

Helping the Little Red Hen

Careers in Wheat Production

Grades: Middle and High School

Purpose

Students will read about the many careers involved in wheat production/Students will identify careers related to their own interests and research to find more information about those careers. Students will play the role of wheat scientist by conducting an experiment to find the DNA in wheat germ.

Keywords

wheat harvest careers technology science business

Materials

Reading Pages included with this lesson
"I Want to." Questionnaire included with this lesson
Career matching sheet included with this lesson
Career research worksheet
Computer access

Wheat Germ DNA Experiment

- DNA Lab Sheet
- water
- 1 beaker
- raw wheat germ (sold with cereal)
- liquid soap
- spoon
- stirrer
- baking soda
- meat tenderizer
- test tube
- eye dropper
- denatured alcohol (sold with paint supplies)
- wooden stirring stick

Interest Approach or Motivator

Ask students to recall the story of the Little Red Hen. What were the jobs involved in producing her loaf of bread? (farmer miller baker etc.) Ask students to list jobs they think might go into producing the bread we get from the grocery store/ Use the following questions to stimulate discussion.

- Where does the harvested wheat go when it is taken from the field?
- How does it get there?
- How does the farmer know how much his wheat is worth?
- How does it get to the miller?
- Where does the farmer get the seed?
- How does he/she know the best seed to buy?

Share background to present students with additional options/Students will list occupations as they are

mentioned in the background.

Background

The Little Red Hen had a small enough operation that she could do all the work herself even though she would have liked to have help. Today's wheat farmer relies on people doing many different kinds of work to help produce the grain that feeds us.

Before the wheat farmer goes to work? there are scientists testing and developing the best seed and methods for growing wheat. There are engineers designing the best machinery not just tractors and combines but satellite positioning devices to help the farmer know when and where to fertilize. There are county Extension educators to share the latest research from universities and industry research labs.

Before the wheat leaves the field³ there are mechanics to keep machinery in good shape. There are the people who manufacture and sell the machinery. There are people in agricultural finance who help the wheat farmer manage the operation and loan money to purchase seed and equipment and other necessities.

When the wheat crop is ready? There is a whole army of harvesters with their combines and hired laborers who come in to cut the wheat at just the right time. There are even cooks to feed the hungry laborers.

After the harvest there are workers at the grain elevator who store the wheat until it is ready to sell. Samples of the wheat are sent to state or private labs where lab technicians determine the wheat grade by testing it for protein levels? moisture content? damage from insects and disease and test weight. The wheat grade determines the price the farmer can get for the wheat. Truckers drive the wheat to the processing plants. There are people working in the processing plants? turning wheat kernels into bread and many other products sold in the grocery store. There are the people who come up with ideas for new products. There are the grocers and the people who run warehouses where the products are stored.

There are opportunities in wheat production for people of all educational levels and all interests? for those who want to work outdoors and those who prefer working inside? at a computer or in a laboratory? for those who like working with their hands and those who enjoy research, for those who like working with people and those who prefer working alone.

If you like math? You might consider a career in agricultural business? Working to provide farmers with the cash they need for producing the crops or helping them to manage their businesses. Wheat farmers need basic math knowledge as well³ to keep good records of their crops and finances. Math is important for other careers related to agriculture. Agricultural engineers design new more efficient technology to produce more and better wheat. An engineer needs a good solid background in math. Computer science is another math-dependent field that is important in all areas of agriculture.

If you like science? wheat research might be the career for you. Wheat research covers every area of wheat production? from plant biology to earth and environmental science? to physics? chemistry and more. Small grain scientists may help find solutions for eliminating pests that attack crops or develop seeds for plants that will survive drought and other extreme conditions. Winter wheat production often involves ranching? since cattle graze the wheat fields in the fall and winter. Animal scientists develop best practices for keeping farm animals healthy. Environmental scientists look for ways to help farmers protect their most valuable resource - our soil, water and air. Although many research jobs require a college education³ there are also jobs in wheat research for persons with specialized associate degrees.

If you like social studies? You might get involved in public policy related to wheat production or you might pursue geography and the exciting field of geospatial positioning systems³ helping wheat farmers use their resources as efficiently as possible. The economics of wheat production is an important field of research that helps make wheat farming more profitable.

There are even careers in wheat production for those whose favorite subjects are in the arts- visual

art3 language arts? public speaking? etc. Graphic artists design packaging and promotional materials for wheat products. Copy writers communicate the advantages of different products. Agricultural journalists keep the public informed about issues important to protecting our food system.

The possibilities are endless and are changing rapidly. Preparing for any career means acquiring knowledge in a broad range of school subjects. Most careers require effective communication³ including speaking and writing. Most careers require knowledge of basic math and scientific principles.

In addition to knowledge gained through the classroom, skills are also important for achieving success. Working with other people may not be a subject for classroom study⁴ but it is essential in the working world. Everyone has different skills. There are some things you do better than your friends and some things they do better than you. Skills employers want include the ability to multi-task the ability to communicate⁴ the ability to work with others the ability to work with computers⁴ and skills specific to the job.

Albert Einstein said, "Education is not the learning of facts. It's rather the training of the mind to think." This is true of training for your career. Because everything is changing so quickly, the best preparation is learning how to learn how to find the credible information you need when you need it and how to think critically to process information.

