*Making Farmland Decisions* 

*in a Changing Climate*

## DESCRIPTION

To learn about challenges associated with agricultural production under climate change conditions, students play a game in which they make management decisions for a farm and evaluate the effects.

## PHENOMENON

What methods can agricultural producers use to adapt to climate change, and is it worth the cost?

## GRADE LEVEL

**6 – 12**

## OBJECTIVES

Students will:

- Evaluate the importance of agriculture and agricultural producers in our society
- Synthesize the effects climate change can have on agriculture and food sources
- Understand some of the decisions agricultural producers make

## TIME

**60 MINUTES**

## COMMON CORE STATE STANDARDS

***English Language Arts Standards » Science & Technical Subjects » Grade 6-8***

CCSS.ELA-LITERACY.RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

CCSS.ELA-LITERACY.RST.6-8.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

***English Language Arts Standards » Science & Technical Subjects » Grade 9-10***

CCSS.ELA-LITERACY.RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

CCSS.ELA-LITERACY.RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

***English Language Arts Standards » Science & Technical Subjects » Grade 11-12***

CCSS.ELA-LITERACY.RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CCSS.ELA-LITERACY.RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

CCSS.ELA-LITERACY.RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

## NEXT GENERATION SCIENCE STANDARDS

***High School Performance Expectation***

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

| Science & Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|
| Developing and Using Models (MS) | ESS3.C Human Impacts on Earth Systems (MS, HS) | Systems and System Models (MS, HS) |

## AGRICULTURE, FOOD, AND NATURAL RESOURCES STANDARDS

CS.01.02. Examine technologies and examine their impact on AFNR systems.
CS.O1.02.01.a. Research technologies used in AFNR systems.
CS.04.02. Assess and explain the natural resource related trends, technologies, and policies that impact AFNR systems.
CS.04.02.01.b. Analyze natural resources trends and technologies and explain how they impact AFNR systems (e.g. climate change, green technologies, water resources, etc.).
ESS.03.01. Apply meteorology principles to environmental service systems.
ESS.03.01.03.b. Assess the environmental, economic, and social consequences of climate change.
ESS.03.01.03.c. Evaluate the predicted impacts of global climate change on environmental service systems.

# BACKGROUND

Climate change will continue to result in increased global temperatures and subsequent changes in atmospheric conditions. In the United States, the last decade was the warmest on record, and 2016 was the warmest year on record. Heavy precipitation and extreme heat events are increasing in frequency, consistent with model projections. Models predict that extreme events, including drought and flooding, will continue to occur more frequently in the future. In general, extreme events tend to decrease crop productivity, degrade soil quality, and increase the prevalence of weeds, disease, and pests that can negatively affect agriculture. Climate change could have a severe impact on global food security and lead to food shortages because of a reduction in crop yields and increase in food prices.

Throughout the southwestern United States, increased temperatures are predicted. Models predict a mixture of increased precipitation and decreased precipitation with a high degree of uncertainty, depending on the area. In areas of increased precipitation, the likelihood is that the increase in annual rainfall will occur in fewer, more intense events.

Adaptation strategies have the ability to increase the resiliency of the agriculture sector to some of the major productivity impacts of climate change. These strategies can include simple improvements to equipment, such as repairing leaking pipes to eliminate waste, or more involved strategies, including planting and practice changes made in the fields, e.g. no-till planting.

# MATERIALS

- *Farms on the Table* handout [1 per student]
  - o If possible, copy each page on a different colored paper to make referencing the pages during the activity easier
- PowerPoint presentation
- Dice [1 per 2-3 students]
- Calculators (optional) [1 per 2-3 students]
- *Farms on the Table* instructional video, optional introduction to the game for the instructor

# PREPARATION

1. If possible, watch the *Farms on the Table* instructional video for an introduction to the game.
2. Set up a computer and projector, and display the PowerPoint presentation.

# PROCEDURES

***Introduction***

1. Give a short introduction about climate change and its effects on agriculture using the PowerPoint presentation.
   a. **Slide 1**: we are going to play a game that will introduce the effects of climate change on agriculture and why it is important to understand these effects.
   b. **Slide 2**: global warming is the increase in Earth's average temperature. Climate change is the long-term change in Earth's climate or the climate of a region. Climate change encompasses global warming because it includes temperature changes, but it also incudes other long-term atmospheric conditions such as precipitation changes. What is the trend of this graph? [Answer: Earth's average surface temperature has been increasing since 1880.]
   c. **Slide 3**: many climate change computer models predict more extreme weather events. Some models might predict that an area will receive more rainfall in the future, but this often translates into fewer, larger rainfall events with longer periods without rainfall in between. In the Southwest, researchers predict: more heat waves, longer and more severe droughts, more extreme precipitation events, insect and pest outbreaks, and more wildfires. All of these issues will degrade soil quality

and negatively affect crop production.

***Farms on the Table Game***

1. Pass out a Farms on the Table handout to each student.
2. Introduce the game using the PowerPoint presentation.
   a. **Slide 4**: in this game, you will play the role of a farmer dealing with the effects of climate change on your farm. You will make decisions about how your farm will be managed on a year-to-year basis with the goal of staying in the black. In finance, staying in the black means that you are making money, and being in the red means that you are losing money.
      i. Each farm will start off with an output rating of 100. During the course of the game, if you stay at ≥100 you are in the black; if you drop to ≤99 you are now considered to be in the red. The goal of the game is to make choices that will help you stay in the black or help you get back in the black.
      ii. Look at page 1 of the handout. Choose one of the counties listed in table 1, and circle it. Most students like to choose the county that is closest to their location. This is the location of your new farm.
      iii. The first thing you will do is customize your farm by choosing climate-mitigating adaptations. You will be able to choose to take as many, or as few, of these actions as you would like on your farm. In this case, a mitigating adaptation is something you can do that will help to lessen the impacts that your farm will experience from climate change and also to reduce the impacts that your farm has on the environment.
   a. **Slide 5**: one option is no-till planting. It is a type of planting where the seeds are inserted directly into the soil, instead of the traditional planting style of turning over the soil before inserting the seeds. This style of planting can be advantageous because it has lower labor, equipment, and fuel costs. A tractor only has to go over a field once to plant the seeds (versus multiple times with traditional planting). It also reduces water runoff from precipitation and irrigation because it slows down the water, allowing it to soak into the ground. This decreases the likelihood of chemical crop treatments contaminating groundwater and streams as well. This method promotes healthier soil by limiting wind erosion of soil, increasing the organic matter layer in the soil, and limiting soil compaction. The biggest drawbacks to this method are the high upfront equipment costs and that it may require the use of herbicides and fungicides due to higher soil moisture.
   b. **Slide 6**: hedgerows are rows of wild shrubs bordering a road or field. Hedgerows create a barrier around the field, helping with the effects of wind and water erosion. They create not only pollinator habitat but also predator habitat (for example, birds and lizards), which will help prevent some of the spread of insect and fungal diseases. The major drawback to this action is that the hedgerows will require some year round watering and maintenance and reduce space for planting crops.
   c. **Slide 7**: water collection and storage units collect rainfall from roofs or runoff from fields to be used at a later date for irrigation of crops. By collecting this water, a farmer will have a water source available during droughts for irrigation purposes. Installation can be expensive and water storage units can take up a large amount of space. It can take a few years to gather enough water to help mitigate the effects of a serious drought, but once the water is collected, it will be available for use.
   d. **Slide 8**: monitoring soil moisture in a field can help a farmer determine the best time to irrigate crops, thus allowing them to eliminate unnecessary watering. The equipment can range from relatively inexpensive to very expensive. The cost of equipment is related to the amount of labor that is needed. Less expensive equipment tends to require more labor.
   e. **Slide 9**: many species of bees are declining because of loss of habitat, increased temperatures, changes in growing seasons, and insecticide use. Farmers rely on bees to pollinate their crops, and without them, many crops would not be able to fruit. If you choose to have beehives and plant flower strips among your crops, you help to ensure that you have reliable pollination of your crops by bees and other pollinators. The major drawback to this action is that you will not be able to use insecticides on your crops due to the harm they inflict on bee colonies.
   f. **Slide 10**: take a moment to decide what adaptations you would like to implement on your farm. You may choose as many adaptations as you would like. There is a cost associated with each, but they may save you money in the long term, depending on the weather conditions that year. In table 2 on page 2 of the handout, place a checkmark under each of your selected adaptions, and write the cost of each in the last column of the table. Once you have finished, add up the cost of all the adaptations you have chosen and enter the Total Cost at the bottom of table 2. Then, subtract your Total Cost from 100 to calculate the Starting

Output Factor, which will be needed for the next part of the game.

