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Agriculture - in a Changing World

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.

Moo Math

1 - Hand milking is hard work. Even a man with very strong hands can only milk 7 cows per hour. There are about 250,000 dairy cows in WA today. Assuming we could find enough people who can still milk a cow, how much time would it take to hand milk them all? _____

2 - What was the average dairy herd size in 1930? _____

3 - Find out how many students are in your school. If one cow produces 90 glasses of milk each day, how many cows are needed to give each student in your school 3 glasses per day? _____



Today's Children...**Tomorrow's Leaders**

tech•nol•o•gy (tek nol´ əje), 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.

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.**

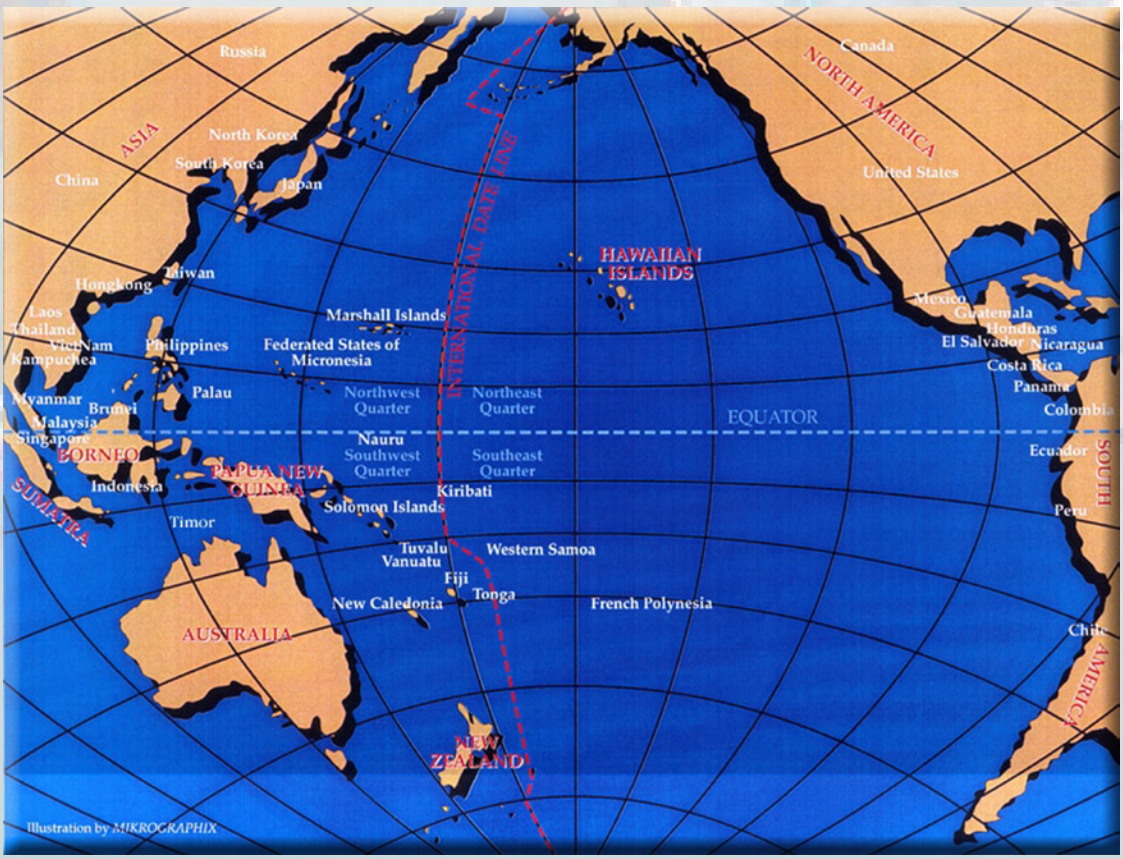
One-seventh of all the farmland in the world is used to grow this grain - far more land than for any other food crop. It is a staple food for 35% of the world's people and is used to make breads, cookies and noodles. North Dakota, Kansas, Montana, Washington, and Idaho are the leading production states 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. Canada, Japan, China, South Korea, Philippines, Mexico, Taiwan, Indonesia, Hong Kong and Vietnam were Washington's top exporting partners in 2020. By ship, Washington ports are about two days closer than California ports to the Asian Markets. In 2020, Washington-grown or processed food and agriculture exports totaled $6.7 billion (WSDA 2020). Washington consistently ranks in the top five largest exporters of food and agriculture products in the US.



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

Activity

1. What is the Pacific Rim?
2. On the map, put an "X" on Washington
3. Locate on the map the top five Washington ag export countries.
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.
6. Use a globe to trace the polar air routes from Washington to Europe

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 14 countries out of approximately 200 nations in the world.

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 2020, $17 billion of food and ag products were exported through Washington Ports. Of that, $6.7 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.

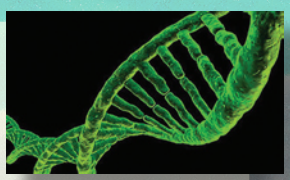
Drones: or **unmanned aerial system** (UAS), use high tech cameras to assess the status of crops and fields. Drones give the aerial view and precise information back the grower that can identify crop health and assess crop damage. Information gathered can assist with irrigation management and utilizing sensory data can determine specific harvest times.

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.

d 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.