Procedures

ACTIVITY ONE

- 1 Provide copies of the Reading Page (background) about careers in wheat production.
- 2 Students will read individually and make an outline of the reading.
- 3 Students will list unfamiliar vocabulary and use dictionaries to find definitions.

ACTIVITY TWO

- 1 As a class discusses the Albert Einstein quote at the end of the background reading. Ask students what they think he meant.
- 2 Provide copies of the two reading pages about advances in agriculture historically and more recently.
- 3 Students will read them individually or in groups taking time to define unfamiliar words. A vocabulary list⁴ with definitions⁴ is provided.
- 4 Students will answer the comprehension questions provided with the readings.
- 5 As a class discussed the rapid changes in agriculture and the need for flexibility in career planning. Read the Albert Einstein quote again and ask how it applies to advances in agriculture.

ACTIVITY THREE

- 1 Students will complete the "I Would Like to __" questionnaire included with this lesson.
- 2 Students will determine their preferred career clusters based on the largest number of items they have checked.
- 3 Students will each select a career in his or her preferred career cluster from the list of careers in agriculture included with this lesson.
- 4 Students will use online resources to research their preferred career. A list of links to information about careers in agriculture has been provided. Students will find as much information as possible about the career, using the "Career Research Worksheet" included with this lesson, as a guide.
- 5 Students will write short reports about careers and make presentations to the class by taking on the persona of a person in the career they have researched. Students may use props, such as lab coats, etc. and describe a few of their duties, education, etc. Students will work in career clusters to make their presentations.

ACTIVITY FOUR (SCIENCE LAB)

- 1 Divide students into groups of three or four. Explain that one important career in wheat production is plant breeding⁴ which starts with understanding wheat DNA.

- Hand out copies of the lab instructions included with this lesson. As a class discuss the information about wheat genomics and DNA included with this lesson. An important part of wheat production begins with research by small grain scientists. plant geneticists and others who study wheat genomics. Scientists cross and select wheat varieties to improve resistance to drought. insects. disease etc. Part of developing new varieties means working with wheat DNA. Explain that you are going to conduct an experiment to separate the DNA from the germ part of the kernel. Students will follow the directions on the lab sheet.
- Students will discuss and record their observations in a journal or on the page provided.

Enriching Activity

ACTIVITY ONE

- The article "Precision Farming" included with this lesson was written in 2001. Since then, there have been more technological advances in production agriculture. Students will select one of the topics below and use online search engines to find two or more sources to research some more recent advances.
 - Robots
 - Unmanned Aerial Vehicles (Drones)
 - Self-driven machinery
- Students will write papers from their research with citations and report to the class.

ACTIVITY TWO

- Review guidelines for writing a resume.
- Students will write resumes to apply for at least three of the jobs within their preferred career area

Vocabulary

agriculture - the science or occupation of cultivating the soil producing crops and raising livestock

career - a profession followed as a permanent occupation

combine - a machine that harvests, threshes and cleans grain while moving over a field commercial-
designed mainly for profit

cradle - a device based upon a scythe to cleanly reap and harvest grain

crop - a plant or animal or plant or animal product that can be grown and harvested

engineering - the art or science of making practical application of the knowledge of pure sciences as physics or chemistry as in the construction of engines, bridges, buildings, etc.

farming - raising crops or animals

finance - the system that includes the circulation of money, the providing of banks and credit and the making of investments

GIS (geographic information system) - a system designed to capture, store, manipulate, analyze, manage and present all types of spatial or geographical data

GPS - Global Positioning System a space-based navigation system that provides location and time information in all weather conditions anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites

hectare - a unit of land measure equal to 2.471 acres

husker - something used to strip the usually thin dry outer covering of barley or corn

incubator - a piece of equipment providing suitable conditions (as of warmth and moisture) for hatching eggs

infrared - being relating to producing or using rays like light but lying outside the visible spectrum at its red end

job - a position at which one regularly works for pay Kaffir corn- a southern African variety of corn

labor - the services performed by workers for wages
manufacturing - to make from raw materials by hand or by machinery
multitask - the ability to do more than one thing at a time
policy - a course of action chosen in order to guide people in making decisions
private - not under public control processing- changing or preparing by special treatment
production - the act of bringing something out by work
promotional - helping increase the sales of something
public - relating to or engaged in the service of the community or nation
radiant - energy transmitted in the form of electromagnetic waves (as heat waves' light waves' radio waves- X-rays)
ranching - working on a place for the raising of livestock (as cattle' horses' or sheep) on range
reaper - a machine for cutting grain or clearing a field
remote sensing data - data obtained from the scanning of the earth by satellite or high-flying aircraft
research - careful study and investigation for the purpose of discovering and explaining new knowledge
revolution - a sudden' extreme' or complete change
sickle - a tool with a sharp curved metal blade and a short handle used to cut grass
skill - a developed or acquired ability
subsistence - the minimum (as of food and shelter) necessary to support life
thermal - of relating to' caused by' or saving heat
threshing - separating seed from a harvested plant especially by using a machine or tool
variable - likely to be changed.