3. Ask students to turn to page 3 of the handout. Students will choose their planting practices for Year 1 on this page. Instruct students to transfer their Starting Output Factor calculated on page 2 to the Starting Output Factor blank in the top right corner.
4. Pass out the dice. Two or three students can share one die. Pass out the calculators (if using); students can share calculators. Use the PowerPoint presentation to explain how students will set up the first year on their farm.
   a. **Slide 11**: in year 1, you will choose at least two of nine planting practices and crop treatments, which we will discuss momentarily. As in real life, the success of your farm will be partially based on chance because you are choosing your options before knowing how the weather will be this year. The weather conditions will be revealed at the end of the year, and the success of your choices will be dependent on the conditions that you experienced. Remember, you are trying to stay in the black, which means having an Output Factor that is ≥100. Each option has an associated cost, but you may be rewarded for your investment. The impact of each option can be positive or negative, depending on the conditions this year, especially the weather. After the first year, you will then have the option to invest in any of these practices and treatments each year for the six total years that we will play this game.
   g. **Slide 12**: your first options are two different crop varieties. Over many years, farmers and researchers have been able to breed crops that grow more successfully in certain environments. For example, there are different varieties of wheat that grow well in drier or wetter than average conditions and varieties that are immune to insect and fungal diseases. For our game, you have the option to choose between drought resistant or flood resistant varieties of crops.
   h. **Slide 13**: interplanting is planting two crops together in a field in alternating rows. By using this method, you can decrease the need for crop treatments, such as pesticides and herbicides. This option also creates less economic risk for you in case there is a crop fail year. You may have to spend more time planning up front in order to carry out this practice.
   i. **Slide 14**: crop rotation is a planting system where varying crops are planted in the same field year after year. This style of planting has been used since the 1600s because it helps preserve soil nutrients. It will also help control weeds, disease, and other pests. Many pests are plant specific, so by moving the plants to a different field every year, it will reduce the chance that the pest will be able to follow them. You may have to spend more time planning up front in order to carry out this practice.
   j. **Slide 15**: spread spacing is increasing the amount of space between the planted rows of crops. This practice can reduce the need for crop treatments because there is less competition for resources from the plants. There will be a lower crop yield per acre because of fewer rows in a single field.
   k. **Slide 16**: most fertilizer contains nitrogen, phosphorus, and potassium. By adding more of these nutrients to what already occurs naturally in the soil, crops will grow larger, faster. Annual application of fertilizer has been shown to deplete the natural soil fertility, causing an annual reliance on it, however. If you choose to do this on your farm, you will have to reapply it every year.
   l. **Slide 17**: herbicide sprays destroy unwanted vegetation (non-crops) in a field. Spraying a field with herbicide can greatly reduce loss from plant pests, but the herbicide becomes less effective with continual use. For example, this is a common agricultural weed called pigweed. For many years, the standard way of removing pigweed was to spray it with herbicides. Now, after many years of this, pigweed is resistant to herbicides in some areas, and the only way to remove it from agriculture fields in these areas is by manual removal (typically pulling it out by hand).
   m. **Slide 18**: insecticide sprays are designed to stop herbivorous insects, and they can greatly reduce loss from insect pests, but they will harm natural pollinators and insect predators. You should not choose this option if you have beehives and flower strips on your farm. Like herbicides, they will also become less effective with continual use.
   n. **Slide 19**: fungicide sprays are designed to destroy unwanted fungal pathogens, and just like all the other crop treatments, fungicide can reduce the loss from pathogens. Unlike other treatments, you cannot use a wait-and-see approach because if the fungicide is not applied before infection, it will not be effective.
5. Give students a few minutes to decide what practices and/or treatments they would like to use on their farm for year 1 and instruct them to place checkmarks under at least two options in the table, and write the cost of each in the Chosen Costs column of the table. Emphasize that they need to think about their farm and local climate when deciding what strategies would be the most effective under those conditions.
6. Ask students to look at the bottom

of page 3 of the handout, and use the PowerPoint to explain how to finish with year 1.

a. **Slide 20**: write your Starting Output Factor into the first blank at the bottom of the page. Then calculate the cost of your planting practices and crop treatments, and write the Total Cost at the bottom of the table and in the second blank at the bottom of page 3 of the handout.
b. **Slide 21**: roll the die once for each checked item that you selected. Roll the die and assign the number rolled to the first checked item in the table. Roll the die again and assign that number to the second checked item, and repeat this for all of the items you selected.
    i. You **may not** roll the die and assign that number to whichever checked item you would like, and you **may not** roll the die until you get a number that you like. The purpose of the die is to be random, so that some practices and treatments will affect your farm more positively or negatively than others, that the effect varies year to year, and different farms are affected in different ways. This is similar to the way it works in the real world.
c. **Slide 22**: the weather for year 1 was historically normal. Record the weather in the blank near the bottom of page 3 of your handout.
    i. During historically normal weather, some of the practices and treatments that you chose will give you a positive return, and some will give you a negative return. The list on the left is positive investments. The practices on this list were helpful during the weather that we had this year, and they resulted in increased profits. Place a **plus sign** next to the die roll number for the practices and treatments from this list that you chose (and **only** the practices and treatments that you chose).
    ii. The list on the right is negative investments. The practices on this list were not helpful during the weather that we had this year, and they did not result in increased profits to offset their costs. Place a **minus sign** next to the die roll number for the practices and treatments from the list that you chose.
    iii. When you customized your farm, you may have chosen one or more of the options in table 2 on page 2 of the handout. Turn back to table 2 on page 2 for reference. If you chose any of the farm adaptations listed at the bottom of the slide, your investments paid off this year. The adaptations on this list were helpful during the weather that we experienced. For each adaptation that you chose from this list, you will receive **three Farm Adaptation Bonus points**.
        1. For example, if you implemented two of the five adaptations that helped mitigate the effects of the weather, you would receive three points for each, for a total bonus of six points.
    iv. Add up how many Farm Adaptation Bonus points you received and write that number in the appropriate blank at the bottom of page 3.
d. **Slide 23**: add up all of the positive and negative investments to calculate the Output Change Total. Be sure to **pay attention to the sign**. Most players will be adding positive and negative numbers; do not just add them all up as if they were all positive. Once you have the total, write it at the bottom of the table and in the Output Change Total blank at the bottom of the page. This number may be negative.
    i. Finally, combine all of the blanks to calculate your new Starting Output Factor. Be sure to **pay attention to the sign**.

7. Ask students to turn to page 4 of their handout and transfer the new Starting Output Factor from Year 1 (calculated on the previous page) into the blank in the top right corner. Continue the game for years 2-6 using the PowerPoint presentation.
    a. **Slide 24**: in year 2, you will again choose at least two of the nine practices and treatments. I will reveal the weather conditions at the end of the year, and the success of your choices will be dependent on the conditions that you experienced. Remember, you are trying to stay in the black. Take a moment to place checkmarks under at least two options in the table, and write the cost of each in the Chosen Costs column of the table.
        i. Write your Starting Output Factor into the first blank at the bottom of page 4 of the handout. Then calculate the cost of your planting practices and crop treatments, and write the Total Cost at the bottom of the table and in the second blank at the bottom of the page.
        ii. Roll the die once for each checked item that you selected. Assign the number rolled to the first checked item in the table, and roll it again until you have written a die roll number in the table for every practice and treatment that you selected.
    b. **Slide 25**: the weather for year 2 was a drought. Record the weather in the blank near the bottom of page 4 of your handout.
        i. Look at the list of positive

investments, and place a **plus sign** next to the die roll number for the practices and treatments from this list that you chose.

ii. Look at the list of negative investments, and place a **minus sign** next to the die roll number for the practices and treatments from this list that you chose.

iii. Add up all of the positive and negative investments to calculate the Output Change Total. Be sure to **pay attention to the sign**. Write it in the Output Change Total space in the table and the blank at the bottom of the page.

iv. Look back at the selections that you made when customizing your farm in table 2 on page 2 of the handout; for each adaptation that you chose from the list at the bottom of this slide, you will receive **three Farm Adaptation Bonus points**. Add up how many Farm Adaptation Bonus points you received and write that number in the appropriate blank at the bottom of page 4.

v. Finally, combine all of the blanks to calculate your new Starting Output Factor. Be sure to **pay attention to the sign**.

vi. Turn to page 5 of the handout, and transfer the new Starting Output Factor from Year 2 (calculated on the previous page) into the blank in the top right corner.

c. **Slide 26**: in year 3, you will again choose at least two of the nine practices and treatments. I will reveal the weather conditions at the end of the year, and the success of your choices will be dependent on the conditions that you experienced. Remember, you are trying to stay in the black. Take a moment to place checkmarks under at least two options in the table, and write the cost of each in the Chosen Costs column of the table.

i. Write your Starting Output Factor into the first blank at the bottom of page 5 of the handout. Then calculate the cost of your planting practices and crop treatments, and write the Total Cost at the bottom of the table and in the second blank at the bottom of the page.

ii. Roll the die once for each checked item that you selected. Assign the number rolled to the first checked item in the table, and roll it again until you have written a die roll number in the table for every practice and treatment that you selected.

d. **Slide 27**: the weather for year 3 was a heat wave. Record the weather in the blank near the bottom of page 5 of your handout.

i. Look at the list of positive investments, and place a **plus sign** next to the die roll number for the practices and treatments from this list that you chose.

ii. Look at the list of negative investments, and place a **minus sign** next to the die roll number for the practices and treatments from this list that you chose.

iii. Add up all of the positive and negative investments to calculate the Output Change Total. Be sure to **pay attention to the sign**. Write it in the Output Change Total space in the table and the blank at the bottom of the page.

iv. Look back at the selections that you made when customizing your farm in table 2 on page 2 of the handout; for each adaptation that you chose from the list at the bottom of this slide, you will receive **three Farm Adaptation Bonus points**. Add up how many Farm Adaptation Bonus points you received and write that number in the appropriate blank at the bottom of page 5.

