

Ag@School

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1790

4 million Americans
90% lived on farms

1850

23 million Americans
64% lived on farms

1950

151 million Americans
12.2% lived on farms

2010

315.5 million Americans
1.8% live on farms

2014

318.9 million Americans,
less than 1% on farms

Agriculture in a Changing World Revolution: A "sudden or complete change"

1820 - 1870 Industrial Revolution in the US

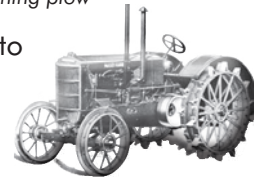
A change from hand and home production to machine and factory production



1837 John Deere invents self-cleaning plow

1920 - 1950 Mechanical Revolution in agriculture

Change from machinery being pulled by horses and mules to using tractors, combines, and other specialized equipment



Massey Harris 25 Tractor
1931 - 1938

1945 - 1960 Chemical Revolution in agriculture

Use of man-made fertilizers and chemical pesticides targeting specific weeds and insects



1965 - 1975 Green Revolution

Dramatic increases in production of wheat and rice in developing countries due to use of genetically improved seeds



Wheat Plant

1975 - Electronic Revolution

Using computer technology in agriculture



GPS Lightbar
Guidance System

1980s - Biotechnology Revolution

Using biology and cellular technology to develop new products.

1982 - Produced human insulin from bacteria



Some crops are GMOs (genetically modified organisms) where a precise gene has been altered to improve the plant in a specific way



Some algae contains more than 60% oil and can even be grown in salty water.

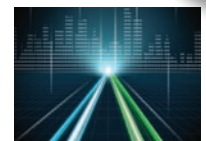
1990s - Electronic Revolution continues

Use of computer technology and global positioning satellites (GPS) to guide equipment
1996 - GPS plus GIS Revolution - Farmers use satellite technology (Global Positioning System) to track and plan their farming practices with Geographic Information Systems
2008- GMO algae is used to make fuel



2000s - Now - High Speed information highway revolution

High Speed information highway revolution - the Internet for information and networking become revolutionary for farmers to communicate and gather information at lightning speed around the country and the world



Today's Children... Tomorrow's Leaders

tech•nol•o•gy (tek nol 'ə jē), n. using scientific knowledge to find a better way of doing something.



AGRICULTURE IN A CHANGING & GROWING WORLD

People continually find better ways of doing things. When people apply what they have learned about science, that's technology!

No industry has made better use of technology than agriculture. Improvements to agriculture have changed America from an **agrarian** to an **urban** society. Less than 1% of our people now work the land. This allows everyone else to live in cities and work in other careers. This means more doctors, more teachers, and more scientists.

Even though less than 1% of the US lives on farms, 17% of our total workforce is employed in agriculture. Growers produce the raw products and others turn them into things we eat and use.

Historically, the early 20th century mechanical revolution put tractors, combines, and other specialized machinery in use rather than horses and mules. Then in the mid-20th century, agriculture experienced a revolution in chemical and genetic knowledge that allowed **high-yield agriculture**. In the late 20th century, agriculture benefited from the electronic revolution, using computers and satellites.

Prior to 1900, nearly all increases in food production came about because more land was brought into production. Now in the 21st century almost all increases must come from higher yields and be based on science and technology.



High-Yield Agriculture

Farmers grow more food on each acre by using technology. They choose improved seeds, add plant food (fertilizer) to the soil, manage pests, and use better equipment and techniques. As a result...



- **World food production has tripled since 1950 with no land use increase**
- **Land is available for other uses like wildlife habitat, wetlands, and recreation**

Name the BIG FOUR!

There are about 380,000 kinds of plants. About 100 are regularly grown and eaten as human food. Amazingly, over half of the world's food comes from only four plants. Three are grains, and one is a tuber vegetable.



First grown by ancient tribes in the mountains of South America, this food is actually an underground storage unit. The roots collect more water and food than the growing plant can use at one time. The plant stores the excess food in oval shapes, called **tubers**. This crop produces more pounds of protein per acre than corn, rice or wheat. Idaho leads US production but **Washington grows more pounds per acre**.



One-seventh of all the farmland in the world is used to grow this grain - far more land than for any other food crop. It is a staple food for 35% of the world's people and is used to make breads, cookies and noodles. Kansas, North Dakota, Montana, Washington, and Oklahoma are the leading production states in the U.S.