Agricultural Careerer Facts

- There are approximately 22 million people who work in agriculture related fields.
- Careers in Agriculture and Forestry make up one of the largest industries and sources of long-term employment in the country.
- 15-20 percent of all American are employed in agriculture and related fields.
- There are more than 40-000 career openings annually in agriculture.
- More than 11 percent of agricultural job openings go unfilled each year.
- New fields and job openings in agriculture are expanding every day.
- Agriculture-related jobs comprise 17 percent of all employment in metropolitan areas.
- US agricultural exports generate more than \$100 billion annually in business activity throughout the U^A S^A economy and provide jobs for nearly 1 million workers.
- Nearly 30 percent of today's farmers and ranchers have attended college, with over half of this group obtaining a degree. A growing number of today's farmers and ranchers with four-year college degrees are pursuing post-graduate studies.
- A recent survey of young farmers and ranchers reveals that computers are used on 83 percent of America's farms^A Nearly 75 percent of today's young farmers have a cellular telephone- and nearly one- third have access to the Internet.
- At the time of the most recent census in 2012 - the average age of a farmer in the US was 58.3,
- Nearly 58-000 high-skill agriculture-related jobs are expected to open up between 2015 and 2020,
- The United Nations estimates there will be nearly 9.6 billion mouths to feed worldwide, by the year 2050- which means agricultural production will need to more than double
- There will be an increasing demand for scientists- engineers and technical experts. Engineers will need to improve farm machinery efficiency- scientists will need to find ways to improve plant yields (and find ways to work with a decreasing water supply). Technicians will be needed to collect all kinds of data.
- Female graduates now outnumber males in fields like plant pathology - conservation biology-

entomology food science and wildlife biology among others.

Standards

NATIONAL AG LITERACY

1 Agriculture and the Environment

- Recognize how climate and natural resources determine the types of crops and livestock that can be grown for consumption

3 Food- Health and Lifestyle Identify sources of agricultural products that provide food fuel clothing shelter medical and other non-food products for their community. state. and/or nation

- Identify the careers in food production processing and nutrition that are essential for a healthy food supply

42 Science. Technology. Engineering and Mathematics

- Identify specific technologies that have reduced labor in agriculture
- Discuss how technology has changed over time to help farmers/ranchers provide more food to more people
- Compare and contrast historical and current food processing and systems
- Provide examples of science and technology used in agricultural systems (e.g. GPS. artificial insemination biotechnology soil testing ethanol production etc.) explain how they meet our basic needs and detail their social economic and environmental impacts?
- Describe how biological processes influence and are leveraged in agricultural production and processing (e.g. photosynthesis. fermentation. cell division. heredity/genetics. nitrogen fixation)
- Identify science careers related to both producers and consumers of agricultural products
- Correlate historical events discoveries in science and technological innovations in agriculture with day-to-day life in various time periods
- Identify current and emerging scientific discoveries and technologies and their possible use in agricultural systems (e.g. biotechnology)
- Predict the types of careers and skills agricultural scientists will need in the future to support agricultural production and meet the needs of a growing population

52 Culture. Society. Economy & Geography

- Distinguish between careers in production (farmers and ranchers) with those that directly involve consumers (business and nutrition)
- Discuss how agricultural practices have increased agricultural production and have impacted (pro and con) the development of the global economy population and sustainability
- Describe essential agricultural careers related to production. consumption and regulation
- Evaluate and discuss the impact of major agricultural events and agricultural inventions that influenced world and U.S. history.

CONTENT STANDARDS

Science- MS-PS1-2U MS-LS12B. 32AB. 4-5U HS-LS1-12A. 2-7. 32A. 42ABU ET S12AB

Economics- D221326-8U D221329-12

History- D221.2.326-8U D221.2.329-12U D321.226-8U D321.229-12

COMMON CORE

ELA- RI21.2.3.4.5.7.10U W2224.5.6.7.8.9.10U SL21.4.5

Resources

- Food. Agriculture and Natural Resources Careers. USDA Living Science. <https://www.agriculture.purdue.edu/usda/careers/contactus.html>

- MyCAERT, <https://www.mycart.com/career-profiles/>
- Study.com, https://study.com/article_directory/q_p/page/Agriculture/q_p/Careers_and_Occupations_List.html
- Occupational Outlook Handbook. Bureau of Labor Statistics. US Department of Labor.
<https://www.bls.gov/ooh/>
- Agriculture and Forestry Careers <https://www.environmentalscience.org/careers/agriculture-and-forestry>
- Careers in Agriculture (Georgia Agricultural Education <https://www.gaaged.org/page.aspx?ID=353>)

Source/Credits

Oklahoma Ag in the Classroom

St. Louis Science Center and Kansas Foundation for Agriculture in the Classroom

"Wheat Germ DNA,' Kansas Ag in the Classroom

Colorado Wheat, "Why is the Wheat Genome So Complicated?" Coloradowheat.org/2013/11/why-is-the-wheat-genome-so-complicated/

Helping the Little Red Hen

Career's in Wheat Production

The Little Red Hen would have liked some help but her operation was small enough so she could do all the work herself. Most wheat producers today have much larger operations and rely on people doing many different kinds of work to help produce the grain that feeds us.

Before the wheat farmer goes to work there are scientists testing and developing the best seed and methods for growing wheat. There are engineers designing efficient machinery. There are county Extension educators sharing the latest research from universities and private labs.

Before the wheat leaves the field there are mechanics to keep machinery in good shape. There are manufacturers who produce and sell the machinery. There are people in agricultural finance who help the wheat farmer manage the operation and provide credit for purchasing seed equipment and other necessities.

When the wheat crop is ready there are harvesting operations with combines and hired labor that come in to cut the wheat at just the right time. There are even cooks to feed the hungry laborers.