8. **SUBSIDY YEARS** – There are two years in which students will receive a government Subsidy Bonus if they have implemented certain practices, year 3 and year 6. Use the PowerPoint presentation to explain the Subsidy Bonus for this year.

a. **Slide 28**: this year, the government issued a subsidy for agricultural producers who installed beehives on their farms. A subsidy is a cash rebate or tax reduction given by the government to incentivize an action or help an economic sector. As mentioned earlier, many bee species populations are in decline. Pollination of crops by bees has been estimated to be worth $14 billion per year, and without them, many of our favorite foods would not exist. Look at the list on the right side of the slide. Does it include any foods that you like to eat?

i. If you chose to invest in beehives and flower strips at the beginning of the game, you will receive 10 Subsidy Bonus points for doing so. If you did, write a 10 in the Subsidy Bonus blank at the bottom of page 5 of the handout, if you did not, write a 0 in that blank.

ii. Combine all of the blanks to calculate your new Starting Output Factor. Be sure to **pay attention to the sign**.

iii. Turn to page 6 of the handout, and transfer the new Starting Output Factor from Year 3 (calculated on the previous page) into the blank in the top right corner.

b. **Slide 29**: in year 4, you will

again choose at least two of the nine practices and treatments. I will reveal the weather conditions at the end of the year, and the success of your choices will be dependent on the conditions that you experienced. Remember, you are trying to stay in the black. Take a moment to place checkmarks under at least two options in the table, and write the cost of each in the Chosen Costs column of the table.

i. Write your Starting Output Factor into the first blank at the bottom of page 6 of the handout. Then calculate the cost of your planting practices and crop treatments, and write the Total Cost at the bottom of the table and in the second blank at the bottom of the page.
ii. Roll the die once for each checked item that you selected. Assign the number rolled to the first checked item in the table, and roll it again until you have written a die roll number in the table for every practice and treatment that you selected.

c. **Slide 30**: the weather for year 4 was windy. Record the weather in the blank near the bottom of page 6 of your handout.

i. Look at the list of positive investments, and place a **plus sign** next to the die roll number for the practices and treatments from this list that you chose.
ii. Look at the list of negative investments, and place a **minus sign** next to the die roll number for the practices and treatments from this list that you chose.
iii. Add up all of the positive and negative investments to calculate the Output Change Total. Be sure to **pay attention to the sign**. Write it in the Output Change Total space in the table and the blank at the bottom of the page.
iv. Look back at the selections that you made when customizing your farm in table 2 on page 2 of the handout; for each adaptation that you chose from the list at the bottom of this slide, you will receive **three Farm Adaptation Bonus points**. Add up how many Farm Adaptation Bonus points you received and write that number in the appropriate blank at the bottom of page 6.
v. Finally, combine all of the blanks to calculate your new Starting Output Factor. Be sure to **pay attention to the sign**.
vi. Turn to page 7 of the handout, and transfer the new Starting Output Factor from Year 4 (calculated on the previous page) into the blank in the top right corner.

d. **Slide 31**: in year 5, you will again choose at least two of the nine practices and treatments. I will reveal the weather conditions at the end of the year, and the success of your choices will be dependent on the conditions that you experienced. Remember, you are trying to stay in the black. Take a moment to place checkmarks under at least two options in the table, and write the cost of each in the Chosen Costs column of the table.

i. Write your Starting Output Factor into the first blank at the bottom of page 7 of the handout. Then calculate the cost of your planting practices and crop treatments, and write the Total Cost at the bottom of the table and in the second blank at the bottom of the page.
ii. Roll the die once for each checked item that you selected. Assign the number rolled to the first checked item in the table, and roll it again until you have written a die roll number in the table for every practice and treatment that you selected.

e. **Slide 32**: the weather for year 5 included increased precipitation. Record the weather in the blank near the bottom of page 7 of your handout.

i. Look at the list of positive investments, and place a **plus sign** next to the die roll number for the practices and treatments from this list that you chose.
ii. Look at the list of negative investments, and place a **minus sign** next to the die roll number for the practices and treatments from this list that you chose.
iii. Add up all of the positive and negative investments to calculate the Output Change Total. Be sure to **pay attention to the sign**. Write it in the Output Change Total space in the table and the blank at the bottom of the page.
iv. Look back at the selections that you made when customizing your farm in table 2 on page 2 of the handout; for each adaptation that you chose from the list at the bottom of this slide, you will receive **three Farm Adaptation Bonus points**. Add up how many Farm Adaptation Bonus points you received and write that number in the appropriate blank at the bottom of page 7.
v. Finally, combine all of the blanks to calculate your new Starting Output Factor. Be sure to **pay attention to the sign**.
vi. Turn to page 8 of the

handout, and transfer the new Starting Output Factor from Year 5 (calculated on the previous page) into the blank in the top right corner.

f. **Slide 33**: in year 6, our final year, you will again choose at least two of the nine practices and treatments. I will reveal the weather conditions at the end of the year, and the success of your choices will be dependent on the conditions that you experienced. Remember, you are trying to stay in the black. Take a moment to place checkmarks under at least two options in the table, and write the cost of each in the Chosen Costs column of the table.
   i. Write your Starting Output Factor into the first blank at the bottom of page 8 of the handout. Then calculate the cost of your planting practices and crop treatments, and write the Total Cost at the bottom of the table and in the second blank at the bottom of the page.
   ii. Roll the die once for each checked item that you selected. Assign the number rolled to the first checked item in the table, and roll it again until you have written a die roll number in the table for every practice and treatment that you selected.

g. **Slide 34**: the weather for year 6 was another heat wave. Record the weather in the blank near the bottom of page 8 of your handout.
   i. Look at the list of positive investments, and place a **plus sign** next to the die roll number for the practices and treatments from this list that you chose.
   ii. Look at the list of negative investments, and place a **minus sign** next to the die roll number for the practices and treatments from this list that you chose.
   iii. Add up all of the positive and negative investments to calculate the Output Change Total. Be sure to **pay attention to the sign**. Write it in the Output Change Total space in the table and the blank at the bottom of the page.
   iv. Look back at the selections that you made when customizing your farm in table 2 on page 2 of the handout; for each adaptation that you chose from the list at the bottom of this slide, you will receive **three Farm Adaptation Bonus points**. Add up how many Farm Adaptation Bonus points you received and write that number in the appropriate blank at the bottom of page 8.

h. **Slide 35**: the government issued another subsidy this year; this time, it is for water conservation. Water conservation involves using only the water needed for crops. Due to the more prolonged and intense droughts resulting from climate change, smart water usage by agriculture has become imperative.
   i. If you invested in soil moisture monitoring you will receive a 5 point Subsidy Bonus. If you invested in water collection and storage you will receive a 10 point Subsidy Bonus. If you invested in both, you will receive a 15 point Subsidy Bonus.
   ii. Combine all of the blanks to calculate your final output factor. Be sure to **pay attention to the sign**.

***Results and Conclusions***

1. Instruct students to turn to the results and conclusions questions on page 9 of the handout. Answer the questions together if possible.
   a. When answering question 1, remember that for this game, being in the black is having a final output factor of 100 or more, and being in the red is having an output factor of less than 100.
   b. For question 2, think back to the positive investments at the end of each year. Were there any practices or treatments that seemed to result in a positive investment more than others? [Answer: interplanting and crop rotation were a positive investment every year.]
      i. Think about the negative investments at the end of each year. Were there any practices or treatments that seemed to result in a negative investment more than others? [Answer: flood resistant crop varieties and fungicide resulted in a negative investment most often.]
      ii. Why do you think that is the case? [Answer: interplanting and crop rotation promote soil health and overall plant health by protecting them from pathogens without causing additional harm to the environment. Buying flood resistant crop varieties and fungicide are usually not the best practices to use in the dry, hot climate throughout much of the Southwest. Even though some areas of the Southwest are predicted to receive more rainfall, the region is not predicted to get flooding that would require flood resistant varieties or cause fungal outbreaks.]
   c. In question 3, think critically about how you would play the game differently if you were to play it again. What are some of your ideas?

