A Message for Everyone

Sustainability is a key concept in this year’s edition of What’s Growin’ On? Agriculture and the Environment. What is Sustainability? To put it simply, it’s raising food and fiber while protecting the environment, people, and the economy. There is a close connection between farming and protecting the natural resources of the earth that are the foundation of agriculture.

California farmers have cared for the environment for many generations. Today, they provide habitat for wildlife and conserve natural resources through innovative farming practices and new technologies. They not only provide us with food and fiber, but manage wildlife, practice conservation, compost and recycle!

Sustainability of agriculture and the environment is not only for farmers but for everyone - through education, innovative solutions and working together to make our communities a better place to live. Let’s all make sure our soil, water, and air remain fertile, safe and productive so we can be assured of the freshest, safest, and healthiest food in the world now and for future generations.

Read on to find out how farmers are leading the way, using new innovations to produce their harvest while sustaining the quality of the limited natural resources we are so fortunate to have in California. Find out how you can become a part of sustainability and innovation by trying out the Citizen Science and Service Learning activities in this issue.

Happy Reading!

Look for Citizen Science Projects throughout this issue!
Citizen Science projects are a collaboration between the public and scientists. Students participate in observing, collecting data, and contributing their findings on a variety of projects. Feel free to search for or even create your own class Citizen Science project.

Look for Service Learning Projects throughout this issue!
Service Learning is a strategy that incorporates community service projects with instruction and reflection. Its goal is to teach community responsibility while strengthening local communities. Feel free to develop your own Service Learning project that will benefit your school and community.

Look for Newspaper in Education (NIE) activities throughout this issue!
Students are encouraged to read the newspaper and challenge themselves with creative extension activities.

Vocabulary words are highlighted in dark red throughout the issue. Look for them in the glossary.

A Message for Teachers

It’s important to consider that our world population could potentially double by the end of this century and we’ll need to be creative in how to manage that – more people, more food, limited land, limited resources. There are many challenges that face all of us. Learning how farmers use new innovations to grow food and sustain the natural environment is a great start to becoming informed. Being informed can help students make decisions about how they will take care of themselves, their families, and the world we all live in.

This issue of What’s Growin’ On? can be a great start to introducing California’s Environmental Principles and Concepts (EP&C’s) into the classroom. These concepts will soon be part of all California textbooks and instructional materials. To learn more about California’s EP&C’s, visit www.californiaeei.org/abouteei/whatistought/epc.

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The sun delivers more energy to the earth in just one hour than is currently used worldwide in a year.

Farmers use the sun’s natural energy in many innovative ways.

Sun Power
Harvesting the sun’s energy

The sun is #1 and farmers know this as well as anyone! Without it we couldn’t grow food, wouldn’t have rain, and our earth wouldn’t be warm enough for us to live here! Why is that? The sun’s energy allows plants to create their own food through photosynthesis. Heat from the sun warms air masses that affect weather such as rain. Solar heat also warms our oceans and keeps earth from being an ice-covered rock.

How do farmers use solar energy?
Farmers have naturally used solar energy forever. Leaving cut hay, such as alfalfa, to dry in the field is an example of using the sun’s energy.

What is solar energy?
Energy in the sun’s rays can be converted into heat and electricity. There are two types of solar energy: passive and active.
- Passive Solar Energy: Does not use solar panels, uses the direction of the sun, building orientation, and insulating materials. Captures the energy by south-facing windows, large overhangs, and building color. A greenhouse uses passive solar energy.
- Active Solar Energy: Uses solar panels to collect sunlight and convert that energy into electrical energy. Solar panels can be near equipment needing electricity such as irrigation pumps. Check out the front cover of this paper for an example.

Why use solar power?
- Naturally, the sun’s heat is used to light and warm buildings by capturing light through skylights and absorbing heat through building color.
- Using solar-powered dryers can dry crops and grains faster and more evenly, while avoiding damage from birds, pests, and weather.
- In areas without electric line access, photovoltaic (PV) panels provide a remote electrical supply for electric fences, lights, and pumps.

How do solar panels work? Solar panels contain solar cells that capture sunlight and hold in the energy until it’s converted into electrical energy. In contrast, plants capture sunlight, hold it in, and use the energy to convert CO₂ (carbon dioxide) and H₂O (water) into C₆H₁₂O₆ (sugar) and O₂ (oxygen) - a process called ____________

Activity
Find 9 examples of solar energy on this page, label ACTIVE or PASSIVE. Think of other ways farmers and YOU use solar energy; add your ideas to the page and label.

Service Learning
Do a school energy audit. Go to Green Schools Initiative at: www.greenschools.net/form.php-modin=53.html

N.I.E.
Check out ads for solar energy panels. Make your own ad to sell the benefits of using solar power.