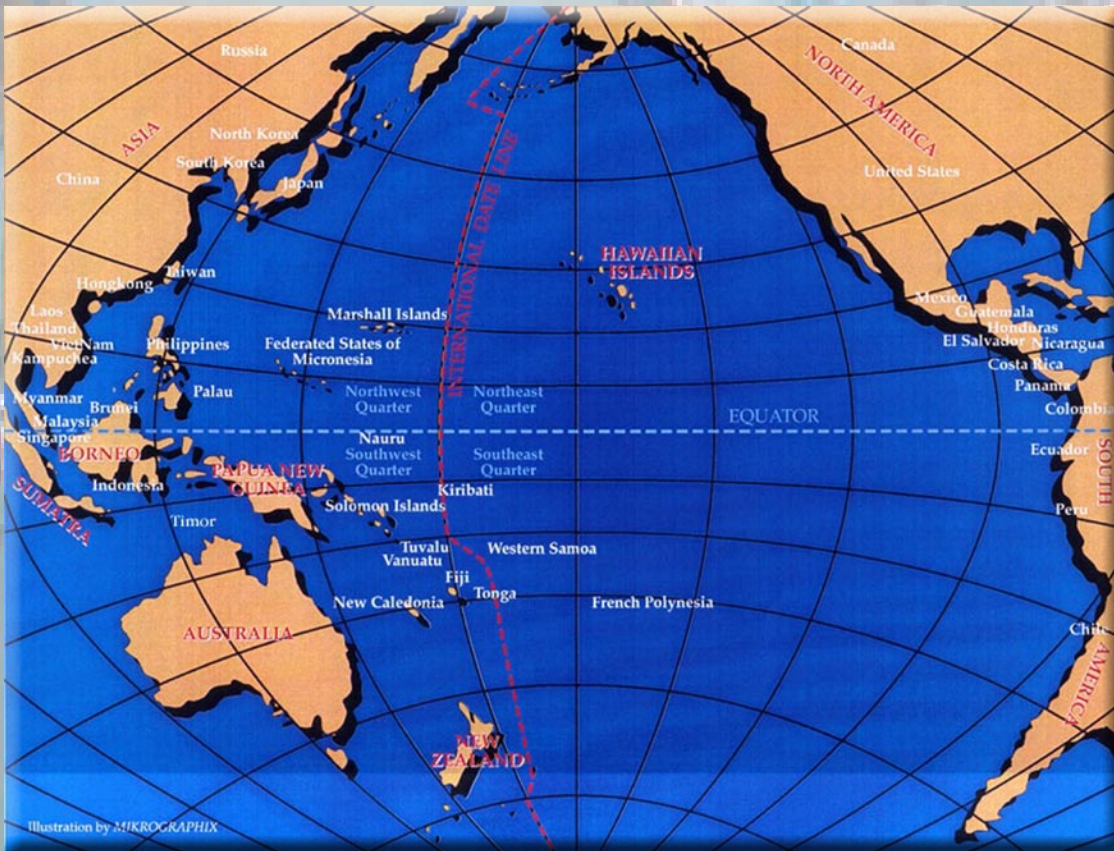
Christopher Columbus found this grain growing in North America in 1492. American Indians helped the Pilgrims survive by teaching them how to plant and cultivate it. Today, it is our country's number one agricultural crop. Iowa, Illinois, Nebraska, Minnesota and Indiana lead US production.



It's a staple food for half the world's people. Native to Asia, it has been grown and eaten there for thousands of years. It grows in warm areas and plants must be under water for most of the growing season. In the US, it is grown mostly in Arkansas, California, Louisiana, Mississippi, Missouri, and Texas.

Washington Trade Is Boosted By The Pacific Rim

Washington's location on the **Pacific Rim** allows for advantageous international trade. Japan, Canada, China/Hong Kong, Philippines, and Republic of South Korea were Washington's top exporting partners in 2016. By ship, Washington ports are just about two days closer than California ports are to the Asian Markets. Agriculture and food exports total 28% of everything that is exported from Washington. Washington exports account for 13% of the total US exports.



Activity

1. What is the Pacific Rim?
2. On the map, put an "X" on Washington
3. Locate on the map the top five countries that Washington exports to.
4. Tell about one item that you use daily that is exported and one that is imported.
5. Tell where your items in #4 were possibly imported from and exported to.