## EXTENSIONS

1. Add more years to the game. Make additional copies of pages 3-8 of the handout. If you would like to include student input, ask students to help decide several years of weather conditions and which treatments and practices would be positive or negative, given the weather. Then choose which of their conditions to implement, adding more slides to the PowerPoint presentation if possible.
2. Add a catastrophic event, such as a wildfire, flood, or earthquake, into one of the rounds. Decide if any of the crops could have survived the natural disaster. If not, all practices and treatments chosen by students would be negative investments. If some crops did survive, decide which practices and treatments, if any, could have helped with their survival, such as flood resistant crops being planted in an area that received a flood. List any practices and treatments that could have helped with survival as positive investments.

## ADDITIONAL RESOURCES

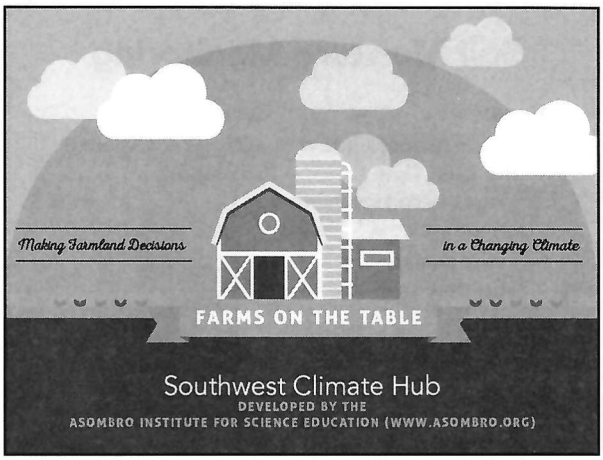
Reports, articles, and websites with helpful background information on agricultural adaptations:

California Department of Food and Agriculture (CDFA). Climate Change Consortium for Specialty Crops: Impacts and Strategies for Resilience. Published 2013. Accessed online 22 Jan. 2016. <https://www.cdfa.ca.gov/environmentalstewardship/pdfs/ccc-report.pdf>.

Howden. S, Soussana, J, Tubiello, F, Chhetri, N, Dunlop, M, and Meinke, H. 2007. Adapting agriculture to climate change. The Proceedings of National Academy of Sciences 104(50), 19691-19696. Accessed online 29 Mar. 2016. <http://www.pnas.org/cgi/doi/10.1073/pnas.0701890104>.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Synthesis Report. Accessed online 29 Mar. 2016. <http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf>.

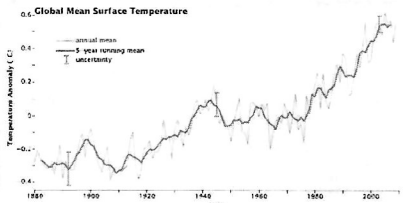
United States Department of Agriculture (USDA). Agricultural Research Service. Climate Change and Agriculture in the United States: Effects and Adaptations. Published Feb. 2013. Web. Accessed 22 Jan. 2016. <http://www.usda.gov/oce/climate_change/effects.htm>.




1

## Global Warming vs Climate Change

- **Global Warming**: increase in Earth's average temperature




Source: earthobservatory.nasa.gov/Features/GlobalWarming/page2.php

- **Climate Change**: long term-change in Earth's climate or the climate of a region
  - Warming AND changes besides temperature (precipitation)

2

## Climate Change & the Southwest

- Longer and hotter heat waves
- More severe and sustained droughts
- Frequency and intensity of extreme precipitation likely to increase
- Insect and pest outbreaks
- Wildfires

Source: texasagriculture.gov/portals/0/forms/ER/dry%20corn.jpg

3

## Farms on the Table

- You are a farmer
- Goal: stay in the black
- Circle one of the counties in Table 1

Source: www.climate.gov/sites/default/files/Chili_7

Source: wbc.agr.mt.gov/portals/149/Images/Homepage/itk_farmer_358x270.jpg

| Cuckoo cow county | MARICOPA CO. AZ | YOLO CO. CA | DONA ANA CO. NM | LYON CO. NV | UTAH CO. UT |
|---|---|---|---|---|---|
| TEMPERATURE 2015 (°F) | 74.6 | 58.8 | 62.2 | 45.0 | 38.4 |
| TEMPERATURE 2065 (°F) | +5.7 | +5.0 | +7.9 | +6.1 | +6.9 |
| PRECIPITATION 2015 (in) | 9.84 | 21.24 | 10.98 | 6.97 | 21.19 |
| PRECIPITATION 2065 (in) | +0.17 | +2.71 | +0.13 | +0.64 | +1.68 |
| AVG. FARM SIZE (ACRES) | 192 | 456 | 302 | 782 | 139 |
| COMMON CROPS | cotton, alfalfa, wheat, corn, watermelon | tomatoes, rice, almonds, walnuts, wheat | chile, cotton, onions, lettuce, onion | onion, potatoes, alfalfa, squash, wheat | alfalfa hay, wheat, corn |

4

## No-till Planting

A type of planting where the seeds are inserted directly into the soil, instead of turning the soil over before inserting the seeds into the soil

- **Pros:**
  - Lower labor, equipment, and fuel costs
  - Reduces water runoff from precipitation and irrigation
  - Limits wind erosion and compaction, and increases organic material
- **Cons:**
  - High upfront equipment costs
  - May require more herbicide and fungicide

Source: www.nrcs.usda.gov/wps/portal/nrcs/detail/in/programs/?cid=nrcs144p2_027311

5

## Hedgerows

A row of wild shrubs and trees bordering a road or field

- **Pros:**
  - Helps prevent some wind and water erosion of the soil
  - Can help prevent the spread of insect and fungal diseases
  - Can create pollinator habitat
- **Cons:**
  - Fewer rows for crops
  - Needs watering and maintenance

Source: nrcs.usda.gov/wps/portal/nrcs/detail/il/newsroom/factsheets/?cid=stelprdb1265079

6

## Water Collection and Storage Unit

Collects rainfall from roofs or runoff from fields to be used for irrigation

- Pros:
  - Water source available during droughts
- Cons:
  - Can take a few years to gather enough water to help mitigate effects
  - Requires space

Source: nrcs.usda.gov/wps/portal/nrcs/detail/tx/newsroom/stories/?cid=nrcseprd882030

7

## Soil Moisture Monitoring

- Pros:
  - Helps farmers know the best time to irrigate crops, saving on water cost
  - Inexpensive equipment
- Cons:
  - Biggest expense is labor

Source: agresearchmag.ars.usda.gov/2013/aug/soil

8

## Beehives and Flower Strips

- Pros:
  - Reliable pollination of crops
  - Can provide habitat for native pollinators other than bees
- Cons:
  - Cannot use insecticides due on harm inflicted to colonies

Source: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/il/newsroom/factsheets/?cid=stelprdb1265079

9

## Customize your farm!

Table 2. Climate-mitigating adaptations

| ADAPTATION | PROS | CONS | COST (POINTS) | CUSTOM COST: |
|---|---|---|---|---|
| NO-TILL PLANTING ☐ | -Reduces costs of labor, equipment, fuel<br>-Reduces soil erosion from water and wind<br>-Retains soil moisture<br>-Increases soil organic matter<br>-Limits soil compaction | -May require more herbicide and fungicide due to higher soil moisture<br>-High upfront cost | 15 | |
| HEDGEROWS ☐ | -Reduce soil erosion from water and wind<br>-Create pollinator habitat<br>-Prevent spread of some insects and fungal diseases | -Require some watering and maintenance<br>-Possibly reduce number of crop rows | 5 | |
| WATER CISTERN COLLECTION & STORAGE UNIT ☐ | -Collects rainfall and/or other water runoff for use when water is scarce | -Requires space<br>-Can take a few years to collect enough water | 10 | |
| SOIL MOISTURE MONITORING ☐ | -Decreases irrigation expenses by eliminating unnecessary watering of crops | -Requires labor to operate equipment | 3 | |
| BEEHIVES & FLOWER STRIPS ☐ | -Reliable pollination of crops<br>-Provide habitat for variety of pollinators | -Requires some maintenance<br>-Unable to use insecticides | 5 | |
| | | TOTAL COST (POINTS) | | |

1. Add up all chosen adaptations and record in the "Total Cost" blank.

$$\text{STARTING OUTPUT FACTOR} = 100 - \frac{\text{TOTAL COST}}{=}$$

2. Then calculate the "Starting Output Factor"

10

## Practices and Treatments – YR 1

- Choose at least two of the nine options
- Success will be dependent on weather
- Will play for 6 years (rounds)

Sources: nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/csp/?cid=nrcseprd546806
nrcs.usda.gov/wps/portal/nrcs/detail/ia/technical/?cid=nrcs142p2_008309
bls.gov/opub/btn/volume-2/growing-demand-for-fertilizer-keeps-prices-high.htm