Did you Know?
Greenhouse walls are insulated - reducing heat loss at night and heat gain during the day!
How Farmers Help Keep the Air Clean

Clean air is important to agriculture. Pollution can cause losses in crop yields. Today, farmers use cleaner-burning tractors and equipment, plant windbreaks for dust control and plant trees that provide oxygen. California agriculture is a major contributor to clean air! Farmers use many conservation practices to decrease pollution. Decide and label which category of air pollution they are helping decrease: SMOKE, DUST, ODOR, OR GROUND-LEVEL OZONE.

1. Rice straw: It can be harvested and manufactured into fiberboard, bricks, or paper pulp. It can also be used for livestock feed, energy generation, soil erosion prevention, or waterfowl habitat.

2. More efficient engines: Farmers can participate in programs like the California Air Resources Board’s (ARB) Carl Moyer program to replace old engines with lower-emitting equipment.

3. Wind breaks: Planting trees and hedgerows for wind breaks reduces soil erosion and blocks dust, lowers temperature, creates habitat, and takes in CO2.

4. Mulch: Crop waste, orchard and vineyard prunings are chipped and shredded. These are then left on top of the soil or incorporated into the soil.

5. Anaerobic Digesters: Dairy digesters capture cow manure’s methane gas and convert it to useable energy and fuel for the dairy farm, homes, and businesses.

6. Controlled burning: Only allowed on burn days as designated by the local air pollution control district or local fire department.

What is in our Air?

We all notice smells in the air. Think about how it smells when something delicious is cooking in the kitchen or when there is smoke in the air! Wind moves the air which can pick up dust, pollens, and other substances causing allergy problems for many! Odors, dust, smoke, and ground-level ozone are all part of the air that we breathe.

What is Air Pollution?

Air pollution can harm living organisms, damage structures, or cause nuisances such as odor or reduced visibility. Odors, dust, smoke and ground-level ozone all make up air pollution. The Air Quality Index (AQI) is a number used to communicate how polluted the air is.

Air Quality Index (AQI) Chart

Go to www.sparetheair.com/aqi.cfm for information to complete the chart.

<table>
<thead>
<tr>
<th>Range</th>
<th>Level</th>
<th>Color</th>
<th>What Colors Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 50</td>
<td>Good</td>
<td>Green</td>
<td>Air pollution poses no or little risk</td>
</tr>
<tr>
<td>51 - 100</td>
<td>Moderate</td>
<td>Yellow</td>
<td></td>
</tr>
<tr>
<td>101 - 150</td>
<td>Unhealthy</td>
<td>Orange</td>
<td>Affects those with respiratory problems</td>
</tr>
<tr>
<td>151 - 200</td>
<td>Hazardous</td>
<td>Red</td>
<td>Affects those with serious health issues</td>
</tr>
</tbody>
</table>

Check out this Carbon Footprint Calculator: coolcalifornia.org/calculator-households-individuals

CA Standards: ELA: CS: 3.10.7, 8, 3.3-3.6; Math: CC: 3.MD.3, 4.MD.4, 5.MD.2; NGSS: 3-ESS2-2, 3-ESS3-2, 4-ESS2-2, 5-ESS3-1
Sources: www.sparetheair.com/aqi.cfm; www.caagests.uc.edu; www.arb.ca.gov; www.energy.ca.gov/wind/overview.html
Digging into Soil!

Life on earth depends on soil; it is the primary source of food, feed, fuel, forage and fiber. It is considered a non-renewable resource - we have to take care of it, we can never replace it!

Soil Types

Sand
Has the largest particle size among soil types and it's dry and gritty to the touch. It doesn't hold water as well as other soil types. Plants that can grow in sandy soils include carrots, radishes, and asparagus.

Silt
Has a medium particle size. When moistened, it's slick. It compacts easily and retains water longer than sand. Plants that can grow in silty soils are trees, flowers, and tomatoes.

Clay
Has the smallest particle size of the three soil types (sand, silt, clay). It's sticky to touch when wet, smooth when dry. Plants that can grow well include broccoli, brussel sprouts, kale and cabbage.

Loam
Is ideal for gardening and farming. It is a combination of all three soil types (sand, silt, clay) plus humus (organic matter). It holds water well and is soft, dry and crumbly in your hands.

Activity

California Farmers conserve soil!
California farmers use sustainable methods to improve the quality of the soil, minimize erosion and prevent other losses of soil.

1. Minimize Erosion: Farmers plant trees and grasses which can help hold soil in place as well as provide a wind break. Contour farming uses the natural contours of the land to slow water runoff.

2. Rotational Grazing: Farmers move livestock often to prevent overgrazing of pasture and rangeland. Hooves can aerate the soil by breaking the crust and allowing for better water penetration.