After the harvest the wheat goes to an elevator where it is stored until it is ready to sell. Samples of the wheat go to analytical labs where technicians test the wheat to determine quality and value. Truckers drive the wheat to processing plants. There are people working in the processing plants turning wheat kernels into bread and other products. There are people who come up with ideas for new products. There are grocers and people who run warehouses where products are stored.

There are opportunities in wheat production for people of all educational levels and all interests for those who want to work outdoors and those who prefer working inside for those who like working with their hands and those who prefer computer work.

If you like math you might consider a career in agricultural finance providing farmers with the credit they need or helping them manage their businesses. Wheat farmers need basic math knowledge as well to keep good records of crops and finances. Agricultural engineers design new more efficient technology to produce more and better wheat. An engineer needs a solid background in math.

If you like science wheat research might be the career for you. Wheat research covers every area of wheat production from plant biology to earth and environmental science to physics and chemistry. Small grain scientists find ways to eliminate pests that attack crops or develop plants that will survive drought and other extreme conditions. Winter wheat production often involves ranching since cattle graze wheat fields in the fall and winter. Animal scientists develop best practices for keeping farm animals healthy. Environmental scientists look for ways to help farmers protect our soil water and air.

If you like social studies you might get involved in public policy related or you might pursue geography and the field of geospatial positioning systems (GPS) helping wheat farmers, use their resources efficiently.

There are even careers in wheat production for writers and artists. Graphic artists design packaging and promotional materials for wheat products. Copy writers communicate the advantages of different products. Agricultural journalists keep the public informed about issues important to protecting our food system.

The possibilities are endless and are changing rapidly. Preparing for any career means acquiring knowledge in a broad range of school subjects. Most careers require effective communication including speaking and writing. Most careers require knowledge of basic math and scientific

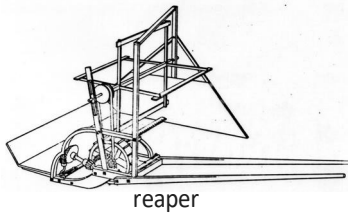
principles. Working with other people may not be a subject for classroom study but it is essential in the working world. Skills employers want include the ability to multi-task the ability to communicate the ability to work with others the ability to work with computers and skills specific to the job.

Albert Einstein said "Education is not the learning of facts. It's rather the training of the mind to think." This is true of training for your career. Because everything is changing so quickly. The best preparation is learning how to learn how to find the credible information you need when you need it and how to think critically to process information.

A Revolution in Agriculture

The revolution in agriculture - paralleling that in manufacturing after the Civil War - involved a shift from hand labor to machine farming's and from subsistence to commercial agriculture. The farmer of 1800, using a hand sickle, could hope to cut a fifth of a hectare of wheat a day. With the cradles 30 years later

he might cut four-fifths) 840 Cyrus McCormick performed a miracle by cutting from two to two-and-a-half hectares a day with the reapers a machine he had been developing for nearly 10 years. He headed west to the young prairie town of Chicago where he set up a factory - and by 1860 sold a quarter of a million reapers.



reaper

Other farm machines were developed in rapid succession: the automatic wire binders, the threshing machines and the reaper-thresher or combines. Mechanical planters, cutters, huskers and shellers appeared as did cream separators, manure spreaders, potato planters, hay driers, poultry incubators and a hundred other inventions.

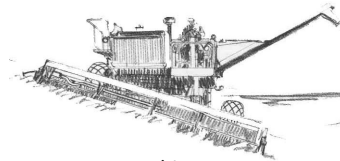
Scarcely less important than machinery in the agricultural revolution was science. In 1862 the Morrill Land Grant College Act allotted public land to each state for the establishment of agricultural and industrial colleges. These were to serve both as educational institutions and as centers for research in scientific farming. Congress subsequently appropriated funds for the creation of agricultural experiment stations throughout the

country and granted funds directly to the Department of Agriculture for research purposes. By the beginning of the new century's scientists throughout the United States were at work on a wide variety of agricultural projects.

One of these scientists Mark Carleton traveled for the Department of Agriculture to Russia. There he found and exported to his homeland the rust- and drought-resistant winter wheat that now accounts for more than half the U.S. wheat crop. Another scientist, Marton Dorset, conquered the dreaded hog cholera while still another, George Mohler, helped prevent hoof-and-mouth disease. From North Africa's one researcher brought back Kaffir corn; from Turkestan another imported the yellow-flowering alfalfa. Luther Burbank in California produced scores of new fruits and vegetables. In Wisconsin, Stephen Babcock devised a test for determining the butterfat content of milk; at Tuskegee Institute in Alabama, the African American scientist George Washington Carver found hundreds of new uses for the peanuts, sweet potatoes and soybeans.



hand sickle



combine

Vocabulary

cradle- a device based upon a scythe to cleanly reap and harvest grain
hectare- a unit of land measure equal to 2.471 acres

husker- something used to strip the usually thin dry outer covering of barley or corn

Kaffir corn- Southern African variety of sorghum

reaper- a machine for cutting grain or clearing a field

threshing- separating seed from a harvested plant especially by using a machine or tool

Excerpt from "Outline of US History" Bureau of International Information Programs, US Department of State, 2011 (p. 160-177)
http://photos.state.gov/libraries/amgov/30145/publications-english/hlstory_outline.pdf

COMPREHENSION QUESTIONS

1. What is the main idea of this passage? What are some of the supporting details?
2. What is the author's purpose? How is it conveyed?
3. Why is it significant that these advances were taking place at the same time as advances in agriculture after the Civil War?
4. What was Cyrus McCormick's miracle?? Why was it called a miracle?