11

## Crop Seed Varieties

- Drought resistant variety pros:
  - Can produce a more reliable yield/acre during periods of prolonged drought
- Flood resistant variety pros:
  - Can tolerate being submerged for longer periods of time or multiple times/year
- Cons:
  - Seeds need to be repurchased every year

12

## Interplanting

Planting a crop together with another in alternating rows

- **Pros:**
  - Decreased need for crop treatments
  - Less economic risk in case of a crop fail year
- **Cons:**
  - Requires more planning

Source: nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/esp/?cid=nrcseprd346806

13

## Crop Rotation

A system of varying crops in the same field year after year

- **Pros:**
  - Avoid depleting the soil of nutrients
  - Helps control weeds, disease, and other pests
- **Cons:**
  - Requires more planning

Source: nrcs.usda.gov/wps/portal/nrcs/detail/ia/technical/?cid=nrcs142p2_006309

14

## Spread Spacing

Increasing the amount of space between planted rows of crops

- **Pros:**
  - Can reduce the need for crop treatments
  - Less competition for resources by plants
- **Cons:**
  - Lower crop yield per acre

15

## Fertilizing

The process of making the soil more fertile or productive by adding nutrients or organic matter to the soil

- **Pros:**
  - Can make crops grow larger, faster
- **Cons:**
  - Depletes natural soil fertility causing an annual reliance

Source: bls.gov/opub/btn/volume-2/growing-demand-for-fertilizer-keeps-prices-high.htm

16

## Herbicide

Spraying a substance that targets unwanted vegetation

- **Pros:**
  - Can greatly reduce loss from plant pests
- **Cons:**
  - Becomes less effective with continual use

Pigweed
*Amaranthus spp.*

Source: plants.usda.gov/core/profile?symbol=amal

17

## Insecticide

Spraying a substance that targets insect pests

- **Pros:**
  - Can greatly reduce loss from insect pests
- **Cons:**
  - Will harm natural pollinators
    - Should not choose if you have beehives and flower strips
  - Becomes less effective with continual use

Source: blogs.usda.gov/2016/06/24/reversing-pollinator-decline-is-key-to-feeding-the-future/

18

## Fungicide

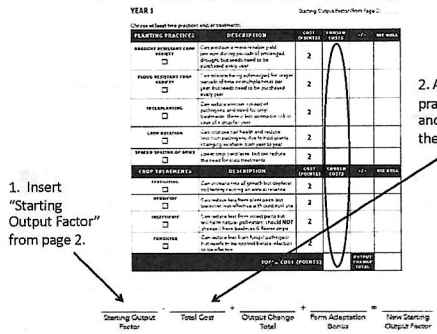
**Spraying a substance that targets unwanted fungal pathogens**

- **Pros:**
  - **Can greatly reduces loss from fungal pathogens**
- **Cons:**
  - **Needs to be applied before infection to be effective**

Source: nifa.usda.gov/sites/default/files/styles/nifa_large/public/blog/26189134073_f4180beee6.jpg?itok=f_9vBT9I

19

## YEAR 1 PRACTICES AND TREATMENTS



1. Insert "Starting Output Factor" from page 2.

2. Add up the cost of the practices and treatments and insert the total into the appropriate blank.

Starting Output Factor − Total Cost + Output Change Total + Farm Adaptation Bonus = New Starting Output Factor

20

## YEAR 1: Roll the Die

YEAR 1 — Starting Output Factor (from Page 2): _____

Choose at least one practice and/or treatment.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| DROUGHT RESISTANT CROP VARIETY ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | 2 | | | |
| FLOOD RESISTANT CROP VARIETY ☐ | Can tolerate being submerged for longer periods of time or multiple times per year but seeds need to be purchased every year | 2 | | | |
| INTERPLANTING ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less monoculture risk in case of a crop failure | 2 | | | |
| CROP ROTATION ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | 2 | | | |
| SPREAD SPACING OF ROWS ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | 2 | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| FERTILIZING ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | 2 | | | |
| HERBICIDE ☐ | Can reduce loss from plant pests but becomes less effective with continual use | 2 | | | |
| INSECTICIDE ☐ | Can reduce loss from insect pests but will harm natural pollinators; should NOT choose if have beehives & flower strips | 2 | | | |
| FUNGICIDE ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | 2 | | | |
| | **TOTAL COST (POINTS)** | | | **OUTPUT CHANGE TOTAL** | |

21

## Year 1 Weather – Historically Normal

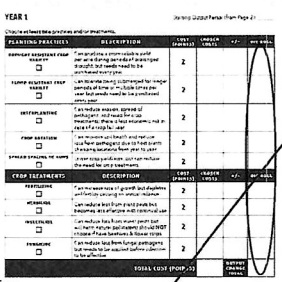
- **Positive investments ("+")**
  - **Interplanting**
  - **Crop rotation**
  - **Spread spacing of rows**
  - **Fertilizing**
  - **Herbicide**
  - **Insecticide**
  - **Fungicide**
- **Negative investments ("-")**
  - **Drought resistant crop varieties**
  - **Flood resistant crop varieties**

**Add 3 points for each of the following farm adaptations implemented:**

- **No-till planting**
- **Hedgerows**
- **Water collection and storage**
- **Soil moisture monitoring**
- **Beehives and flower strips**

22

## Year 1 Handout



3. Add up the positive and negative investments and insert the total into the appropriate blank.

5. Add up all of the blanks to calculate the "Starting Output Factor" for the next year (be sure to pay attention to the sign).

4. Insert total adaptation bonus (bottom of previous slide).

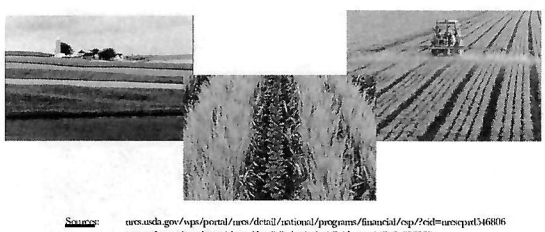
Starting Output Factor − Total Cost + Output Change Total + Farm Adaptation Bonus = New Starting Output Factor

6. Repeat for each year.

23

## Practices and Treatments – YR 2

- **Choose at least two of the nine options**
- **Success will be dependent on weather**



Sources: ares.usda.gov/vps/portal/nres/detail/national/programs/financial/esp/?cid=nrcseprd546806
ares.usda.gov/vps/portal/nres/detail/ia/technical/?cid=nres142p2_008509
hls.gov/opub/btn/volume-2/growing-demand-for-fertilizer-keeps-prices-high.htm

24

## Year 2 Weather - Drought

- Positive investments ("+")
  - Drought resistant crop varieties
  - Interplanting
  - Crop rotation
  - Fertilizer
  - Insecticide
- Negative investments ("-")
  - Flood resistant crop varieties
  - Spread spacing
  - Herbicide
  - Fungicide

Add 3 points for each of the following farm adaptations implemented:
- No-till planting
- Water collection and storage
- Soil moisture monitoring
- Beehives and flower strips

25

## Practices and Treatments – YR 3

- Choose at least two of the nine options
- Success will be dependent on weather

Sources: nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/esp/?cid=nrcseprd346806
nrcs.usda.gov/wps/portal/nrcs/detail/fa/technical/?cid=nrcs142p2_008509
hls.gw/opub/btn/volume-2/growing-demand-for-fertilizer-keeps-prices-high.htm

26

## Year 3 Weather – Heat Wave

- Positive investments ("+")
  - Interplanting
  - Crop rotation
  - Spread spacing of rows
  - Insecticide
- Negative investments ("-")
  - Drought resistant crop varieties
  - Flood resistant crop varieties
  - Fertilizer
  - Herbicide
  - Fungicide

Add 3 points for each of the following farm adaptations implemented:
- No-till planting
- Water collection and storage
- Soil moisture monitoring

27

## Year 3 – Subsidy Announcement

**Beehives**
- Pollination from bees in the US is worth over $14 billion
- Many crops would not exist, or be less productive without bees

***Add *10 points* in the Subsidy Bonus blank if you have invested in beehives***

Important crops pollinated by bees
- Kiwi
- Peppers – red, green, bell, chile
- Watermelon
- Cucumber
- Pumpkin
- Strawberry
- Cotton
- Apple
- Mango
- Alfalfa
- Avocado
- Cherry
- Almond
- Peach
- Pear
- Raspberry/Blackberry
- Blueberry
- And many, many more

Sources:
www.dos.nygov/kids_room/web_images/reality_images/800px-McIntosh.jpg
www.usda.gov/media/blog/2015/01/16/spraying-smarter-strengthens-strawberry-production

