncertain outcome, and certain gain.

Our findings show, independent of country, the percent of participants who cooperate are always higher in the normal rainfall condition compared to the drought condition. Thus, the experience of a certain gain results in more cooperation than the experience of a certain loss. Cooperation in the flood condition, however, is similar to the normal rainfall condition for the U.S. and Japan, and to the drought condition for India and Spain. Thus, there is a cultural element to the cooperative choice when it is made under the experience of uncertainty. This is further supported by the observed moderation of cooperation by culture in the flood condition only. Finally, we find local trust predicts cooperation, independent of culture.

Results in the normal rainfall and drought conditions (certain gain and loss) may be explained through the theoretical lens of the logic of appropriateness, wherein choices are derived from the answer to the question "what does a person like me (identity) do (rules) in a situation like this (recognition) given culture (group)?" (Kopelman, 2009; Kopelman et al., 2016). In the certain loss condition for example, the participants are highly concerned with reducing the certainty of a loss and ensuring survival, thereby showing increased self-interested focus. Conversely, in the certain gain condition there is limited environmental or economic uncertainty where the participants are willing to consider maximizing collective gain, suggesting perhaps it is the nature of the outcome that influences the framing and therefore what is seen as "appropriate" (Aaldering & Bohm, 2020).

The flood or uncertain condition, however, presents an interesting dynamic where culture moderates choice. When faced with uncertainty, participants appear to look beyond the frame of the situation for additional information to help them make a choice. Specifically, we find a moderation of cooperation by culture in this condition, controlling for local trust. Perhaps participants are seeking information beyond trust in interdependent others to inform their choice to cooperate under conditions of uncertainty.

The Globe Project (2004) suggests nine cultural dimensions of which we believe three may be relevant and should be further explored – collectivism, uncertainty avoidance, and future orientation. Past research has shown that there is a main effect of collectivism on cooperation (Parks & Vu, 1994). Furthermore, cultural differences in group identity, accountability, and communication can also be moderators of the effect of collectivism on cooperation (Chen et al., 1998). Irwin and Berigan (2013) have made the case that the influence of trust on cooperation also varies between individualist and collectivist societies.

There is also strong cultural variation in dealing with uncertainty. Ladbury and Hinsz (2009) find that uncertainty avoidance influences choices in potential gains but not losses. Uncertainty avoidance has been studied in negotiations, where uncertainty avoidant negotiators look to rules and seek out structure to help guide them. Future orientation may be even more relevant than the individual social value orientation in predicting cooperative behavior in social dilemmas (Hernandez et al., 2006; Joireman et al., 2004), and is another factor whose influence under uncertainty is not well understood. India and Spain have a lower future orientation (as per the Globe Project). Therefore, they are more likely to defect and maximize gain in the short-term, suggesting this may be one of the variables influencing the lower rate of cooperation in the uncertain condition. Future studies need to unpack the true influence of these cultural variables on cooperation in social dilemmas and its interaction with local trust.

In our studies we distinguish between local trust in the neighbor, which is relevant to our dilemmas and is a strong predictor of cooperation, and general trust measured as a global cultural construct. Trust, however, manifests at multiple levels (Delhey et al., 2011; Fukuyama, 1999; Goertz, 2006) that have not been studied in an interdependent context. The level of trust measured in our study in Spain is higher than what would be expected when the global or cultural level is considered but is consistent with what is expected at the neighborhood or communal level. These differences are meaningful when local actions need to be nested within a global context: Farmers are more likely to follow water management strategies or plant specific seed varieties that may be globally prescribed by scientists and agricultural experts if those strategies account for short-term local constraints (Gonzalez et al., 2018) and their day-to-day survival, further necessitating that choices are understood in context (Arora et al., 2016).

Future research might especially focus on extended group sizes and repetition of the dilemma. Extending the group of decision makers to more than two might have an effect on the local trust between decision makers and therefore on the decision to cooperate. Additionally, repeated games would allow us to better understand decision makers' timeframes and potential discounting of future payoffs under conditions of uncertainty. With increasing frequency and intensity of extreme weather events, this becomes especially relevant. Our findings have policy implications for issues involving environmental dilemmas and negotiation ramifications for global environmental treaties whose implementation is steeped in cultural nuances. As uncertainty and economic risk increases with climate change, our findings ask for a stronger local and contextualized focus when studying decision making in environmental dilemmas.

Conclusion and Future Directions

Though the impacts of climate change and resulting weather patterns are global, their manifestation as extreme droughts and floods is local. It is these local responses to the resulting environmental dilemmas at the farm level that influence global issues of food and agricultural sustainability and conflict. For there to be good policies and responses to environmental dilemmas, such issues need to be better understood at the level at which they occur so that interventions and nudges are developed within a local context.

In this research, we began with real-world dilemmas posed by droughts, floods, and normal rainfall levels, which were then brought into a controlled environment to gain insight into underlying motivational mechanisms across four cultures. Our unusual methodological approach provided a realistic account of why people cooperate in varying contexts. Furthermore, it gave some insight into how contextualized dilemmas can be approached to develop the necessary knowledge for more effective designs of policies that promote cooperation. We show that across cultures, policymakers can increase cooperation by guaranteeing a certain minimum gain, e.g., through climate insurances, pooling of resources, or guaranteed subventions in years with climate extremes. Through this, long-term sustainability of groundwater resources can be ensured supporting a stable food supply. However, while these groundwater dilemmas are global in scope, choices are made locally and a grasp of the cultural variables that matter in the local context becomes essential, particularly when uncertainty is central to the dilemma, as is the case with most wicked problems humanity faces today.