THE DEFINITION OF EXPORT IS:

to send to another country for trade or sale

THE DEFINITION OF IMPORT IS:

to bring in from another country for trade or sale

How do we increase exports?

Trade is not always a simple process. Countries can impose **tariffs** (taxes on imported products). If consumers want to buy the imported products they must pay a higher price to cover the cost of the tariff. Tariffs and other trade barriers can be used to protect producers within a country from foreign competition. Tariffs can lead to trade wars as exporting countries retaliate with their own tariffs on imported goods.

One method of increasing trade is to make trade agreements between countries. **Free Trade Agreements (FTAs)** have proven to be one of the best ways to open up foreign markets to U.S. exports. We currently have agreements with 20 countries out of approximately 200 nations in the world.

Can you find US FTA partners on the map above?

Australia, Bahrain, Chili, Columbia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, Israel, Jordan, Morocco, Canada, Mexico, Oman, Korea, Panama, Peru, and Singapore

Trade – A Heritage In Washington

Our tradition as a trade state began back in the early nineteenth century with the fur trading activities of Hudson's Bay Company and the Canadian North West Company. Seattle became a major seaport during the Klondike gold rush by selling provisions to miners and transporting prospectors to the Alaskan gold fields. In 1916, William Boeing started building wooden airplanes in a small red barn. Today Boeing Company is the country's largest exporter.

Global demand for the things we produce helped to build our state and drives our economy today. More than 40% of all Washington jobs are linked to trade. The value of Washington exports, per resident, is more than twice the national average. In 2016, \$15 billion of food and ag products were exported through Washington Ports. Of that, \$7 billion were WA grown.

Technology has improved

Precision farming allows small areas of land within a field to be managed separately so that the best possible crop yield will be reached using the exact amount of seed, fertilizer, and chemical for each small area. This farming method requires several technologies like **GPS** (global positioning system). GPS uses a network of satellites orbiting the earth to transmit exact locations to computers on the ground. GPS can automatically guide huge farm machines to stay along a track hundreds of meters long with only a few centimeters of difference.

Geographic Information Systems (**GIS**) is used to collect specific data about various locations within a farmer's field. Data is gathered from multiple soil samples, yield monitors from harvest, even aerial photographs. GIS plus GPS can reduce the number of passes needed to cover a field and save seed, chemicals, fertilizer, fuel, and time. Skips and overlaps are eliminated and work can be done even at night or in dust or fog.



Direct-Seeding: The red tractor provides the power (more than 500 hp) to pull the equipment and operate the hydraulic pumps. It operates with GPS guidance to prevent skips or overlaps. The yellow box contains the seed; a fan moves the seed with air pressure to the drill. The large round tank contains fertilizer that is placed in bands away from the seed row, while the small round tank contains different fertilizer that is placed with the seed. The green equipment behind the tanks is the drill (or seeder) that opens the ground and places the seed and fertilizer at the correct depth and seed row width. Based on GIS field maps, seed and fertilizer can be varied for the soil conditions. All these mechanical operations are done in one-pass across the field. It saves time, fuel, and soil moisture, while reducing soil erosion.



More efficient irrigation: The modern center pivot irrigation system has come a long way from just flooding fields with water. The system uses a long water pipe that is mounted on motorized wheels and has one end connected to the water line at the center of the field. When operating, the irrigation system swings in a circle, sprinkling water as it rotates. These systems are computer controlled using GIS (Geographic Information System) and can even be operated from the farmer's cell phone. Irrigation is the reason our farmers lead the nation in the yield/acre of corn and potatoes.



Production Agriculture

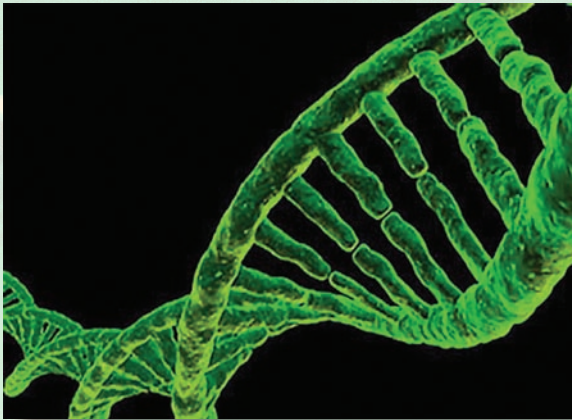
Genetic Science - Biotechnology

Genes are distinct portions of a cell's DNA. Genes are coded instructions that determine a particular characteristic, like red hair or blue eyes. Plants and animals also pass genetic traits to their descendants. Biotechnology is people using biology along with new technology to make better products. A special branch of biology is called genetics and deals with heredity (passing characteristics from parents to the next generation).