Precision Farming

Imagine you are a farmer riding along in your 50 000-acre wheat field early in the growing season. You push a button on your tractor to turn on its Global Positioning System (GPS) monitor which pinpoints your exact location to within one meter. Touching another button you display a series of Geographical Information System (GIS) maps that show where the soil in your field is moist where the soil eroded over the winter and where there are factors within the soil that limit crop growth. Next you upload remote sensing data collected just yesterday that shows where your budding new crop is already thriving and areas where it isn't. You hit SEND to upload these data into an onboard machine that automatically regulates the application of fertilizer and pesticides- just the right amount and exactly where the chemicals are needed. You sit back and enjoy the ride saving money as the machines do most of the work. Congratulations you are among a new generation of growers called "precision farmers."

... A number of scientific studies over the last 25 years have shown that measurements in visible near-infrared thermal infrared and microwave wavelengths of light can indicate when crops are under stress. Using satellite- and aircraft-based remote sensors to precisely measure the wavelengths of radiant energy that are absorbed and reflected from the land surface scientists can diagnose a wide range of growing conditions. For instance these data can tell farmers where their crop is thriving and how efficiently the plants are photosynthesizing. Alternatively remote sensing data can tell not only where but why their crop is under stress and help them diagnose the source.

... The term "precision farming" refers to the use of an information and technology-based system for within-field management of crops. "It basically means adding the right amount of treatment at the right time and the right location within a field- that's the precision part" R. Susan Moran research hydrologist with the US Department of Agriculture and member of the NASA Landsat 7 Science Team explains. "Farmers want to know the right amounts of water chemicals pesticides and herbicides they should use as well as precisely where and when to apply them."

Critical to the success of precision farming is the sophisticated new equipment that is now commercially available. Called "variable rate technologies" mounted on tractors and programmed to control the dispersion of water and chemicals gained from the remote sensors.

... Charles Walthall also a research physical scientist at the U.S. Department of Agriculture in Beltsville recalls that the old way of doing business was planting a crop and then applying fertilizer evenly across the whole field.

"But now we're characterizing zones within the field so we can optimize what inputs are needed to go into that zone according to what they need to produce the crop" Walthall says. "But if you limit your inputs- such as fertilizers seeds water pesticides or herbicides- to precisely where and how much is needed you are putting less on the landscape. So, the cost is less, and energy is saved which means better profit."

Perhaps more significantly it can mean there is much less chemical runoff from farms to negatively impact the environment.

... Using precision farming techniques to refine "irrigation scheduling" is a research area of particular interest to Moran. She explains that in the southwest irrigation is both difficult and expensive. There she says

Vocabulary

GIS (Geographic Information System)- a system designed to capture store manipulate analyze manage and present all types of spatial or geographical data

GPS (Global Positioning System)- a space-based navigation system that provides location and time information in all weather conditions anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites

infrared- being relating to producing or using rays like light but lying outside the visible spectrum at its red end

radiant energy- energy transmitted in the form of electromagnetic waves (as heat waves light waves radio waves X-rays)

remote sensing data- data obtained from the scanning of the earth by satellite or high-flying aircraft

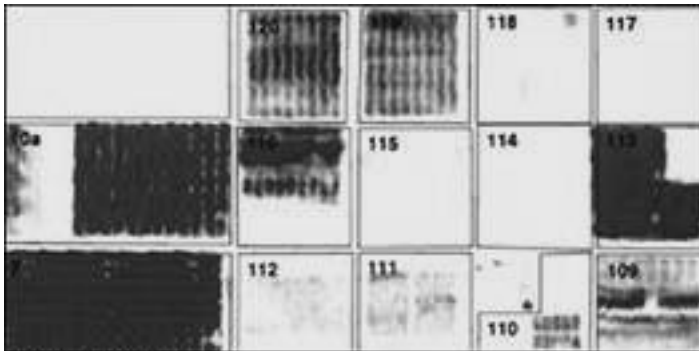
thermal devices- devices that use heat to produce information

variable- likely to be changed

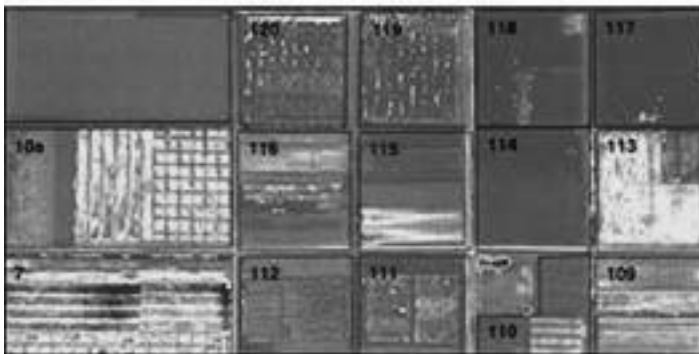
farmers have a tendency to over-irrigate, spending both more time and money than is necessary.

"I'm trying to provide new information that could be used by farmers to schedule irrigations to improve their profitability and use less water," Moran says. "Often times, farmers look at weather variables and then schedule irrigation based on that information. But if they had better information, they could use scientific models and equations to compute more precisely how much water their crop is using."