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Appendix
Prompts for Each Condition

Uncertain Condition (Flood) Scenario

Please read the scenario below and put yourself in the role of the CEO of an agribusiness – a business that owns farms, grows crops like soybeans and corn on that land and then sells the crops on the world commodity markets.

You are the owner of an agribusiness that owns a large amount of farmland in a very fertile area of the country. Your land borders along one edge with a single neighbor who has a similar farm. Your farm has been in your family for three generations and is a very profitable enterprise. Currently, you employ 15 individuals full-time ranging from agricultural experts to farm workers. The farm and agribusiness have managed to support these 15 individuals, as well as your family for many years now. You generally grow some combination of soybean, corn, and wheat and given growing global demand for these grains, have no trouble selling all you grow. In fact, you could probably sell a lot more, if you could grow it.

Every year, before planting season you look at the weather forecasts for the upcoming growing season to get an idea of what crops you should plant as the temperature and rain will determine how well the plants grow, and thus the overall profit made by your farm. The average level of rainfall over the past few years has been higher than normal. In five of the last ten years your farm was flooded due to excessive rain. Floods in your region destroy part of your harvest but rarely all of it. This year it has been raining a lot so far and the ground is already quite wet. Since your farm is not entirely flat, during a flood the lower-lying areas have standing water, while the higher areas are fine. Although you lose the crop from the lower areas due to flooding, you can come close to break-even or even break-even from the crop that survives in the higher-lying areas of the farm. The neighboring farm that borders your land is a lot like yours, and also has lower-lying and higher-lying areas with similar outcomes.

At the start of the planting season, you can choose to dig a channel that will drain excessive water from the lower-lying areas of your farm. Once you plant, you cannot dig a channel. Digging a channel could help any standing water due to flooding in your lower-lying areas to flow out, but it can also result in underground water that is very close to the surface. Thus, a channel could worsen the flood this year, and may increase the chances of flooding in the following years. Participants were asked to choose whether or not they would dig a channel.

Certain Loss Condition (Drought) Scenario

Please read the scenario below and put yourself in the role of the CEO of an agribusiness – a business that owns farms, grows crops like soybeans and corn on that land and then sells the crops on the world commodity markets.

You are the owner of an agribusiness that owns a large amount of farmland in a very fertile area of the country. Your land borders along one edge with a single neighbor who has a similar farm. Your farm has been in your family for three generations and is a very profitable enterprise. Currently, you employ 15 individuals ranging from agricultural experts to farm workers full time. The farm and agribusiness have managed to support these 15 individuals, as well as your family for many years now. You generally grow some combination of soybean, corn, and wheat and given growing global demand for these grains, have no trouble selling all you grow. In fact, you could probably sell a lot more, if you could grow it.

Every year, before planting season you look at the weather forecasts for the upcoming growing season to get an idea of what crops you should plant as the temperature and rain will determine how well the plants grow, and thus the overall profit made by your farm. The average level of rainfall over the past few years has been lower than normal. In five of the last ten years your farm experienced drought due to minimal rain. Drought in your region destroys almost all of your entire harvest. This year it has not rained much so far, and the ground is already quite dry. Since your farm is not entirely flat, during a drought the lower-lying areas have some moisture, while the higher areas are very dry. Therefore, you lose the crop from the higher areas due to the drought but can harvest a little from the lower-lying areas. However, it is never enough to allow you to cover your costs, thus you end up with a substantial loss. The neighboring farm that borders your land is a lot like yours, and also has lower-lying and higher-lying areas with similar outcomes.

At the start of the planting season, you can choose to plant drought resistant seeds. These seeds have deeper roots allowing them to reach lower levels of groundwater. Groundwater is water that is available deep under the soil and if plants are able to reach it, they can use it even in times of drought. Drought resistant seeds will grow and provide a regular harvest despite even extremely dry

conditions, but they will lower the water level available underground. Thus, they will worsen the drought this year and may increase the chances of drought in the following years.
Participants were asked to choose whether or not they would plant drought resistant seeds.

Certain Gain Condition (Normal Rainfall) Scenario

Please read the scenario below and put yourself in the role of the CEO of an agribusiness – a business that owns farms, grows crops like soybeans and corn on that land and then sells the crops on the world commodity markets.

You are the owner of an agribusiness that owns a large amount of farmland in a very fertile area of the country. Your land borders along one edge with a single neighbor who has a similar farm. Your farm has been in your family for three generations and is a very profitable enterprise. Currently, you employ 15 individuals ranging from agricultural experts to farm workers full time. The farm and agribusiness have managed to support these 15 individuals, as well as your family for many years now. You generally grow some combination of soybean, corn, and wheat and given growing global demand for these grains, have no trouble selling all you grow. In fact, you could probably sell a lot more, if you could grow it.

Every year, before planting season you look at the global demand for crops. You use this to decide which crops to plant and in what quantity. What you plant will determine the overall profit made by your farm. This year the U.S. changed its subsidy for corn and as a result there will be less farmers growing corn in the US. Because of this, financial experts are predicting that corn prices will be substantially higher than normal for the next years while the supply and demand readjust to a new equilibrium. You are considering growing corn during the next few cropping cycles to benefit from the forecasted high prices. Given the price forecast you could end up with a substantial profit if you plant corn. However, corn is particularly prone to certain insects local to your area that tend to attack the young plants and reduce yield. This could reduce your total profit, though it is not likely that you won't have some profit.

At the start of planting season, you can choose to plant an insect resistant variety of corn called BT corn, which will increase the yield despite the presence of local insects. In this case the insects will attack other corn plants that are not of the BT resistant variety. The downside is that the more BT corn you grown, the more resistant the insects become. Insect resistance can develop very quickly and may occur within one season. Thus, it will increase your profits this year, but it might lower profits in the future. Participants were asked to choose whether or not they would plant insect resistant seeds.