28

## Practices and Treatments – YR 4

- Choose at least two of the nine options
- Success will be dependent on weather

Sources: nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/esp/?cid=nrcseprd346806
nrcs.usda.gov/wps/portal/nrcs/detail/fa/technical/?cid=nrcs142p2_008509
hls.gw/opub/btn/volume-2/growing-demand-for-fertilizer-keeps-prices-high.htm

29

## Year 4 Weather - Wind

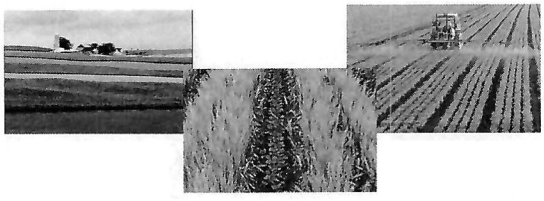
- Positive investments ("+")
  - Interplanting
  - Crop rotation
  - Spread spacing of rows
- Negative investments ("-")
  - Drought resistant crop varieties
  - Flood resistant crop varieties
  - Fertilizer
  - Herbicide
  - Insecticide
  - Fungicide

Add 3 points for each of the following farm adaptations implemented:
- No-till planting
- Hedgerows

30

## Practices and Treatments – YR 5

- Choose at least two of the nine options
- Success will be dependent on weather



Sources: nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/esp/?cid=nrcseprd546806
nrcs.usda.gov/wps/portal/nrcs/detail/ia/technical/?cid=nrcs142p2_008309
hlg.gov/epub/btn/volume-2/growing-demand-for-fertilizer-keeps-prices-high.htm

31

## Year 5 Weather – Increased Precipitation

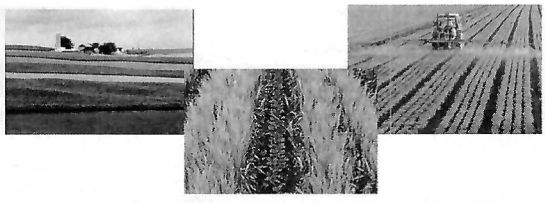
- Positive investments ("+")
  - Flood resistant crop varieties
  - Interplanting
  - Crop rotation
  - Spread spacing of rows
  - Fungicide
- Negative investments ("-")
  - Drought resistant crop varieties
  - Fertilizer
  - Herbicide
  - Insecticide

Add 3 points for each of the following farm adaptations implemented:
- No-till planting
- Hedgerows

32

## Practices and Treatments – YR 6

- Choose at least two of the nine options
- Success will be dependent on weather



Sources: nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/esp/?cid=nrcseprd546806
nrcs.usda.gov/wps/portal/nrcs/detail/ia/technical/?cid=nrcs142p2_008309
hlg.gov/epub/btn/volume-2/growing-demand-for-fertilizer-keeps-prices-high.htm

33

## Year 6 Weather – Heat Wave

- Positive investments ("+")
  - Interplanting
  - Crop rotation
  - Spread spacing of rows
  - Insecticide
- Negative investments ("-")
  - Drought resistant crop varieties
  - Flood resistant crop varieties
  - Fertilizer
  - Herbicide
  - Fungicide

Add 3 points for each of the following farm adaptations implemented:
- No-till planting
- Water collection and storage
- Soil moisture monitoring

34

## Year 6 – Subsidy Announcement

Water conservation includes using water resources responsibly (not overwatering) and only watering when necessary.

Extreme droughts are predicted to happen more often as a result of global climate change.

*Add *5 points* in the subsidy bonus blank if you invested in soil moisture monitoring*

*Add *10 points* in the subsidy bonus blank if you invested in water collection and storage*

*If you invested in both, add *15 points* total*

35

Name _____ Date _____


# *Making Farmland Decisions in a Changing Climate*

*Step 1 Directions:* choose **one** of the counties from table 1 to be the location for your new farm and **circle it**.

*Table 1.* Farm locations and data: 2015 values are averages, and 2065 values are predicted changes

| Circle one county: | | MARICOPA CO, AZ | YOLO CO, CA | DONA ANA CO, NM | LYON CO, NV | UTAH CO, UT |
|---|---|---|---|---|---|---|
| TEMPERATURE | 2015 (°F) | 84.8 | 74.4 | 76.2 | 65.0 | 58.4 |
| | 2065 (°F) | +5.7 | +5.0 | +7.9 | +6.1 | +6.6 |
| PRECIPITATION | 2015 (in.) | 9.94 | 21.24 | 10.98 | 8.97 | 21.19 |
| | 2065 (in.) | +0.17 | +0.71 | +0.13 | +0.64 | +1.88 |
| AVG. FARM SIZE (ACRES) | | 192 | 456 | 302 | 792 | 139 |
| COMMON CROPS | | cotton, alfalfa, wheat, oats, watermelon | tomato, rice, almonds, walnuts, wheat | chile, cotton, pecan, lettuce, onion | onion, potato, alfalfa, squash, wheat | alfalfa, hay, wheat, corn |

*Weather data source: swclimatehub.info*

*Step 2 Directions:* customize your new farm by choosing as many, or as few, as you would like of the climate-mitigating adaptations from table 2. **Place a checkmark** under each adaptation that you choose, and **write the cost (points) in the last column** for each selected adaptation.

Table 2. Climate-mitigating adaptations

| ADAPTATION | PROS | CONS | COST (POINTS) | CHOSEN COSTS |
|---|---|---|---|---|
| **NO-TILL PLANTING** ☐ | -Reduces costs of labor, equipment, fuel<br>-Reduces soil erosion from water and wind<br>-Retains soil moisture<br>-Increases soil organic matter<br>-Limits soil compaction | -May require more herbicide and fungicide due to higher soil moisture<br>-High upfront cost | **15** | |
| **HEDGEROWS** ☐ | -Reduce soil erosion from water and wind<br>-Create pollinator habitat<br>-Prevent spread of some insects and fungal diseases | -Require some watering and maintenance<br>-Possibly reduce number of crop rows | **5** | |
| **WATER CISTERN COLLECTION & STORAGE UNIT** ☐ | -Collects rainfall and/or other water runoff for use when water is scarce | -Requires space<br>-Can take a few years to collect enough water | **10** | |
| **SOIL MOISTURE MONITORING** ☐ | -Decreases irrigation expenses by eliminating unnecessary watering of crops | -Requires labor to operate equipment | **3** | |
| **BEEHIVES & FLOWER STRIPS** ☐ | -Reliable pollination of crops<br>-Provide habitat for variety of pollinators | -Requires some maintenance<br>-Unable to use insecticides | **5** | |
| | | | **TOTAL COST (POINTS)** | |

**STARTING OUTPUT FACTOR = 100 – _____ = _____**
**TOTAL COST**

## FARMS ON THE TABLE GAME DIRECTIONS

1. Your goal is to **keep your farm in the black**. Being in the black means that you are making money, and being in the red means that you are losing money.
2. Choose **at least two** of the practices and treatments from the table for each year, and write the cost of each selected item in the Chosen Costs column of the table.
3. Add up the cost of your practices and treatments, and write the Total Cost at the bottom of the table.
4. Roll the die and assign the number rolled to your first selection; write it in the last column of the table. Roll the die again and assign that number to the second checked item, and repeat this for all of the selected items.
5. Your instructor will then reveal the weather for the year and whether each of the practices and treatments were positive or negative investments. In the table, assign a plus sign to the die roll numbers of the positive investments and a minus sign to the die roll numbers of the negative investments.
6. Add up the positive and negative die roll numbers. Be sure to **pay attention to the sign**.
7. Fill in the equation at the bottom of each page, and calculate the Starting Output Factor.

## YEAR 1

Starting Output Factor (from Page 2): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| **DROUGHT RESISTANT CROP VARIETY** ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | **2** | | | |
| **FLOOD RESISTANT CROP VARIETY** ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | **2** | | | |
| **INTERPLANTING** ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | **2** | | | |
| **CROP ROTATION** ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | **2** | | | |
| **SPREAD SPACING OF ROWS** ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | **2** | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| **FERTILIZING** ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | **2** | | | |
| **HERBICIDE** ☐ | Can reduce loss from plant pests but becomes less effective with continual use | **2** | | | |
| **INSECTICIDE** ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | **2** | | | |
| **FUNGICIDE** ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | **2** | | | |
| | | **TOTAL COST (POINTS)** | | **OUTPUT CHANGE TOTAL** | |

Weather for this year (from instructor): _____

_____ (Starting Output Factor) - _____ (Total Cost) + _____ (Output Change Total) + _____ (Farm Adaptation Bonus) = _____ (New Starting Output Factor)

## YEAR 2

New Starting Output Factor (from the end of Year 1): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| DROUGHT RESISTANT CROP VARIETY ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | 2 | | | |
| FLOOD RESISTANT CROP VARIETY ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | 2 | | | |
| INTERPLANTING ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | 2 | | | |
| CROP ROTATION ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | 2 | | | |
| SPREAD SPACING OF ROWS ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | 2 | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| FERTILIZING ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | 2 | | | |
| HERBICIDE ☐ | Can reduce loss from plant pests but becomes less effective with continual use | 2 | | | |
| INSECTICIDE ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | 2 | | | |
| FUNGICIDE ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | 2 | | | |
| | **TOTAL COST (POINTS)** | | | **OUTPUT CHANGE TOTAL** | |