3. Reduced Tillage: Farmers reduce the number of tractor passes across their field and allow grasses and vegetation to remain in place after harvest. This helps prevent soil from blowing or being washed away.

4. Cover Crops: Farmers plant cover crops, such as clover, which can add nitrogen back into the soil and also “cover” the soil - protecting it from wind and water erosion.

5. Crop Rotation: Changing or “rotating” crops in the same field each season ensures that the soil is not depleted of certain nutrients. It also helps reduce soil erosion and increase soil fertility and crop yield.

DID YOU KNOW?
Alfalfa has many benefits for soil. It is a fertilizer, naturally adding nitrogen to the soil! It's also a perennial crop, staying in the ground for 4-5 years. It improves drainage, moisture content, and aeration of soil. In addition, it hosts many beneficial insects such as lady beetles and provides habitat for wildlife such as the Swainson’s Hawk.

Service Learning
Start a composting project in your backyard or school garden. Read about how composting can benefit your school and community. Check out ewww.cornell.edu/composting.html for composting information.

Erosion Activity
Erosion is a process where the surface of the Earth gets worn down or washed away. Walk the school yard and look for signs of erosion. Discuss causes and measures to reduce erosion.

CA Standards: ELA CC: R.L.1.5.1, 3, 7; R.L.6-8.7; W.3.5-7, 8; SL.3-8.1; WHSL.6-8.7, 8; NGSS
3-LS4-4, 3-ESS3-1, 4-ESS1-1, 4-ESS2-1, 2; 5-ESS2-1, 5-ESS3-1; MS-LS2-1; MS-ESS2-2, MS-ESS3-3
Sources: everest.nmA.edu/Com_Ag/Soils/Sonoma-county.org/gpcomm/pdf/bmp_handbook3.pdf
Water Innovations
What is agriculture doing to use water more efficiently?

Manage Soil
Compost & Mulch: Organic matter holds moisture in.
Conservation Tillage: No tillng or reduced tillng slows or limits evaporation from soil.
Healthy Soil: Holds water by acting like a sponge.

Manage Plants & Livestock
Irrigation Scheduling: Determines moisture needs of plants and soil.
Cover Crops: Allow better water penetration and soil moisture retention.
Rotational Grazing: Increases water absorption and decreases run off.

Direct, Capture, Reuse
Drip Irrigation: Waters directly to the roots, reducing evaporation.
Capture Water: Ponds store water, provide animal habitat, and recharge groundwater.
Dry Farming: No irrigation, relies on moisture in the soil.

Activity
Investigate and find examples of methods that use water more efficiently in your school or community. Add to the boxes below.

DID YOU KNOW?
California’s developed water supply is used as follows:
50.1% to the Environment; 40.8% to Agriculture; and the remaining 9.1% to Urban use. Create a pie chart by showing the correct percentage of water used in each of these three areas. Don’t forget to label your graph.

California Farmers have to make every drop count
There are many innovative water projects going on in California. Check out agwaterstewards.org to learn more.

Recycled Water Project: Recycled water can be used for food crops, parks, schools, golf courses, and landscapes. The Los Carneros Water District Project in Napa uses recycled sewer water and pipes it to landowners for irrigating their vineyards and landscapes.

Math Activity: If it costs $1.57 per 1,000 gallons to purchase recycled water, how much does 100 gallons cost? 5,000 gallons? What about an acre-foot of water? Hint: An acre-foot of water is 325,851 gallons.

Floating Farms?
What is it? Is it plausible? Research floating farms online and then design your own floating farm, show it to your class! Discuss the pros and cons of why it might or might not be a good idea and if it could work - then have a class debate!

CA Standards: ELA CC.1.3, 4, 5, 7, 8, 1; 4, W.3.4, 2, 7, 6, 3, 8, 1, 4; Math CC.3.OA.7, 4.OA.2; 5.NBT.1; NGSS-3-LS4-4, 4-ESS3-1, 4-ESS3-2, 5-ESS3-1, MS-ESS3-3
Journey on the Climate Trail

It's clear that Earth's climate is changing and many scientists tell us our planet is warming up due to human activity. So the big question is... how do we all live sustainably on Planet Earth? Embark on a journey to learn about climate change, contributing factors, renewable energy resources, what AGRICULTURE is doing, and what YOU can do to reduce your carbon footprint.

Good luck!

Did you know? Have you heard of bioplastics packaging? Bioplastics are compostable plastics derived from biomass (once-living) sources rather than plastics made from petroleum products. Go to www.agriskills.org/theanswermatrix/lessonplan.cfm?pid=341 and try making your own bioplastic from corn!
Technology Ties It All Together!

