For Extra! Extra! Classroom Extensions, visit LearnAboutAg.org/wgo or call (800) 700-AITC.
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.

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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/whatistaught/epc.

Happy Reading!

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

SHARE YOUR PHOTOS AND PROJECT STORIES Via Facebook, Twitter and Instagram! Include @LearnAboutAg in your posts and use the hashtags #AgServeAndLearn and #AgCitizenScience.

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

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.

CA Standards: ELA CCSS: R1.3-8.1, W.3-8.1, 4, 5, SL.3-8.4, 5, RST.3-8.7; NGSS: 4-ESS3-1, 2, 5-ESS3-1
Sources: harec.ucanr.edu; sandia.gov; ucsusa.org; extension.purdue.edu/extmedia/ae/ae-108.html; climatekids.nasa.gov/energy
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 Digester**: 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

<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><strong>Green</strong></td>
<td>Air pollution poses no or little risk</td>
</tr>
<tr>
<td>51 – 100</td>
<td>Moderate</td>
<td><strong>Yellow</strong></td>
<td></td>
</tr>
<tr>
<td>101 – 150</td>
<td>Unhealthy for Sensitive Groups</td>
<td><strong>Orange</strong></td>
<td>Affects those with serious health issues</td>
</tr>
<tr>
<td>151 – 200</td>
<td>Very Unhealthy</td>
<td><strong>Red</strong></td>
<td></td>
</tr>
</tbody>
</table>

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

Did you know?

Wind energy is an example of kinetic energy, the energy of motion. The wind causes turbines to move, which creates energy that can be converted to electricity!
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.

**Service Learning**

Start a composting project in your backyard or school garden. Read about how composting can benefit your school and community. Check out cwmi.css.cornell.edu/composting.htm 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.

**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 4-6 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.

**SOIL SCIENCE**

Collect two soil samples from school or home. With the descriptions above, determine which type of soil you have.

CHALLENGE: Put your soil in a jar, add water, close the lid, shake and leave overnight. In the morning, you’ll see soil layers. Sand settles to the bottom, silt in the middle, and clay at top. Estimate the percentage of each soil type in your soil and then create a graph to show your estimates.
**Did You Know?**

California flower farmers use eco-friendly practices! 100% of all water used in hydroponic growing is reclaimed and recycled.

**Compost & Mulch:** Organic matter holds moisture in.

**Conservation Tillage:** No tilling or reduced tiling slows or limits evaporation from soil.

**Healthy Soil:** Holds water by acting like a sponge.

**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.

**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.

**DID YOU KNOW?**

California’s developed water supply is used as follows:

- 50.1% to the Environment
- 40.8% to Agriculture
- The remaining 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.

**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!

**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.

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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!
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!

Climate Change: Climate change is a significant change in the Earth’s climate. What is a way you’ve seen or heard about our climate changing? Find an example and share.

Global Warming: Global warming is an increase in temperature near the surface of the Earth that may be caused by people’s activities. What could some of these activities be?

Ab 32 and SB 32: The state of California raises the bar when it comes to a sustainable, low-carbon future. A California law, called the California Global Warming Solutions Act of 2006, aims to reduce greenhouse gas (GHG) emissions to year 1990 levels by year 2020. The goals of AB 32 were extended in 2016 by SB 32. Look online for the laws. Find out what AB and SB mean and name two greenhouse gases. Share with a partner.

News: Did you know? If we didn’t have any greenhouse gases our planet would be all ice? Go to Climate Kids: NASA’s Eyes on the Earth at climatekids.nasa.gov to find out more.

Climate vs. Weather: What’s the difference? Climate is the average weather in a place over a period of time. Weather is the wind, rain, clouds, and temperature in our atmosphere over a short period of time. Name an example of each.

Vehicle Usage: Reducing GHG emissions is a responsibility of everyone. You can help! Decrease your carbon footprint. List three modes of transportation that don’t involve a car.

Heating & Air Systems: Adjust your thermostat to 68 degrees F in the winter and 78 degrees F in the summer. Turn down or turn off your controlled air system when you are away to save energy. Beyond adjusting your thermostat, what else can you do to keep warmer in the winter?