Farmers have been improving plants and animals since agriculture began by selecting the best individuals to use as parents for the next generation. This process involves the crossing of thousands of genes with the hope of randomly passing on desirable traits. It is a hit-or-miss process. Unfortunately, undesirable traits might also result. For instance, when farmers selected for heavily muscled pigs, it also resulted in easily stressed pigs, and meat that could be tough.

Using new technology, scientists can now identify the specific genes that carry a certain trait, and pass that single trait on. This more precise science eliminates passing along undesirable traits.

GMO (Genetically Modified Organism)



A GMO plant is one where a precise gene from one plant is inserted into another. This differs from traditional plant breeding where one whole plant is bred with another just hoping that the new plant will have desired traits. In agriculture, GMO crops have proven to be very successful tools to prevent plant diseases, control insects, manage weeds and combat drought. Farmers are able to use fewer applications of chemicals on their fields and produce more crops on

fewer acres. Did you know there are only 10 GMO crops that are certified for U.S. production? It takes approximately 13 years (regulatory process alone takes 5-7 years) and \$130 million dollars for research and developments before a GMO comes to market.



Technology Has Improved Machines

Fruit can be sorted by cameras and computers. After apples are washed, polished, and waxed they are dropped into cups on a moving belt where a camera takes four pictures that creates a three dimensional computer view. The color and diameter are determined and scars and blemishes detected. The apple is evaluated for weight, color, defects, and shape. The computer signals each belt cup to drop its apple at the correct packing box, perhaps hundreds of feet down the line. The machine made by Aweta is fast; each camera can evaluate 10 apples per second.



Controlled Atmosphere (CA) Storage

Eating crisp, juicy Washington apples year-round is possible due to controlled atmosphere storage that involves careful control of temperature, oxygen, carbon dioxide and humidity in sealed rooms. As apples ripen, they naturally take in oxygen and give off carbon dioxide. If we reduce the oxygen, we will slow ripening. Oxygen levels in the sealed rooms are reduced, usually by adding nitrogen gas, from the approximate 21% in the air we breathe to 1 or 2%. Temperatures are kept at a constant 32 to 36 degrees Fahrenheit. Humidity is maintained at 95% and carbon dioxide levels are also controlled. Exact conditions in the rooms are set according to the apple variety. Computers help keep conditions constant. Washington has the largest capacity of CA storage of any growing region in the world.

Wheat for the World

Thanks to innovations like GPS, drones and GMOs, farmers grow more superior food on less land than ever before. This is the very definition of **sustainable agriculture** — good for the Earth and for the future of our family farms!

The top technologies for wheat include GPS steering systems, smartphones, combine yield monitors, aerial drones, and even driverless tractors! GPS tracking shows the tractor driver where he has already been which avoids overlaps that waste fuel, fertilizer, seed, and chemicals.

In the past, every part of a field received the same amounts of seed, fertilizer and herbicides. Today, farmers manage their farms with much more precision, using GPS technology and field mapping (soil types and yield data) to create sectors.



The field map is uploaded to the computer in the farm equipment and each sector is managed separately. For example, an area with rich soil and a history of excellent production, would receive extra nitrogen and seed to match yield potential. On a hilltop with sandy soil, less fertilizer and seed might be applied. If their farming ancestors could see what they've done with data and technology, the dramatic changes would astonish them! Sprayers programmed with field maps are programmed to shut off when they go over ground they've already covered and will vary the amount of spray if fewer weeds are detected.

The drone, or **unmanned aerial system (UAS)**, could be an eightrotor "octo-copter." It uses high tech cameras to assess the status of crops and fields. Science continues to innovate with crops as well. Advances in seed technology may allow farmers to grow gluten-free wheat for the less than 1% of the population who suffer from celiac disease (an autoimmune disease caused by a reaction to gluten protein found in wheat).



Today, farmers manage their farms with much more precision, using GPS technology and individual field recipes of nutrient, seed and pesticide rates. When planting and protecting crops, soil, topography and historical yield data gathered by combine yield markers are taken into consideration as well by farm management software.