Tissue Culture

A collection of techniques is used to grow plant cells under sterile conditions on a nutrient culture medium. This practice allows us to make many exact copies of the desired plant which creates uniform growth, desired traits and pest and disease free seedlings. New varieties can be introduced and multiplied in a short time. This procedure done on a large scale is called **micro-propagation**.

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, from the approximate 21% in the air we breathe to 1 or 2%, usually by adding nitrogen gas . 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.

1790	1850	1950	2010	2020
4 million Americans 90% lived on farms	23 million Americans 64% lived on farms	151 million Americans 12.2% lived on farms	315.5 million Americans 1.8% live on farms	329.5 million Americans, less than 1% on farms

Agriculture in a Changing World

Revolution: A "sudden or complete change"

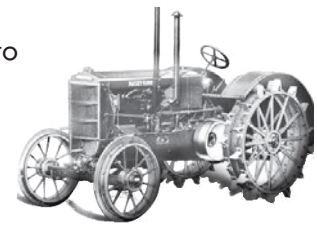
1837 John Deere invents self-cleaning plow

1820 - 1870 Industrial Revolution in the US

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

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

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

2000s - Now - High Speed information and the latest in technology

The internet gathers and communicates information at lightning speed, wi-fi can operate systems remotely, and human labor is replaced with machines, including sensors, 3D cameras, lasers, robots, drones, etc.

2008- GMO algae is used to make fuel

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

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.

How an out-of-this-world apple was created!

Since Washington state is #1 in apple production it's only fitting that an apple be designed especially for our climate and the needs of the apple market. A group of individuals set out to do just that – have a Washington created apple that was specific to our climate, sweet in taste, firm, crisp, slow to turn brown when cut or cooked, and would last up to a year in cold storage.

Researchers, tree fruit growers, and industry partners in the state collaborated to develop and promote the **Cosmic Crisp®** WA 38 cv.—an apple that will have a "cosmic" effect on the world. The Cosmic Crisp® demonstrates how the science of breeding and the art of imagination can come together to make a new star apple.

Horticulturist Bruce Barritt and **pome** fruit breeder Kate Evans crossed Honeycrisp and Enterprise apples, taking the best parts of each—the crispy texture and sweetness from Honeycrisp, the long shelf life, durability, and color of Enterprise—and methodically repeated the breeding process for 20 years at the Washington State University (WSU) Tree Fruit Research and Extension Center in Wenatchee, Washington. Originally known as WA-38, this apple got its name from a focus group who noted that the **lenticels**—small freckles that function as pores on the skin of the apple—reminded them of constellations.

Barritt and Evans had three main requirements. First, the apple needed to be able to thrive in Washington's cool, rainy climate. Second, the apple must be crisp and crunchy as well as have balanced sweetness and acidity. And lastly, the apple should have a long shelf life, which would make it easy to transport and reduce food waste. The apple growers of Washington took a major risk, pulling out Red Delicious apple orchards and planting 12 million Cosmic Crisp apple trees in their place. Washington state farmers have exclusive rights to grow Cosmic Crisp trees for 10 years. Premium priced and non-GMO, the Cosmic Crisp is the result of intense research and plant breeding that took 20 years to meet their requirements and tens of millions of dollars to produce.

"It takes a lot of time to produce a new variety," says Evans, noting work is ongoing. "We have apple selections in every stage all the time. The bad ones are discarded, and the good ones move to the next stage of evaluation."

Have you tried one? You can look for their comic appearance in the produce department of most grocery stores. Since their release a year ago they've proved to be out-of-this-world!

Washington Innovations

Combine Automatic leveling device:

The combine shown here is harvesting wheat, but it is also used in Washington to harvest corn, barley, canola, mustard, garbanzo beans and many other crops. It harvests a 30-40 foot wide cut and when fully loaded with grain weighs over 25 tons. For harvesting the hillsides of the Palouse an automatic leveling device was patented in 1946 by mechanical engineer R.A. Hanson from Spokane, Washington.

Raspberry Harvester:

This Korvan (now Oxbow) 9000 raspberry harvester, invented and built in Lynden, Washington, harvests ripe berries by gently shaking the bushes. Because of the high cost of picking by hand, most raspberries in Washington are now harvested mechanically. The self-propelled harvester travels about 1 mile per hour during the harvest process.

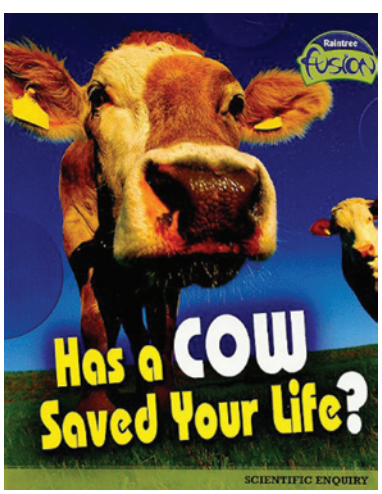
Robotics:

Robots are becoming increasingly popular to meet the demands of labor intensive procedures. Robots have many applications in agriculture and are designed for a specific task that might range from fruit picking and sorting, weeding, planting, and even driverless tractors/sprayers and robotic milkers. Engineers and scientists at Washington State University Tri-Cities and the WSU Center for Precision and Automatic Agricultural Systems (CPAAS) are creating a practically adoptable robot that will pick apples as efficiently as people.

The robot features an arm and "hand" in which eight motors operate in congruence with a vision system to delicately grasp and twist the fruit off the tree as a human does.

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.

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