Hot Water Usage: The process of heating water utilizes a lot of energy. How does this relate to you? Shorten your hot showers and use the “cold” water setting on your washing machine. Research and share the temperature your water heater should be set at so the water never gets unnecessarily hot.

Appliances: Decreasing GHG emissions and minimizing your carbon footprint goes beyond vehicle usage. Turn off your lights and appliances when you are not using them. Name two appliances that you can turn off when you’re not using them.

Effects on Agriculture: Agriculture could be affected by climate change in a number of ways. Higher temps cause crops to grow too quickly and yield less or increases in water temp can affect fish. Droughts and floods can also affect crop yields and many weeds and pests thrive under warmer, wetter climates. Heat waves can affect the livestock industry and animal feed supplies can be affected. Can you think of other ways? How might this affect YOU?

Reduce, Reuse, Recycle... and Compost: Do you recycle your glass, paper, and plastic at home? School? Do you compost yard waste and food scraps at home? School? Think about how you can reduce or reuse items at home. Write and share your answers with a classmate.

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.agclassroom.org/teacher/matrix/lessonplan.cfm?pid=141 and try making your own bioplastic from corn!

Finally, using the graphs you make, share the temperatures for a period anywhere in the United States. Use the National Weather Service site at www.weather.gov to gather your data and create graphs.

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Past Technologies

• 5,000 years ago: Ancient Egyptians farmed the fertile soil around the Nile and used wooden tools such as a plow pulled by oxen.
• 1,000s: Farmers worked their fields with horse-drawn implements, such as plows.
• 1800s: 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 technologies greatly improved farm production. These innovations included: data collection, farm planning, mapping, and technologies have been used throughout history. Learn how today’s farmers use smart phones, drones, and GPS! Finally, look forward with us, imagining what technologies are yet to come to produce the best quality food in the world, while taking care of the natural environment!

Technology Ties It All Together!

Today - 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 research, www.morningagclips.com/improvement-in-nitrogen-assessment.
   - Distance and Area: The farmer walks or drives around a field while the app measures its area and determines the acreage.

2. DRONES
   Farmer Ryan Schohr (pictured) says the “toolbox of technology” helps his farming operation be more sustainable, economically and environmentally.
   He has a drone to help identify areas in his fields that need more attention, for example better weed control. He uses smartphone apps to monitor the weather and opportunities for selling his crops. “Technology, and the data it provides, is a critical part of farming and is becoming a more and valuable resource on our farm.”

3. GLOBAL POSITIONING SYSTEM (GPS)
   You may be familiar with a GPS system in your car or phone, but farmers use GPS systems in their tractors. The tractor’s GPS receives satellite signals which determine the precise location of the tractor – within yards! GPS technology has allowed 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.cropscience.bayer.com/en/stories/2014/digital-farming-bit-by-bit to see how ag machinery such as tractors, combines, and sprayers can be tracked via satellites. Sensors collect data on plant health, harvest yield, and soil composition.

Create a Time Capsule! You may be familiar with a time capsule at a graduation or a birthday party! Why not make a time capsule of your own? Here is a brief summary of what it will accomplish. Check out www.apps-for-ag.com to find out what recent apps have been developed.

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?

Create a Time Capsule! The future of our world is in our hands! As you use your smartphone, think about what you are doing. What will your technology do in the future? How will it change our world?

Create a Time Capsule! What will your technology do? How will it change our world?

Create a Time Capsule! Write a letter to include in your time capsule. Explain what you are including in your time capsule. Make a drawing of the time capsule. Describe the location where you would leave your time capsule. Protect your time capsule in your class capsule.

Create a Time Capsule! What will your technology do? How will it change our world?

Create a Time Capsule! What will your technology do? How will it change our world?

Create a Time Capsule! What will your technology do? How will it change our world?
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.

**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.

**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.

**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/WhatsIPM.

**Service Learning**

Create a Public Service Announcement (PSA): With a group, brainstorm a message to teach about Invasive species. Write a script, act it out, and record your PSA. Keep it to 30 seconds and show your class!
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 ¼ 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?