Weather for this year (from instructor): _____

_____ (Starting Output Factor) - _____ (Total Cost) + _____ (Output Change Total) + _____ (Farm Adaptation Bonus) = _____ (New Starting Output Factor)

## YEAR 3

New Starting Output Factor (from the end of Year 2): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| **DROUGHT RESISTANT CROP VARIETY** ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | **2** | | | |
| **FLOOD RESISTANT CROP VARIETY** ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | **2** | | | |
| **INTERPLANTING** ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | **2** | | | |
| **CROP ROTATION** ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | **2** | | | |
| **SPREAD SPACING OF ROWS** ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | **2** | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| **FERTILIZING** ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | **2** | | | |
| **HERBICIDE** ☐ | Can reduce loss from plant pests but becomes less effective with continual use | **2** | | | |
| **INSECTICIDE** ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | **2** | | | |
| **FUNGICIDE** ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | **2** | | | |
| | | **TOTAL COST (POINTS)** | | **OUTPUT CHANGE TOTAL** | |

Weather for this year (from instructor): _____

| _____ | - | _____ | + | _____ | + | _____ | + | _____ | = | _____ |
|---|---|---|---|---|---|---|---|---|---|---|
| Starting Output Factor | | Total Cost | | Output Change Total | | Farm Adaptation Bonus | | Subsidy Bonus | | New Starting Output Factor |

## YEAR 4

New Starting Output Factor (from the end of Year 3): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| **DROUGHT RESISTANT CROP VARIETY** ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | **2** | | | |
| **FLOOD RESISTANT CROP VARIETY** ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | **2** | | | |
| **INTERPLANTING** ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | **2** | | | |
| **CROP ROTATION** ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | **2** | | | |
| **SPREAD SPACING OF ROWS** ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | **2** | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| **FERTILIZING** ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | **2** | | | |
| **HERBICIDE** ☐ | Can reduce loss from plant pests but becomes less effective with continual use | **2** | | | |
| **INSECTICIDE** ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | **2** | | | |
| **FUNGICIDE** ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | **2** | | | |
| | **TOTAL COST (POINTS)** | | | **OUTPUT CHANGE TOTAL** | |

Weather for this year (from instructor): _____

| _____ | - | _____ | + | _____ | + | _____ | = | _____ |
|---|---|---|---|---|---|---|---|---|
| Starting Output Factor | | Total Cost | | Output Change Total | | Farm Adaptation Bonus | | New Starting Output Factor |

## YEAR 5

New Starting Output Factor (from the end of Year 4): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| **DROUGHT RESISTANT CROP VARIETY** ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | **2** | | | |
| **FLOOD RESISTANT CROP VARIETY** ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | **2** | | | |
| **INTERPLANTING** ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | **2** | | | |
| **CROP ROTATION** ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | **2** | | | |
| **SPREAD SPACING OF ROWS** ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | **2** | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| **FERTILIZING** ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | **2** | | | |
| **HERBICIDE** ☐ | Can reduce loss from plant pests but becomes less effective with continual use | **2** | | | |
| **INSECTICIDE** ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | **2** | | | |
| **FUNGICIDE** ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | **2** | | | |
| | | **TOTAL COST (POINTS)** | | **OUTPUT CHANGE TOTAL** | |

Weather for this year (from instructor): _____

| _____ | - | _____ | + | _____ | + | _____ | = | _____ |
|---|---|---|---|---|---|---|---|---|
| Starting Output Factor | | Total Cost | | Output Change Total | | Farm Adaptation Bonus | | New Starting Output Factor |

## YEAR 6

New Starting Output Factor (from the end of Year 5): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| **DROUGHT RESISTANT CROP VARIETY** ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | **2** | | | |
| **FLOOD RESISTANT CROP VARIETY** ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | **2** | | | |
| **INTERPLANTING** ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | **2** | | | |
| **CROP ROTATION** ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | **2** | | | |
| **SPREAD SPACING OF ROWS** ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | **2** | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| **FERTILIZING** ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | **2** | | | |
| **HERBICIDE** ☐ | Can reduce loss from plant pests but becomes less effective with continual use | **2** | | | |
| **INSECTICIDE** ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | **2** | | | |
| **FUNGICIDE** ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | **2** | | | |
| | **TOTAL COST (POINTS)** | | | **OUTPUT CHANGE TOTAL** | |

Weather for this year (from instructor): _____

| _____ | - | _____ | + | _____ | + | _____ | + | _____ | = | _____ |
|---|---|---|---|---|---|---|---|---|---|---|
| Starting Output Factor | | Total Cost | | Output Change Total | | Farm Adaptation Bonus | | Subsidy Bonus | | New Starting Output Factor |

## RESULTS AND CONCLUSIONS

1. How many years were you able to keep your farm in the black? Did you end the game in the red or in the black?

2. Were there certain practices or treatments that seemed to be a positive investment more than others? Were there certain practices or treatments that seemed to be a negative investment more than others? Why do you think that is the case?

3. If you were to play this game again, what would you do differently? Why?

# ANSWER KEY


*Making Farmland Decisions* *in a Changing Climate*

*Step 1 Directions:* choose **one** of the counties from table 1 to be the location for your new farm and **circle it**.

*Table 1.* Farm locations and data: 2015 values are averages, and 2065 values are predicted changes

| Circle one county: | | MARICOPA CO, AZ | YOLO CO, CA | DONA ANA CO, NM | LYON CO, NV | UTAH CO, UT |
|---|---|---|---|---|---|---|
| TEMPERATURE | 2015 (°F) | 84.8 | 74.4 | 76.2 | 65.0 | 58.4 |
| | 2065 (°F) | +5.7 | +5.0 | +7.9 | +6.1 | +6.6 |
| PRECIPITATION | 2015 (in.) | 9.94 | 21.24 | 10.98 | 8.97 | 21.19 |
| | 2065 (in.) | +0.17 | +0.71 | +0.13 | +0.64 | +1.88 |
| AVG. FARM SIZE (ACRES) | | 192 | 456 | 302 | 792 | 139 |
| COMMON CROPS | | cotton, alfalfa, wheat, oats, watermelon | tomato, rice, almonds, walnuts, wheat | chile, cotton, pecan, lettuce, onion | onion, potato, alfalfa, squash, wheat | alfalfa, hay, wheat, corn |

*Weather data source: swclimatehub.info*

*Step 2 Directions:* customize your new farm by choosing as many, or as few, as you would like of the climate-mitigating adaptations from table 2. **Place a checkmark** under each adaptation that you choose, and **write the cost (points) in the last column** for each selected adaptation.

Table 2. Climate-mitigating adaptations

| ADAPTATION | PROS | CONS | COST (POINTS) | CHOSEN COSTS |
|---|---|---|---|---|
| **NO-TILL PLANTING** ☐ | -Reduces costs of labor, equipment, fuel<br>-Reduces soil erosion from water and wind<br>-Retains soil moisture<br>-Increases soil organic matter<br>-Limits soil compaction | -May require more herbicide and fungicide due to higher soil moisture<br>-High upfront cost | **15** | |
| **HEDGEROWS** ☐ | -Reduce soil erosion from water and wind<br>-Create pollinator habitat<br>-Prevent spread of some insects and fungal diseases | -Require some watering and maintenance<br>-Possibly reduce number of crop rows | **5** | |
| **WATER CISTERN COLLECTION & STORAGE UNIT** ☐ | -Collects rainfall and/or other water runoff for use when water is scarce | -Requires space<br>-Can take a few years to collect enough water | **10** | |
| **SOIL MOISTURE MONITORING** ☐ | -Decreases irrigation expenses by eliminating unnecessary watering of crops | -Requires labor to operate equipment | **3** | |
| **BEEHIVES & FLOWER STRIPS** ☐ | -Reliable pollination of crops<br>-Provide habitat for variety of pollinators | -Requires some maintenance<br>-Unable to use insecticides | **5** | |
| | | | **TOTAL COST (POINTS)** | |

*student answers will vary*

**STARTING OUTPUT FACTOR = 100 – _____**

**TOTAL C**

*student answers will vary*

## FARMS ON THE TABLE GAME DIRECTIONS

1. Your goal is to **keep your farm in the black**. Being in the black means that you are making money, and being in the red means that you are losing money.
2. Choose **at least two** of the practices and treatments from the table for each year, and write the cost of each selected item in the Chosen Costs column of the table.
3. Add up the cost of your practices and treatments, and write the Total Cost at the bottom of the table.
4. Roll the die and assign the number rolled to your first selection; write it in the last column of the table. Roll the die again and assign that number to the second checked item, and repeat this for all of the selected items.
5. Your instructor will then reveal the weather for the year and whether each of the practices and treatments were positive or negative investments. In the table, assign a plus sign to the die roll numbers of the positive investments and a minus sign to the die roll numbers of the negative investments.
6. Add up the positive and negative die roll numbers. Be sure to **pay attention to the sign**.
7. Fill in the equation at the bottom of each page, and calculate the Starting Output Factor.