Past Technologies

What is technology? Technology is any tool, equipment, or machinery that is developed to solve a problem and make life better, easier and safer!

Technology of the Past

- 6000 years ago: Ancient Egyptians formed the fertile soil around the Nile River and used irrigation and wooden tools such as a plow pulled by oxen.
- 1880s: Farmers worked their fields with horse-drawn plows, such as the plow.
- 1900s: First gas-powered tractors became available, allowing farmers to work their fields more efficiently. By the 1950s, there were more tractors than horses on farms.
- 1990s: Information technology and precision technology greatly improved crop production. These innovations included: data collection, farm planning, soil sampling, yield monitoring, and higher crop efficiency.

Activity - Map & Measure

Floor your classroom or school on a piece of paper, then using a scale, map measure, or foot, map the length and width. Find the perimeter and area. Finally, height (note: length of all dimensions can be used to calculate the volume).

Activity - Tractor Timeline

There is more... To the story!
Research and find more inventions in farming equipment that changed agriculture. Create a timeline: date, facts, and drawing. To get started, find out what invention was patented in 1940 and list here...

Activity - Tractor Tools

What do a fork, a shovel, a tractor, and a computer all have in common? They are all examples of technology. Make a list of other technologies you are aware of throughout the day...

Activity - Tech Tool

How many do you know of? Go to this page and throughout this issue and list them. Did you know by now hands are used for too?

Check out this video at: [www.youtube.com/watch?v=9TVd122111]

Today's Precision Farming

1. SMART PHONE APPS
- CropManager: Helps farmers to accurately apply fertilizer to their crops.
- Check out the following link to learn more about this app and other current resources on: www.morningtimesapps.com/improving-precision-agriculture-assessment.
- Distance Area: The farmer drags or drives a field while the app measures its area and determines the acreage.

Activity - Map & Measure

Draw your classroom or school on a piece of paper, then using a scale, map measure, or foot, map the length and width. Find the perimeter and area. Finally, height (note: length of all dimensions can be used to calculate the volume).

Activity - Tractor Tools

What do a fork, a shovel, a tractor, and a computer all have in common? They are all examples of technology. Make a list of other technologies you are aware of throughout the day...

Activity - Tech Tool

How many do you know of? Go to this page and throughout this issue and list them. Did you know by now hands are used for too?

Check out this video at: [www.youtube.com/watch?v=9TVd122111]

Tomorrow's Farmers

2. DRONES
- Farmer Ryan Schir (picture) says the “cloud of technology” helps his farming operation be more sustainable, economically and environmentally...
- Drones can help to identify areas in their fields that need more attention, for example, better weed control. He uses smartphones to monitor the weather and opportunities for selling his crops. Could “Technology, and the data it provides, be a critical part of farming, and become a measure of one and more valuable resource on our farm.”

3. GLOBAL POSITIONING SYSTEM (GPS)
- You may be familiar with a GPS system from your car or phone, but farmers use GPS systems in their tractors. The tractor’s GPS receiver collects satellite signals which determine the precise location of the tractor. GPS technology has allowed for accuracy in spacing between rows, mapping of fields, harvesting, planting, and fertilizing crops. It also allows farmers to work during limited visibility such as fog and darkness. This precision information reduces fuel use, saves time, and provides accurate feedback on what plants need, such as fertilizer requirements and water needs. Check out [www.cornell.ca/essoripes/42146/digital-farming-bit-by-bit-to-sees how ag-machinery such as tractors, combines, and sprayers be tracked via satellite]. Sensors collect data on plant health, harvest yield, and soil composition.

As you can see, the technologies that are used in agriculture have come a long way! Precision farming has helped farmers improve their crops and how they take care of the natural resources of the land. What do you think is next?
Stay Calm and “Native” On!

New plant and animal species have been introduced into California since the mid-1700s. Not all of these species are desirable. Agriculture can be affected by the undesirable species. These undesirable, or invasive species, can spread rapidly, reproduce quickly, and cause problems with farmers’ crops and livestock, not to mention the environment. So, stay calm and read on to learn more:

- **Native:** A plant or animal that is part of the balance of nature that has lived in or developed over hundreds of years in a particular region or ecosystem.

- **Non-Native:** A plant or animal introduced with human help (intentionally or accidentally) to a new place or new habitat where it was not previously found.

- **Invasive:** A plant or animal that is non-native and able to establish in many areas, grow or reproduce quickly, and spread to the point of disrupting plant communities and ecosystems. Important! Not all non-native species are invasive.

### Native or Non-Native Activity

Research online to learn more about each species. Using information from this page, complete the columns for Native or Non-Native and Invasive or Not Invasive.