Prolific Pollinators
Pollinators are essential to agriculture and the environment. 80% of plants are pollinated by animals (biotic pollination) and 20% are pollinated by wind and water (abiotic pollination). There are about 200,000 species of animals that pollinate, most of which are insects and only about 1,000 of which are vertebrates such as birds, bats, and small mammals. For abiotic pollination, 98% is due to wind and 2% is from water.

Activity
Use this information to create a pollinator graph.

Pollen: Anthers
Grains
Pistil
Almond
Alfalfa
Legumes
Spirea
Salvia
Honeysuckle
Blueberry
Milkweed
Peach
Avocado
Magnolia
Clover
Mallow
Pollen: Grains
Anthers

Pollinator Chart
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>Avocado, Peaches, Figs</td>
<td>Sheds, or molts, its skin five times before the pupa stage.</td>
</tr>
<tr>
<td>Bats</td>
<td>Magnolia trees, Spirea shrubs</td>
<td>Bats use smell, sight, and echolocation to find flowers.</td>
</tr>
<tr>
<td>Beetles</td>
<td>Blueberries, Honeysuckle, Salvia</td>
<td>Around for 200,000,000 years! Largest group of pollinators.</td>
</tr>
<tr>
<td>Hummingbirds</td>
<td>Mallows, Legumes, Alfalfa</td>
<td>Fly up to 60 mph, wings beat 20-170 beats per second.</td>
</tr>
<tr>
<td>Gray Hairstreak Butterfly</td>
<td></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.

CA Standards:
CCSS ELA: RI.3-8.4, SL.3-8.2, 5; CCSS Math: 3.OA.2, 3; 4.OA.3, 4.NBT.1, 5.NBT.1, 7, 6.RP.3d

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Animals not only give us food and fiber, they also provide nutrients to grow crops.

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? (Answer: 144 servings = 16 cups per gallon. 16 x 16 = 9 gallons)

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?
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.

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>

3. Nutrients
One cow produces 17 gallons of manure per day which provides enough soil nutrients to fertilize 56 pounds of corn or 84 pounds of tomatoes!

JUST THINKIN’ - Just like plants need nutrients to grow, so do people! Milk is rich in nutrients people need – name two: ____________________________________________

4. Innovations
Manure is becoming a source of additional value. Anaerobic digester systems convert manure into energy.

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

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-YyfftMjQ.

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!

Homophone Chart

<table>
<thead>
<tr>
<th>Homophone</th>
<th>Meaning</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste</td>
<td>Manure, garbage, unused</td>
<td>Waist</td>
</tr>
<tr>
<td>Ate</td>
<td></td>
<td>Eight</td>
</tr>
</tbody>
</table>

CA Standards: K.E.L, C.H.S.S., A.L.3-5, A.5, W.3-8.7, L.3-8.6, R.3-8.7, 25 L.3-8.7, W.H.T.E. 4-6.7, 4-S.G.S.S., E.S.S.1-3 - E.S.S.3-5, E.S.S.1-3-4-5-6-7

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

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

**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 ___________.

**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.

**CITIZEN SCIENCE**

Join a national network of citizen scientists and monitor plants as the seasons change. Go to Project Bud Burst at www.budburst.org

**CA Standards:** CCSS ELA: RI.3-6.1, 4, 7, W.3-5.7, SL.3-6.4, RI.7-8.4, W.6-8.2, 6, 7, 8, RST.6-8.4, 7; CCSS Math: 6.SP, 7.SP.5; NGSS: 3-LS3-1, 2, 5-ESS3-1, MS-LS3-2, MS-LS4-5

**Sources:** gmoanswers.com, bfa.org/bioscience-in-brief/plantbreeding/what-is-plant-breeding, Smithsonian.com, en.wikipedia.org/wiki/History_of_plant_breeding

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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.

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. ____________________

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

Meals                  List
1                      ____________________
2                      ____________________
3                      ____________________

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

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?

________________________________________
________________________________________
________________________________________

POSSIBLE ANSWERS:

- Request “to go” box for extra food, take leftover bread/chips home, split entrée with a friend.

Check out Food Product Dating at www.fsis.usda.gov

Check it out: www.nationalgeographic.com/magazine/2016/03/

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.

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

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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!
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 can 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 (O₃). 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.
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.

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