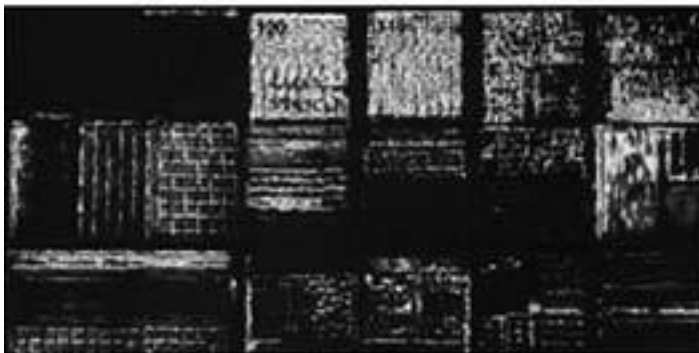
"Both irrigation and satellite remote sensing data are expensive. But then again many farmers are used to working together as a group: They are used to sharing. I'm hoping they could do the same with remote sensing data- purchase one scene over a large area to cover many farms, which would further offset the cost."



Vegetation Density



Water Deficit Index



Crop Stress Index

False color refers to a group of color rendering methods used to display images in color which were recorded in the visible or non-visible parts of the electromagnetic spectrum. These three false-color images were acquired by the Daedalus sensor flying aboard a NASA aircraft. The top image shows the color variations determined by crop density (also referred to as "Normalized Difference Vegetation Index," or NDVI), where dark blues and greens indicate lush vegetation and reds show areas of bare soil. The middle image is a map of water deficit, derived from the Daedalus 0 reflectance and temperature measurements. The image shows an ongoing flood irrigation in the northern Field 7 and Field 107, in which greens and blues indicate wet soil and reds are dry soil. The bottom image shows where crops are under serious stress, as is particularly the case in Fields 120 and 119 (indicated by red and yellow pixels). These fields were due to be irrigated the following day. (Image courtesy Susan Moran, Landsat 7 Science Team, NASA Earth Observatory)

Excerpt from Herring, David, Earth Observatory, NASA, January, 2001, <http://earthobservatory.nasa.gov/Features/PrecisionFarming/>

COMPREHENSION QUESTIONS

1. What is the main idea of this article? What are the supporting details?
2. Compare wheat production as described in the article "A Revolution in Agriculture" with wheat production as described in this passage:
3. Contrast the author's purpose with the author's purpose in "A Revolution in Agriculture."
4. What are some of the advantages of using precision agriculture in wheat production? What are some of the disadvantages?

I would like to...

Based on your personal goals and preferences, put a check mark next to all the phrases below that would accurately complete the sentence "I would like to ____". Then count the number of check marks in each category and write the number in the space provided for each group on the next page. The one(s) with the most check marks is your preferred career cluster. Career clusters contain occupations in the same field of work that require similar skills.

CAREER CLUSTER 1

- _____ work outdoors
- _____ grow crops
- _____ work with animals
- _____ manage my own business

TOTAL FOR CAREER CLUSTER 1 _____

CAREER CLUSTER 6

- _____ draw and create art
- _____ make movies
- _____ write or broadcast news stories
- _____ take pictures

TOTAL FOR CAREER CLUSTER 6 _____

CAREER CLUSTER 2

- _____ coach young people
- _____ teach young people how to take care of animals
- _____ teach young people how to grow crops
- _____ help young people communicate correctly

TOTAL FOR CAREER CLUSTER 2 _____

CAREER CLUSTER 7

- _____ work outdoors
- _____ help protect the soil and water
- _____ study insects and plants
- _____ explore outdoor areas

TOTAL FOR CAREER CLUSTER 7 _____

CAREER CLUSTER 3

- _____ work in a laboratory
- _____ develop new food products
- _____ develop nonfood products
- _____ solve problems

TOTAL FOR CAREER CLUSTER 3 _____

CAREER CLUSTER 8

- _____ sell things
- _____ work in an office or bank
- _____ manage a business
- _____ help people

TOTAL FOR CAREER CLUSTER 8 _____

CAREER CLUSTER 4

- _____ help people with legal problems
- _____ help keep our food safe
- _____ work in government or politics
- _____ study laws

TOTAL FOR CAREER CLUSTER 4 _____

CAREER CLUSTER 9

- _____ work with computers
- _____ design computer programs and applications
- _____ write code
- _____ work with geospatial positioning systems (GPS)

TOTAL FOR CAREER CLUSTER 9 _____

CAREER CLUSTER 5

- _____ work with my hands and/or tools
- _____ build and repair things
- _____ work on machinery
- _____ design machinery and invent things

TOTAL FOR CAREER CLUSTER 5 _____

Some Careers in Wheat Production

Select one of the careers below from the preferred career cluster as you selected on the "I would like to..." page. Use online resources to find as much information as possible about the career, including education and training required, most likely employer (public or private), kind of work, salary range, etc.