## YEAR 1

Starting Output Factor (from Page 2): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| DROUGHT RESISTANT CROP VARIETY ☑ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | 2 | 2 | - | 4 |
| FLOOD RESISTANT CROP VARIETY ☐ | Can tolerate being submerg… periods of time or m… year, but seed… every… | | | | |
| INTERPLANTING ☐ | | | | | |
| CROP ROTATION ☑ | …d reduce …ns due to host plants c… …ocations from year to year | 2 | 2 | + | 6 |
| SPREAD SPACING OF ROWS ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | 2 | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| FERTILIZING ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | 2 | | | |
| HERBICIDE ☑ | Can reduce loss from plant pests but becomes less effective with continual use | 2 | 2 | + | 3 |
| INSECTICIDE ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | 2 | | | |
| FUNGICIDE ☑ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | 2 | 2 | + | 1 |
| | **TOTAL COST (POINTS)** | | 8 | OUTPUT CHANGE TOTAL | 6 |



Weather for this year (from instructor): Historically Normal

(From blank at bottom of page 2) – 8 + 6 + (Three points for each chosen on page 2) = _____

Starting Output Factor – Total Cost + Output Change Total + Farm Adaptation Bonus = New Starting Output Factor

## YEAR 2

New Starting Output Factor (from the end of Year 1): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| DROUGHT RESISTANT CROP VARIETY ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | 2 | | | |
| FLOOD RESISTANT CROP VARIETY ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | 2 | | | |
| INTERPLANTING ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | 2 | *student answers will vary* | | |
| CROP ROTATION ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | 2 | | | |
| SPREAD SPACING OF ROWS ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | 2 | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| FERTILIZING ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | 2 | | | |
| HERBICIDE ☐ | Can reduce loss from plant pests but becomes less effective with continual use | 2 | | | |
| INSECTICIDE ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | 2 | *student answers will vary* | | |
| FUNGICIDE ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | 2 | | | |
| | **TOTAL COST (POINTS)** | | | **OUTPUT CHANGE TOTAL** | |

Weather for this year (from instructor): *Drought*

_____ - _____ + *student answers will vary* _____ = _____

Starting Output Factor | Total Cost | Total | Farm Adaptation Bonus | New Starting Output Factor

## YEAR 3

New Starting Output Factor (from the end of Year 2): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| **DROUGHT RESISTANT CROP VARIETY** ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | **2** | | | |
| **FLOOD RESISTANT CROP VARIETY** ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | **2** | | | |
| **INTERPLANTING** ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | **2** | | | |
| **CROP ROTATION** ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | **2** | | | |
| **SPREAD SPACING OF ROWS** ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | **2** | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| **FERTILIZING** ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | **2** | | | |
| **HERBICIDE** ☐ | Can reduce loss from plant pests but becomes less effective with continual use | **2** | | | |
| **INSECTICIDE** ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | **2** | | | |
| **FUNGICIDE** ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | **2** | | | |
| | | **TOTAL COST (POINTS)** | | **OUTPUT CHANGE TOTAL** | |

student answers will vary

Weather for this year (from instructor): _____ *Heat Wave*

_____ - _____ + _____ + _____ = _____

Starting Output Factor | Total Cost | Output C... | ...n Adaptation Bonus | Subsidy Bonus | New Starting Output Factor

student answers will vary

## YEAR 4

New Starting Output Factor (from the end of Year 3): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| DROUGHT RESISTANT CROP VARIETY ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | 2 | | | |
| FLOOD RESISTANT CROP VARIETY ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | 2 | | | |
| INTERPLANTING ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | 2 | student answers will vary | | |
| CROP ROTATION ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | 2 | | | |
| SPREAD SPACING OF ROWS ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | 2 | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| FERTILIZING ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | 2 | | | |
| HERBICIDE ☐ | Can reduce loss from plant pests but becomes less effective with continual use | 2 | | | |
| INSECTICIDE ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | 2 | student answers will vary | | |
| FUNGICIDE ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | 2 | | | |
| | **TOTAL COST (POINTS)** | | | **OUTPUT CHANGE TOTAL** | |

Weather for this year (from instructor): Wind

_____ - _____ + student answers will vary = _____

Starting Output Factor | Total Cost | Total | Farm Adaptation Bonus | New Starting Output Factor

## YEAR 5

New Starting Output Factor (from the end of Year 4): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| **DROUGHT RESISTANT CROP VARIETY** ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | **2** | | | |
| **FLOOD RESISTANT CROP VARIETY** ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | **2** | | | |
| **INTERPLANTING** ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | **2** | *student answers will vary* | | |
| **CROP ROTATION** ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | **2** | | | |
| **SPREAD SPACING OF ROWS** ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | **2** | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| **FERTILIZING** ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | **2** | | | |
| **HERBICIDE** ☐ | Can reduce loss from plant pests but becomes less effective with continual use | **2** | | | |
| **INSECTICIDE** ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | **2** | *student answers will vary* | | |
| **FUNGICIDE** ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | **2** | | | |
| | | **TOTAL COST (POINTS)** | | **OUTPUT CHANGE TOTAL** | |

Weather for this year (from instructor): *Increased Precipitation*

| Starting Output Factor | - | Total Cost | + | *student answers will vary* Total | Farm Adaptation Bonus | = | New Starting Output Factor |
|---|---|---|---|---|---|---|---|
| _____ | | _____ | | _____ | _____ | | _____ |

## YEAR 6

New Starting Output Factor (from the end of Year 5): _____

Choose **at least two** practices and/or treatments.

| PLANTING PRACTICES | DESCRIPTION | COST (POINTS) | CHOSEN COSTS | +/- | DIE ROLL |
|---|---|---|---|---|---|
| DROUGHT RESISTANT CROP VARIETY ☐ | Can produce a more reliable yield per acre during periods of prolonged drought, but seeds need to be purchased every year | 2 | | | |
| FLOOD RESISTANT CROP VARIETY ☐ | Can tolerate being submerged for longer periods of time or multiple times per year, but seeds need to be purchased every year | 2 | | | |
| INTERPLANTING ☐ | Can reduce erosion, spread of pathogens, and need for crop treatments; there is less economic risk in case of a crop fail year | 2 | student answers will vary | | |
| CROP ROTATION ☐ | Can improve soil health and reduce loss from pathogens due to host plants changing locations from year to year | 2 | | | |
| SPREAD SPACING OF ROWS ☐ | Lower crop yield/acre, but can reduce the need for crop treatments | 2 | | | |
| **CROP TREATMENTS** | **DESCRIPTION** | **COST (POINTS)** | **CHOSEN COSTS** | **+/-** | **DIE ROLL** |
| FERTILIZING ☐ | Can increase rate of growth but depletes soil fertility causing an annual reliance | 2 | | | |
| HERBICIDE ☐ | Can reduce loss from plant pests but becomes less effective with continual use | 2 | | | |
| INSECTICIDE ☐ | Can reduce loss from insect pests but will harm natural pollinators; should **NOT** choose if have beehives & flower strips | 2 | student answers will vary | | |
| FUNGICIDE ☐ | Can reduce loss from fungal pathogens but needs to be applied before infection to be effective | 2 | | | |
| | **TOTAL COST (POINTS)** | | | **OUTPUT CHANGE TOTAL** | |

Weather for this year (from instructor): Heat Wave

_____ - _____ + _____ + _____ = _____

Starting Output Factor | Total Cost | Output [illegible] Adaptation Bonus | Subsidy Bonus | New Starting Output Factor

student answers will vary

## RESULTS AND CONCLUSIONS

1. How many years were you able to keep your farm in the black? Did you end the game in the red or in the black?

   *Student answers will vary.*

2. Were there certain practices or treatments that seemed to be a positive investment more than others? Were there certain practices or treatments that seemed to be a negative investment more than others? Why do you think that is the case?

   *Interplanting and crop rotation were a positive investment every year. Flood resistant crop varieties and fungicide resulted in a negative investment most often.*

   *Interplanting and crop rotation promote soil health and overall plant health by protecting them from pathogens without causing additional harm to the environment. Buying flood resistant crop varieties and fungicide are usually not the best practices to use in the dry, hot climate throughout much of the Southwest. Even though some areas of the Southwest are predicted to receive more rainfall, the region is not predicted to get flooding that would require flood resistant varieties or cause fungal outbreaks.*

3. If you were to play this game again, what would you do differently? Why?

   *Student answers will vary.*