For example, an area with rich soil and a history of excellent production, extra nitrogen and seed might be added so that it matches yield potential, allowing the crops to attain



as much protein as possible. On a hilltop with sandy soil, less might be applied. If their farming ancestors could see what they've done with data, the dramatic changes would astonish them.

GPS helps in exacting with the sprays that protect crops against weeds, pests and disease. Although farmers have never "drenched" their fields with chemicals, they apply just the right amounts, measuring everything to the drop. Sprayers even are programmed to shut off when they go over ground they've already covered.

The drone, or unmanned aerial system (UAS), is an eight-rotor "octo-copter." It uses high tech cameras to assess the status of crops and fields. On the family farm, farmers are on the verge of using drones for additional data collection

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So why wheat?

Wheat is a healthy, nutrient rich food easy to grow and store. Thanks to wheat, our hunter-gatherer ancestors were able to cease the endless roaming for food, and create villages and towns.



Most breads come from hard red wheat grown mostly in the Midwest and Northern tier states, while pasta comes from durum wheat grown mostly in the Dakotas and Southwest. The Northwest states grow soft white wheat used in cookies, crackers, steam breads, sponge cakes and noodles. Most soft white wheat is exported. Top markets for white wheat last year included Japan, Philippines, South Korea, Yemen, Indonesia, Thailand, Guatemala, Taiwan, Sri Lanka and Chile.

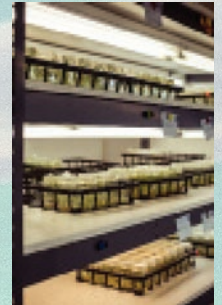
Almost 50% of the wheat produced in the US is exported from seven ports located in Washington and Oregon to about 68 countries around the world. Wheat is the 5th largest farm product in the state, bringing into the state's economy over \$657 million annually. The farmer's goal is to help people of the world to have the best food possible. For centuries, they have looked for ways to be as efficient as possible and that trend is alive and well today, with new and even greater innovations on the horizon.



No Ordinary Potato!

At Dick Bedlington Farms in Lynden Washington, young potatoes are grown in a greenhouse, but before they end up in the greenhouse they start in a laboratory by a process called tissue culture. Plant **tissue culture** is a collection of techniques used to grow plant cells under sterile conditions on a nutrient culture **medium**. This practice allows you to make many exact copies of the desired plant. Tissue culture is a growing industry that is used in many agricultural fields. With potatoes, we start with a whole potato and place it in a brown paper bag and let the potato begin to sprout. After the potato sprouts we remove the sprouts and start the process of cleaning the sprouts. After the sprouts are cleaned we take them to our tissue culture "hoods" where light is brought from above and air is forced through the area to keep any contamination out! We place the sprouts in a gel like substance that helps to promote the growth of a plant sprout. The gel has lots of sugar and nutrients that help jumpstart growth. The sprout will have produced about 4-5 leaves and then propagation starts. We cut the stem on the plant sprout about 1 millimeter under the leaf. This then gets placed in a new container with the gel in it so the leaf is resting right on the surface of the gel or "**media**". The plant usually has a part of the stem already growing to give it a little jump start. We repeat this process until we have enough plants to plant in our greenhouse! It is very sanitary, everybody must wash their hands and wear lab coats, but our farm is one of the only farms in Whatcom county that does tissue culture on its own potatoes! We use technology to make sure that the grow lights turn on at the right time, and that the temperature is correct when growing them. We still need to check on them daily to make sure they are healthy and growing correctly, but we have a computer system that looks at the temperature and we have a box in each room that we can change the light settings! Even more technology is used in the greenhouses! Within same computer system that works in our labs, we can check on our growing potatoes in the greenhouses. The computer system, called "Argus", monitors our greenhouses for us. The system checks temperature, humidity, fan usage, water usage, watering times, and much, much more! We can log on in the morning and look at a graph that tells what happened overnight, so we don't have to stay overnight with our potatoes! It's really amazing to make the fans go on in the west greenhouse from a computer and then look outside and the fans are on! We have been able to get the best crop by adding these features in our greenhouses and producing quality, nutritious potatoes.