1. PRODUCTION AGRICULTURE _____

- Wheat Farmer
- Rancher
- Farm Laborer
- Custom Harvester

2. AGRICULTURAL EDUCATION _____

- High School Agriculture Teacher
- University Agriculture Teacher
- County Cooperative Extension Service Educator
- Curriculum Writer

3. AGRICULTURAL RESEARCH _____

- Milling and Baking Specialist
- Agronomist
- Laboratory Manager
- Plant Geneticist

4. GOVERNMENT/LEGAL _____

- Agricultural Grader
- Food Inspector
- Patent Attorney
- Agriculture Economist

5. MANUFACTURING/ENGINEERING/ CONSTRUCTION/MECHANICS _____

- Agricultural Machinery Mechanic
- Custom Equipment Operator
- Feed Mill Equipment Operator
- Mechanical Engineer

6. AGRICULTURAL COMMUNICATION/ART/ DESIGN _____

- Agricultural Journalist
- Packaging Designer
- Marketing Communications Manager
- Social Media Specialist and Web Designer

7. NATURAL SCIENCE AND RESOURCE MANAGEMENT _____

- Entomologist
- Geographer
- Hydrologist
- Soil Scientist

8. AGRICULTURAL FINANCE, BUSINESS AND MANAGEMENT _____

- Agricultural Equipment Salesperson
- Farm Loan Officer
- Farm Manager
- Truck Driver

9. INFORMATION TECHNOLOGY (COMPUTERS) _____

- Computer Programmer
- Computer Software Engineer
- Computer Hardware Engineer
- Precision Agriculture Technician (GPS)

Name _____

Career Research Worksheet

Select one of the careers in your preferred career cluster, and research to find the information below about that career.

JOB DESCRIPTION:

DUTIES :

SKILLS NEEDED:

EDUCATION NEEDED:

POTENTIAL EMPLOYER (PUBLIC OR PRIVATE):

SALARY RANGE:

Wheat Genomics

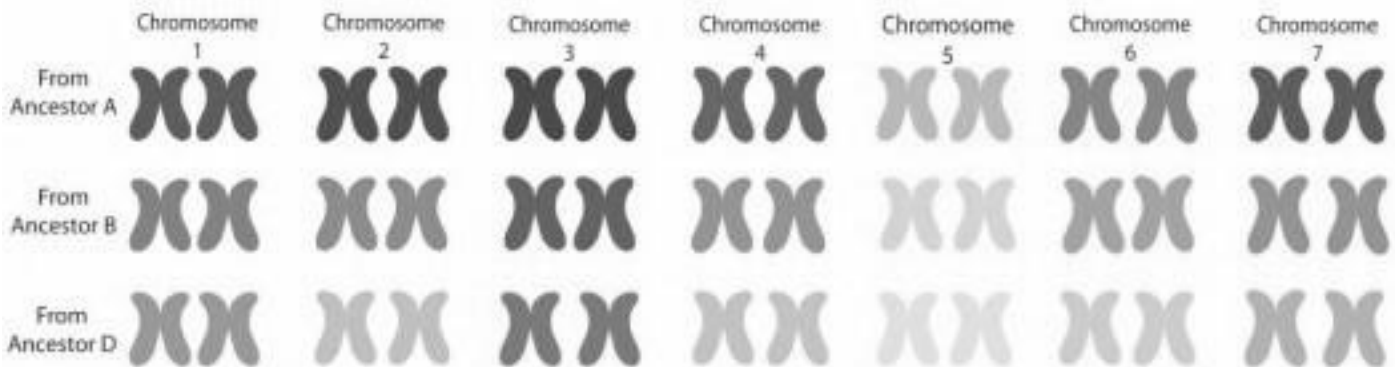
A genome is all of a living thing's genetic material, the entire set of instructions for the creation and the function of an organism. Wheat has the largest genome among commonly grown agricultural crops.

Every cell in every living thing, plant or animal, contains deoxyribonucleic acid (DNA). It holds the instructions for all of the processes and parts of the cells. An important part of wheat production begins with research by small grain scientists, plant geneticists and others who study wheat genomics. Scientists cross and select wheat varieties to improve resistance to drought, insects, disease, etc. Part of developing new varieties means working with wheat DNA.

DNA is organized into long structures called chromosomes. Because of the way different species have developed, some of them have more chromosomes than others.

Further complicating the matter, different organisms have different numbers of copies of chromosomes. So while a human cell (diploid) has two copies of 23 chromosomes for a total of 46 chromosomes, corn has 20 chromosomes total, and rice has 24.

Wheat came from three related ancestors. Each who had seven chromosomes. For gene sequencing purposes, that means modern wheat has 21 different chromosomes to map. Since they come in pairs that means each cell has 42 total chromosomes.



While wheat has fewer pairs of chromosomes than humans, it has a greater number of genes, with an estimated 164,000 to 334,000 genes, compared to 20,000 to 25,000 genes for a human. A gene is a stretch of DNA which holds specific instructions for an organism's structure or function.

In traditional wheat breeding, two varieties of wheat are selected to be crossed because they both have desirable traits, such as insect resistance, high yield, or drought tolerance. The crossing is done by hand pollination.

Wheat is a highly self-pollinating plant, so the pollen has to be removed by hand before it has a chance to pollinate the plant. Then, the plant is hand pollinated with pollen from the variety or line the breeder wants to cross with. The generation of plants that result from that cross is then inbred by self-pollination to produce a type that doesn't change with more cycles of seed generation.