<table>
<thead>
<tr>
<th>Species</th>
<th>Native or Non-Native</th>
<th>Fact and Ag Connection</th>
<th>Invasive or Not Invasive</th>
</tr>
</thead>
</table>
| CA Poppy | Native | 1. Named the state flower of California in 1903. 
2. Can be part of habitat restoration. | Not Invasive |
| Yellow Starthistle | Non-Native | 1. Poisonous to horses. 
2. Spreads easily on rangeland reducing forage and habitat. | INVASIVE |
| Black Bear | Native | 1. They are opportunistic eaters: they eat grasses, roots, berries, and insects. 
2. Will raid beehives. | |
| Mallard Duck | Native | 1. Migratory birds, they travel the Pacific Flyway. 
2. Rice fields provide feed and nesting areas for them. | |
| Monarch Butterfly | Native | 1. Migrate south every fall, about 2,000 miles, to a warmer climate. 
2. Living mostly near meadows and grasslands, monarchs pollinate many types of wildflowers. | Not Invasive |
| Lupin | Native | 1. Grows as a wildflower in California. 
2. Can be toxic to cattle grazing on rangeland. | |
| Valley Oak | Native | 1. Provide nesting habitat for red-tailed hawks. 
2. Once covered the valley, old farming practices cut many down. | Not Invasive |
| California Tree Frog | Native | 1. Lives in Coastal Southern California. 
2. Eats insects, spiders, centipedes, and other invertebrates. | Not Invasive |

### Transportation Trivia - Insects!

Due to an increase in trade and travel over the past century, insect populations have increased rapidly which directly affects agriculture. Invasive insects are transported many ways including “hitchhiking” in produce, firewood, luggage, etc. This has had a significant effect on agriculture. Review the invasive insects and complete the chart. Go to learnaboutag.org/resources/fact_invasion.cfm for more information.

<table>
<thead>
<tr>
<th>Insect</th>
<th>Origin</th>
<th>Effect on Ag</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oriental Fruit Fly</td>
<td>Taiwan</td>
<td>Attacks 200 different crops.</td>
<td>6,700</td>
</tr>
<tr>
<td>European Grapevine Moth</td>
<td>Italy</td>
<td>Destroys grapevines</td>
<td>7,700</td>
</tr>
<tr>
<td>Asian Citrus Psyllid</td>
<td>Mediterranean</td>
<td>Destroys citrus crops.</td>
<td></td>
</tr>
<tr>
<td>Mediterranean Fruit Fly</td>
<td>Mediterranean</td>
<td>Lives in various climates and attacks more than 250 crops.</td>
<td></td>
</tr>
</tbody>
</table>

### Agriculture Uses Native Plants

Native plants are used in farming in many ways. They are used as cover crops to help suppress weeds, build productive soil, and help control pests and diseases. Native plants are also grown near fields to provide nectar, pollen, and seeds that serve as food for native butterflies, insects, birds and other animals.

### Did you Know?

In the 1970s, the development of Integrated Pest Management (IPM) research began. IPM naturally controls pests through crop rotation, utilizing predator species (such as ladybugs), and deploying Genetically Engineered (GE) crops which are protected from certain pests and diseases. Pesticides are used only if natural control methods are not successful. For more information, check out www2.ipm.ucanr.edu/WhatisIPM.

### Citizen Science

Go to www.inaturalist.org and help scientists! Observe and document your native, non-native, and invasive species findings.
**What is Pollination?**

Pollination is the transfer of pollen grains from the male anthers of flowers to the female pistils of flowers. This allows for fertilization which allows the flowers to produce seeds.

**Pollinator Math:**
1. A \( \frac{1}{4} \) cup of bees is about 200 bees. If a colony of bees contains 40,000 bees, how many cups of bees is that?
2. An 8-frame colony of bees contains 12,000 bees. How many bees are in 1-frame?
3. Almond flowers produce about 1.0 mg of pure pollen. If you have 2 million flowers/acre, about how many grams of pollen will be produced on a 100-acre orchard? If 1 gram = .0022 pounds, how many pounds of pollen is that?

**Activity**

Using the information from the pollinator chart below, or your own research, write the pollinator's name on the top line. Then list three facts about them.

