Rice provides more than 20% of the calories consumed worldwide, and in some countries accounts for more than 90% of the agriculture. A grain of rice is the seed of the *Oryza sativa* plant. There are more than 100,000 varieties, differing in texture, color, grain length, and taste. To grow rice takes a lot of water. Some varieties, however, suffer damage in floods, while others are flood-tolerant and can be submerged in water for up to two weeks and remain unharmed.

Imagine you are a university professor studying food crop genetics. Your team specializes in selective breeding to produce crops with specific traits. The team has been studying flood tolerance and flavor in rice strains and is working with two strains of rice plants, which are described in the table below.

<table>
<thead>
<tr>
<th>Rice Strains</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRAIN</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

Your team would like to selectively breed a variety of rice that tastes good and can be grown in flood-prone areas of the world.

This photograph shows 12 types of rice, each with a different genotype and phenotype. They vary in taste, nutritional value, optimal growing conditions, and other characteristics.
**Challenge**

What trade-offs are involved in selectively breeding a desirable strain of rice?

**Materials**

**FOR EACH PAIR OF STUDENTS**
- 2 yellow allele cards (A)
- 2 yellow allele cards (a)
- 2 green allele cards (E)
- 2 green allele cards (f)

**FOR EACH STUDENT**
- Student Sheet 7.1, “Breeding Rice—Class Data”
- Student Sheet 2.3, “Genetics Case Study comparison,” from Activity 2

**Procedure**

**Part A: The First Generation of Rice**

1. Your research team breeds plants from Strain 1 with plants from Strain 2. After cross breeding the plants and allowing the offspring (F₁ generation) to grow, you find that none of these offspring are aromatic, but 100% are flood-tolerant. Based on these results, determine which traits are dominant and decide
   a. whether A or a represents the aromatic trait.
   b. whether F or f represents the flood-tolerant trait.

   Write your responses and your key to the alleles in your science notebook.

2. a. Based on the team’s results, what is the genotype for both traits (aromatic and flood-tolerant) for the parent plant from Strain 1?
   b. Based on the team’s results, what is the genotype for both traits (aromatic and flood-tolerant) for the parent plant from Strain 2?

3. Based on the genotypes you determined above for the parent plant from Strain 1 and the parent plant from Strain 2, what genotypes do you predict for the F₁ offspring described in Step 1? Construct a Punnett square to model your prediction.

4. Compare your work with the work done by the other pair in your group. If there are differences, discuss why the results do not agree.
**Part B: The Second Generation of Rice**

Now that you have determined the genotypes of the parent and F₁ generations, you will simulate the results (F₂ generation) of a cross between two F₁ generation plants. The goal is to produce rice that contains both desired traits.

5. Prepare a Punnett square to show all of the possible F₂ generation genotypes that could result from breeding two plants from the F₁ generation.
   a. What types and ratio of phenotypes would you expect from the cross?
   b. What percentage of the offspring do you predict will have the desired traits?

6. Create the chart shown below in your science notebook. Make rows for 10 offspring.

<table>
<thead>
<tr>
<th><strong>F₂ Generation Rice Plants</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Offspring</strong></td>
</tr>
<tr>
<td>------------------------------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

7. With your partner, simulate a cross between two F₁ generation rice plants. Each person should place four allele cards—A, a, F, and f—face down on the table and mix them up. Now, each of you takes one of the green cards and one of the yellow cards. Pair your two cards. You now have a gamete from one of the parent rice plants, and your partner has a gamete from the other parent rice plant. Individually your cards are the alleles. Lay your cards face up.

8. The four cards that are face up represent the genotype of an F₂ generation plant. Record the phenotype and genotype in your chart.

9. Reset by placing the cards you turned over back in the original pile and mixing them up.

10. Repeat Steps 7–9 until you have phenotypes and genotypes for 10 F₂ generation plants.

11. Add all of your results to the results of the other pair in your group, and record the data for the 20 offspring on Student Sheet 7.1, “Breeding Rice—Class Data.”
12. Fill in the data from all the other groups on Student Sheet 7.1, and add the numbers of each type of gamete.

13. Discuss the class’s results according to your teacher’s instructions.

Part C: Selective Corn Breeding Case Study

14. Individually read the case study on selective breeding at right. Follow the literacy strategy, “Read, Think, and Take Note,” as you read.

15. After reading, share your thinking with your group. Place your sticky notes on the table in front of you. Look for connections between your sticky-note comments and those of others in your group.

   **Hint:** Were there common questions people asked? Were people unfamiliar with the same words? Did people react differently to statements in the reading?

16. Place your sticky notes in your science notebook. Below them, write a short summary of what your group discussed and any conclusions the group came to.

17. Record the appropriate information from this case study on Student Sheet 2.3, “Genetics Case Study Comparison.”

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*Corn is the most widely grown crop in the United States.*