Samantha Bedlington, greenhouse & laboratory Manager at Dick Bedlington Farms



Hand Milking to High Tech



When the first dairy cow arrived in Washington more than 75% of the US population lived on farms and most of them had a cow or two for fresh milk. Milking was done by hand into a metal bucket. Without refrigeration excess milk had to be sold or traded quickly to neighbors.

Mechanical milking machines were developed around 1930 but even then the average herd size was only 11 cows. The most modern dairies at the time could only milk 30 cows per hour and there was still much hand labor involved. Average yearly production was only 718 gallons per cow.

Today, technology has dramatically changed the dairy industry. Milk is never touched by human hands nor is it exposed to open air. Closed systems transfer milk directly from the cow through pipes to cooling tanks. Then tank trucks deliver the milk to processing plants. Modern dairies can milk 300 cows per hour and computers record each cow's production. (In fact the largest rotary parlor can milk nearly 700 cows per hour as they take a nine minute ride around the carousel). Advances in animal nutrition and health have increased average production per cow to 2500 gallons per year.



Some farms have added robotics to their dairies with individual robots that do specific tasks to entire robotic milking machines that milk the cow! Each cow has a neck collar that contains her personal data. After the cow enters the robot machine, she is identified by that collar which triggers the milking process. This includes 3D cameras and lasers within this technology that aids in the process.

Next time you drink a glass of milk or enjoy ice cream, remember the technology that made it possible!



Corn, More with Less



Because of science and technology, eight of the largest corn crops in history occurred in the last eight years. Science has developed plants that are tolerant of some **herbicides** (chemicals that kill weeds that compete with crops for space and water), and also some plants that will resist insect pests. These plants

mean that farmers use fewer chemicals. High-tech equipment places hybrid seeds at the correct depth in the soil with the best spacing between seeds, and puts fertilizer where it will be most available for the growing plant, thus using less fertilizer.



Food and Fuel

Corn is a grass, and belongs to the group of six true grains, or cereals, that also includes wheat, barley, oats, rice, and rye. 85% of US produced grain corn is fed to animals. Another valuable use of corn is **ethanol** fuel for cars. 70% of the corn kernel is used to make ethanol. The remaining 30% becomes high protein, high fat, livestock feed.

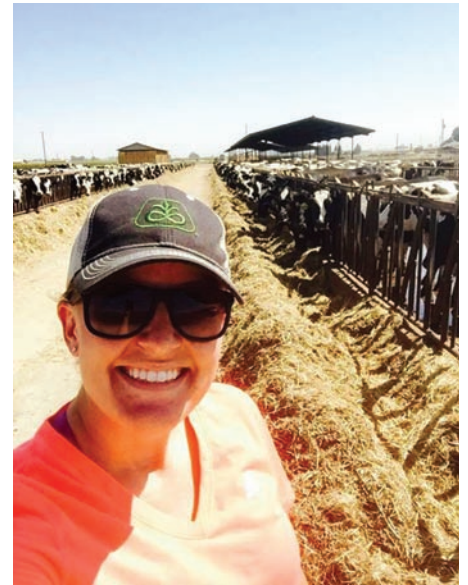
Some corn is harvested while the plant is still green and the corn kernels have not dried. The entire plant is chopped and stored as silage for animal feed.

Good for the Environment

You can find corn-based plastics in a growing number of utensils, gift cards, safety seals, bags, plant containers, weed barriers, water bottles and more. They will break down completely when composted.



Career Highlight



Agronomists, sometimes known as crop scientists, improve the quality and amount of food crops by conducting experiments, developing new methods of production, and advising farmers about crop production.

As plant scientists, agronomists can have many career paths, they can be teachers, agricultural business consultants, researchers, or even work for the U.S. Department of Agriculture (USDA). They often work in the field, on farms, or in agricultural labs and mills.

A bachelor's degree is required to become an agronomist, although many professionals obtain further degrees.

LIBRARY CORNER



Has A Cow Saved Your Life?

Millions of people are now safe from Smallpox, a deadly disease. With excellent historical color pictures this book tells the story of how the smallpox vaccine was discovered.

Let's Grow Together gives Washington State consumers the facts about producing safe and healthy food in Washington State. The website includes a variety of topics on farms that are large and small, traditional and organic; in order to help consumers make informed choices for their families. On their site, www.letsgrowtogether.ws, you can read articles or watch videos about Washington farmers on a variety of subjects, ask questions and find information! Log onto their site, they'd love to hear from you! Eastern and Western Washington, *Let's Grow Together!*