<table>
<thead>
<tr>
<th>Pollinator</th>
<th>Plants They Visit</th>
<th>Fact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honey Bees</td>
<td>Almonds, Apples</td>
<td>Visit flowers to get pollen or nectar for their food.</td>
</tr>
<tr>
<td>Monarch Butterfly Caterpillar</td>
<td>Milkweed</td>
<td>Sheds, or molts, its skin five times before the pupa stage.</td>
</tr>
<tr>
<td>Bats</td>
<td>Avocado, Peaches, Figs</td>
<td>Bats use smell, sight, and echolocation to find flowers.</td>
</tr>
<tr>
<td>Beetles</td>
<td>Magnolia trees, Spirea shrubs</td>
<td>Around for 200,000,000 years! Largest group of pollinators.</td>
</tr>
<tr>
<td>Hummingbirds</td>
<td>Blueberries, Honeysuckle, Salvia</td>
<td>Fly up to 60 mph, wings beat 20-170 beats per second.</td>
</tr>
<tr>
<td>Gray Hairstreak Butterfly</td>
<td>Mallows, Legumes, Alfalfa</td>
<td>Caterpillars known to cause damage to certain crops.</td>
</tr>
</tbody>
</table>

**Pollinator Conservation:**

There is a concern that we are losing pollinators due to habitat loss, disease, parasites, and environmental contaminants. Farmers help by planting cover crops, wildflowers and native grasses in areas not in production. By building hedgerows, windbreaks, and providing a variety of flowering plants, farmers are attracting the native pollinators they need to grow their crops. How can you help? Add bee-friendly plants to your school yard or home to help increase native honey bee populations.
1. Production
One cow produces an average of 144 servings of milk per day, which is enough for 48 people to get 3 daily servings of milk. How many gallons of milk is that?

2. By-Products
Cows can eat by-products such as almond hulls and tomato pomace that otherwise might go straight to a landfill.

Activity
- Cows are ruminants; name three other ruminant animals: ____________________________
- An animal that is a ruminant chews their ____________________________

What about Waste?
Utilizing animal waste is becoming increasingly important. You've learned about Dairy Digesters on this page, now research other methods of how animal waste (biomass) can be utilized. Work with a team to create a Waste Solutions plan.

1. How is biomass currently used? What are the pros and cons?
2. Brainstorm and develop new ideas to use biomass, "Waste Solutions."
3. Present your Waste Solutions plan to the class. Have your class evaluate and vote on which options are the most reasonable. Add to the Waste Management Chart.

Dairy Digesters
A Dairy Digester uses dairy manure to produce biogas. Composted mostly of methane, biogas can be used to generate electricity or as transportation fuel. Check out www.cafr.ca.gov/oefi/ddrmp and view the "Cow Power" video to learn about the SMUD project at New Hope Dairy.

Waste Management Chart

<table>
<thead>
<tr>
<th>Animal</th>
<th>Products</th>
<th>Uses for Waste</th>
<th>Waste Solutions</th>
<th>Class Vote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy Cows</td>
<td>Milk, cheese, yogurt</td>
<td>Renewable energy, bio-fuel</td>
<td>Yea: ___ Nay: ___</td>
<td></td>
</tr>
<tr>
<td>Beef Cattle</td>
<td>Meat, leather, medicine</td>
<td>Fertilizer</td>
<td>Yea: ___ Nay: ___</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>Meat, wool, lanolin</td>
<td>A natural, slow-release fertilizer</td>
<td>Yea: ___ Nay: ___</td>
<td></td>
</tr>
<tr>
<td>Poultry</td>
<td>Meat, eggs</td>
<td>Fertilizer</td>
<td>Yea: ___ Nay: ___</td>
<td></td>
</tr>
</tbody>
</table>

Homophone Chart

<table>
<thead>
<tr>
<th>Homophone</th>
<th>Meaning</th>
<th>Illustration</th>
<th>Homophone</th>
<th>Meaning</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ate</td>
<td>Manure, garbage, unused</td>
<td>Eight</td>
<td>Waist</td>
<td>Area around middle of your body</td>
<td></td>
</tr>
</tbody>
</table>

N.I.E.
Did you know "waste" is a homophone? Two examples are waste - waist and ate-eight. Look for more homophones in your local newspaper, add them in and finish filling out the chart. Create a homophone notebook to share with your class!

Activity
Research and learn more about anaerobic digesters. How many are being used in CA? Are they making a difference? Write a report and give a presentation to your class explaining the process. Discuss the pros and cons of digesters and include a visual display. Check out this Dairy Digester at www.youtube.com/watch?v=wc-YyftMjQ.

California farmers provide habitat for wildlife animals too. Each year approximately seven million ducks and geese migrate along the Pacific Flyway and use rice fields to feed and rest. Check out calrice.org for more information and examples of migratory birds.

CA Standards: ELA CCSS.ELA-Literacy.RL.1-2,3-7, 5-8, SL.1-2,3-7, 5-8, W.1-2,3-7, 5-8, 11-12, L.1-2,3-7, 5-8, E.1-2,3-7, 5-8, WHST.1-2,3-7, 8, RST.1-2,3-7, 8, NGSS-3-ESS3-1, 3, 5-ESS3-1, 3, 5

Photo courtesy of SteveReport.
The cultivation of kale began about 2000 years ago with the Ancient Greeks and Romans.