Adapted, with permission, from "Why is the Wheat Genome So Complicated," Colorado Wheat Blog, November, 2013: <http://coloradowheat.org/2013/11/1/why-is-the-wheat-genome-so-complicated/>

Wheat Germ DNA Lab Instructions

Materials Needed

water
beaker or clear plastic cup
raw wheat germ
liquid soap
spoon
stirrer
baking soda
meat tenderizer
test tube
eye dropper
denatured alcohol, chilled
wooden craft sticks or other narrow wooden sticks

- 1 Pour 100 ml of warm water into a cup/beaker.
- 2 Add one spoonful of raw wheat germ and stir a few times.
WHY? Everything living contains DNA. Raw wheat germ is a living thing.
- 3 Add one squirt of liquid soap and stir a few more times, but not so hard that you generate bubbles.
WHY? The cell membrane and nuclear membrane are broken down by soaps such as those found in shampoo and dish soap. When you wash dishes, the fats (grease) are removed from your dishes by the dish soap. When you wash your hair the shampoo removes the grease and oils.
- 4 Add 1 tsp baking soda and 1/8 tsp meat tenderizer. Stir for 5-10 minutes, then let solids settle to the bottom.
WHY? The positively-charged sodium ions in the baking soda and meat tenderizer (Na^+) are attracted to the negative charge of the DNA. This creates a "shield" around the DNA molecules and causes them to stick together (coalesce). This enables the DNA to quickly separate from the liquid when mixed with alcohol in a later step.
- 5 Draw off some of the clear liquid at the top with an eyedropper. You do NOT want the solids at the bottom.
- 6 Fill a test tube 1/3 full of the clear liquid.
- 7 Add chilled denatured alcohol slowly with the eyedropper. Mix very gently.
- 8 Watch the DNA strands appear at the interface between the wheat germ slurry and the alcohol.
- 9 Use the craft sticks to lift the DNA strands from the solution.

Discuss and record your observations.

Describe the experiment in your own words.

What did you expect to see?

What did you see?

Was the experiment a success?

What did you learn from the experiment?

Helping the Little Red Hen

Career's in Wheat Production (Sample Outline)

I. Introduction Wheat producers rely on many people to help produce wheat

- A. Before the farmer goes to work
 - 1 Scientists
 - 2 Engineers
 - 3 County Extension agents
- B. Before the wheat leaves the field
 - 1 Mechanics
 - 2 Machinery manufacturers
 - 3 Ag finance
- C. When the wheat crop is ready
 - 1 Harvesting operations
 - 2 Cooks
- D. After the harvest
 - 1 Grain elevator workers
 - 2 Truckers
 - 3 Analytical lab technicians
 - 4 Processing plant workers
 - 5 New product developers
 - 6 Grocers
 - 6. Warehouse workers

II. Education

- A. Math
 - 1 Agricultural business
 - 2 Wheat farmers
 - 3 Agricultural engineers
- B. Science
 - 1 Small grain scientists
 - 2 Animal scientists
 - 3 Environmental scientists
- C. Social Studies
 - 1 Graphic artists
 - 2 Copy writers
 - 3 Agricultural journalists

III. Skills

- A. Communication- speaking and writing
- B. Basic math and scientific principles
- C. Working with other people
- D. Multi-tasking
- E. Working with computers
- F. Skills specific to the job.

IV. Conclusion- Albert Einstein quoteT Prepare for change

A Revolution in Agriculture (Sample Answer's)

1 What is the main idea of this passage?

The main idea is to provide an overview of the rapid advances in agriculture in the 19th Century.

2 What are some of the supporting details?

Supporting details are a list of advances³ including

- McCormick's reaper
- automatic wire binder
- threshing machine
- reaper-thresher or combine
- mechanical planters
- cutters
- huskers
- shellers cream separators
- manure spreaders
- potato planters
- hay driers
- poultry incubators
- ag research from the new ag colleges and the Department of Agriculture⁴ which produced
 - new varieties of wheat
 - treatment for hog cholera
 - prevention of hoof-and-mouth disease
 - Kaffir corn
 - yellow-flowering alfalfa
 - new fruits and vegetables
 - test for determining the butterfat content of milk
 - new uses for the peanut, sweet potato, and soybean

3 What is the author's purpose?

The author's purpose is to inform the audience about agricultural advances in the 19th Century

4 How is it conveyed?

The purpose is conveyed by listing some of the major agricultural advances in the 19th Century.

5 Why is it significant that these advances were taking place at the same time as advances in agriculture after the Civil War?

To show that advancement wasn't limited to manufacturing and that agriculture embraces new technology. Also, that after the Civil War the agricultural South was changing along with the manufacturing North.

6+ What was Cyrus McCormick's "miracle?" Why was it called a miracle?

McCormick's "miracle" was his reaper. It was called a miracle because it more than doubled the amount of what that could be cut in a day.

Precision Farming (Sample Answers)

1. What is the main idea of this article?
2. The main idea is to introduce the reader to precision agriculture.
3. What are the supporting details?
 - Summary in the introduction of some of the elements of precision agriculture
 - Explanation of how it works scientifically (measuring wavelengths)
 - variable rate technologies
 - Limiting inputs saves money and the environment
 - Irrigation scheduling
4. Compare wheat production as described in the article "A Revolution in Agriculture" with wheat production as described in this passage.

"A Revolution in Agriculture" explores technological advances in the 19th Century. "Precision Farming" shows how much more wheat production has advanced since then.
5. Contrast the author[s purpose with the author[s purpose in "A Revolution in Agriculture."
6. The purpose in "A Revolution in Agriculture" is to give a historical overview of advances in agriculture during the 19th Century. "Precision Farming" focuses on one aspect of more recent technology.
7. What are some of the advantages of using precision agriculture in wheat production? What are some of the disadvantages?

Advantages: Saves money; Better for the environment
Disadvantages: Expensive
8. How does Moran propose solving the problem of cost?

She suggests farmers can work together to share the cost.