**“Plant Part We Eat” Activity**

Kohlrabi  Kale  Broccoli  Brussels sprouts  Cabbage  Cauliflower

**Activity**

Kale is a descendant of Brassica oleracea, a wild mustard plant. The ancient Greeks and Romans noticed that some plants had longer and curlier leaves. The plants were bred together and produced the subspecies of kale. Some of the wild plants had larger flower buds and were bred together to produce broccoli and cauliflower. Fill in the plant part we eat (stem, leaves, buds, flowers) under the name of the plant above. Also, check out this online video: www.untamedscience.com/biodiversity/wild-cabbage

**What are GMOs?**

A gene with a desired trait such as “pest resistance” is identified within a plant. This trait is transferred to a new plant. The new plant is tested for food and environmental safety. Once approved, it is used to grow stronger plants that have less problems with pests. Farmers are then able to use less chemicals such as pesticides to protect the crop from damage. Check out gmoanswers.com to learn more about GMOs.

**Gregor Mendel**

Mendel conducted experiments with garden peas and discovered that specific traits are transferred from parent to offspring. Through Mendel’s experimentation with pea plants, he was able to select for plant height, pod shape and pod color.

**Punnett Square Activity**: Determine the probability of pea pod color based on the genes passed on by the parent plants.

1. One parent plant is homozygous recessive gg (yellow pods) and the other parent plant is homozygous dominant GG (green pods). Looking at chart #1 below, what is the probability the offspring will have green pods? ___________. What is the probability for yellow pods? ___________.
2. If one parent is heterozygous Gg (green pods) and the other parent plant is homozygous gg (yellow pods), what will be the outcome? Complete chart #2 and determine the probability the offspring will have green pods ________ and yellow pods ___________.

**CA Standards**: CCSS ELA: RL.3-6.4, 1, 4, 7, SL.3-6.4, 2, W.6-8.2, 6, 7, 8, RST.6-8.4. 7. CCSS Math. 6.SP.5, 7.SP.5. NGSS. 3-LS3-1, 2, 5-ESS3-1. MS-LS3-2, MS-LS4-5. Sources: gmoanswers.com, bfa.org/biotech-in-brief/planbreeding/what-is-plant-breeding; Smithsonian.com, en.wikipedia.org/wiki/History_of_plant_breeding

**Luther Burbank**

Luther Burbank developed more than 800 varieties of plants. His creations included fruits, flowers, grains, grasses, and vegetables. He experimented with grafting, hybridization and cross-breeding.

**Did you Know?**

Organic crops are grown on land that only uses natural fertilizers such as animal manure and compost to build healthy soils.
The Trouble with Trash
How can we ensure we do our part to reduce food waste?

Farmers incorporate unused produce back into the soil for organic matter, utilize by-products such as rice straw for erosion, and even convert manure and agricultural wastes into renewable diesel and fertilizer.

By-products of food processing are used to feed livestock. Some examples include: beet, citrus, and tomato pulp; wheat mill run (from making flour); soy hulls; cull onions; and apple pomace.

Purchasing food from their deli or salad bar allows grocery stores to use imperfect produce. Shop often for small amounts of fresh produce to reduce spoilage and waste. Buy fresh food at Farmer’s Markets or shop locally for what’s in season.

Encourage food sharing tables and allow students to serve themselves.

**Challenge:** Think about the extra food from school at breakfast, snack and lunch times. Brainstorm 3 ways to reduce waste at your school:
1. ____________________________
2. ____________________________
3. ____________________________

Use overripe and bruised food in smoothies and other recipes. Freeze or preserve excess produce (bananas, tomatoes, etc.) for future use.

**Plan ahead Challenge!**
Name 3 meals you cook at your home and make a shopping list! Don’t buy more than you need!

<table>
<thead>
<tr>
<th>Meals</th>
<th>List</th>
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<tbody>
<tr>
<td>1</td>
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<td>2</td>
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<tr>
<td>3</td>
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**Challenge:**
1. Using the Labels Chart below, which type of label do you think causes the most food waste? ____________________________
   Why? _____________________________________________________________________
2. How will you store your food to keep it fresh? ____________________________

**Labels Chart**

Citizen Science
FOOD WASTE AUDIT:
Follow the lead of San Mateo County and conduct a food waste audit at your school. Check it out: www.recycleworks.org/schools/s_audits

Service Learning
Check out the “Waste No Food Smart Phone” application at www.wastenofood.org. It connects people with excess food to the hungry. With your classmates, create a brochure to educate others about this opportunity.

Restaurant
When eating at restaurants, order smaller portions, or hold extras such as chips and bread if you don’t plan to eat them.

**Challenge:** What do you order at a restaurant, and do you consume everything you order? What can you do to reduce your food waste?

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**Bingo Brainstorming Activity**
Ask a classmate to answer each of the following BINGO card questions. Have a conversation with them, each sharing your own ideas. Record their answer.

- List one way you can reduce wasting food at home.
- Name one food you might have at home and where you should store it.
- Name one thing to check on the food label before making a purchase at the grocery store.
- What is one way to track food in the refrigerator, to help reduce waste?
- Explain one way to organize the way you store food at home to minimize waste.
- Name one way to repurpose extra food at school or home.
- Name one food that you can freeze or eat later.
- Name one place in your community where you can donate extra food.

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90 billion pounds of edible food goes uneaten every year. Check out www.choosemyplate.gov/lets-talk-trash for awesome ideas on how to reduce food waste!
Agriculture and the Environment Glossary

Abiotic: Non-living parts of the environment such as sunlight, wind, rocks, and rain.

Anaerobic Digesters: Microorganisms break down biodegradable material in the absence of oxygen. One of the end products is biogas which can be combusted to generate electricity and heat or be processed into renewable natural gas and transportation fuels.

Biomass: Derived from living or once living organisms. Wood and manure are considered biomass.

Biotic: Of or relating to living things, including plants, animals, and microorganisms.

Carbon Footprint: The amount of greenhouse gases produced from human activities, it includes carbon dioxide and other carbon compounds.

Colony: A family unit of bees, usually about 40,000, including one queen.

Controlled Burning: A technique used in forest management, farming, or prairie restoration to reduce hazards or clean fields.

Cover Crops: Crops planted to protect soil and nutrients.

Developed Water: Water that is controlled and managed for a variety of uses.

Economy: The wealth and resources of a country or region.

Ecosystem: A system, or group of interconnected elements, formed by the interaction of organisms with their environment.

Emitting: Producing or discharging.

Forage: Food such as grass or to search for food.

Global Warming: The increased temperature of earth as indicated through ocean, earth’s surface, and satellite data.

Greenhouse Gases (GHG): A gas that contributes to the greenhouse effect (sun’s warmth is trapped in the planet’s atmosphere) by absorbing infrared radiation, for example carbon dioxide.

Ground-level ozone: Ozone is a gas composed of three atoms of oxygen (O_3). In the upper atmosphere it protects us from the sun’s harmful UV rays, but at ground-level it causes harm to animals and plants. It is the main ingredient of smog. Visit www.epa.gov/ozone-pollution/ozone-basics for more information or watch a video at www.youtube.com/watch?v=THYoUULn_2U.

Habitat: The natural environment of an organism.

Habitat Restoration: Repairs a habitat or ecosystem that has been damaged enabling native plants and wildlife to live there.

Hedgerows: A hedge of shrubs and/or trees bordering a field or road.

Homophone: Words having the same pronunciation but different meanings or spellings.

Hydroponic: Grown in nutrient solutions without soil.

 Implements: Equipment or tools.

Information Technology: The use of computers and telecommunications for storing, retrieving, and sending information.

Insulating: Materials that prevent loss or absorption of heat.

Kinetic: Energy of motion, an example of kinetic energy is wind moving a windmill.

Legumes: Plants that bear their fruit inside a pod – beans and peas are an example.

Methane Digesters: Convert manure into methane and use the biogas to produce energy.

Non-renewable: A natural resource on earth that exists in limited supply, it cannot be replaced if used up.

Opportunist: Taking advantage of what’s available. Some animals are opportunistic feeders such as crows or raccoons.

Parasitoid: An insect whose larvae live as parasites that eventually kill their host.

Photosynthesis: The process plants go through to convert carbon dioxide and water into oxygen and glucose. It requires the energy of the sun.

Photovoltaic (PV): Converts light directly into electricity. A typical PV system uses solar panels, each with a specific number of solar cells, which generate electrical power. A solar cell is also called a solar battery.

Pomace: The solid remains after pressing for oil or juice.

Ruminant: Mammals that have a stomach divided into four compartments and chew their cud.

Species: A group of plants or animals that are similar and can produce young.

Tillage: Preparation of soil by digging or overturning. Uses mechanical processing with implements such as discs, plows or rippers. Tillage by hand would use shovels, hoes, or rakes.

Trait: Characteristic.

Urban: Related to or in a city or town.

Windrows: A line of raked hay laid out to dry in the sun.

Activity
Choose two glossary words and use both in a complete sentence. Write your sentence in the space provided.
California Foundation for Agriculture in the Classroom is a 501(c)(3) non-profit organization that provides educators with free standards-based resources about California agriculture. Agriculture fits into every subject area. Contact LearnAboutAg.org to learn more or to request additional classroom resources, such as the Extra! Extra! Classroom Extensions that complement this newspaper.