Instructions for Day 1, Livestock Industry

If you have access to iCEV sign on to watch the videos or at least read the video transcript.

After reviewing the materials, research the history of cattle driving in America including prominent figures from the past. Use this information to create a powerpoint as described in the project instructions. Follow all the instructions.

Cattle Drive

Project Overview:

You will research the history of cattle drives and create a PowerPoint® presentation comparing past and present practices.

Directions:

1. Using resources such as the library, industry magazines and the internet, research the history of cattle drives.

2. Create a five to seven slide Microsoft® PowerPoint® presentation with your findings. The presentation should compare and contrast the past to the present and should contain photos and a citation slide.

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The Livestock Industry

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1. Introduction

The livestock industry has played an important role in the success of not only the United States, but that also of the agricultural industry. In this production, we will discuss the advancements of the livestock industry and the development of its marketing practices. We will additionally cover the marketing of meat and meat products, as well as career development and entrepreneurship opportunities. Discovering the changes and how the livestock industry came about will provide a fresh new insight and increase awareness of how the meat we eat gets to our plate.

2. The Evolution of Livestock

The evolution of livestock-- the first livestock animals, such as sheep, horses, and cattle, were brought over to America in 1493, during Christopher Columbus's second journey to the New World. Once these livestock animals were brought over to the New World, herds of animals-- predominantly cattle-- were allowed to roam and graze freely. Since they were unprotected, they were more susceptible to predator attacks.

The early human civilizations were required and dependent upon hunting the animals and using wild plants with the animals' hides for food and clothing. They then realized that if they maintained the animals in a confined area, they would be able to have a stable supply of food and clothing. With a steady supply of food, there would also be an increase in the human population. Some historians have argued that without the domestication of these animals, we would have never become civilized.

3. Origins of Livestock

The cattle we are familiar with today are descendants from the Bos taurus and the Bos indicus. Bos taurus cattle came from either the aurochs, which is from Europe, or the Celtic short horn, which came from the British Isles. Bos indicus cattle, which are more commonly known for their hump, are found in the tropical countries, and are more resistant to some diseases, parasites, and heat than the Bos taurus cattle.

TEXT ON SCREEN - [Time Line of Stone Age: Paleolithic or Old Stone Age, 2.5 Million Years – Mesolithic or Middle Stone Age, 15000 years ago – Neolithic or New Stone Age, 11000 years ago]

Cattle were first tamed early in the Neolithic Age, also known as the New Stone Age, and were used for meat, milk, and draft. Draft is where the animals are used for pulling loads. During this age, the wealth of a person was measured by the number of cattle they had, meaning the more cattle they had, the wealthier they were. As the years progressed onward, selection and cross-breeding began to occur in order to improve the cattle and started the introduction of different breeds.

TEXT ON SCREEN - [Dell Allen – VP Technical Services & Food Safety, Cargill Meat Solutions, Retired]

Breeding now is taught through the old-- they call them gene jockeys, but actually looking down at the molecular level of genes and studying that, and so it's dramatically different than what it was back in the 1950s as far as animal breeding. And it's allowed us, and will continue to allow us to make some major advances in animal production by allowing us to look inside the gene pool, identify traits that are affected by certain genes, and in particular, make improvement in our animals through those types of technologies. And we're just beginning in that. We're not even close to scratching the surface yet of what can be done in the future on those things.

With the population moving westward, so did the cattle herds. The states in the Great Plains were the most successful because of the enormous amount of grazing land available to the settlers. Additionally, the number of

dairy cattle in the United States kept increasing till the mid 1940s, and milk production now occurs in all 50 states. Also, with the population going west, so did the men and their cattle. Many men began hiring other men to drive their livestock to the market to save on expenses, while those men who could afford it would haul their cattle using the railroads.

TEXT ON SCREEN - [Chance Brooks, Ph.D. – Associate Professor, Meat Science – Texas Tech University]

I think if you look at the history of the meat industry, one of the most fascinating things about it are the evolutions that have occurred in transportation. If you look at the way that it was originally provisioned, we used to drive animals to the market place. Historically, you typically saw cattle drives, and they were the most famous, but they would also draft pigs, and sheep, and even turkeys and poultry to markets.

So we would actually transport the livestock to the processing facility for harvest. And then what we started to see is that it was actually easier to harvest the animals in the areas where they were actually fed because it became expensive to transport grain products to the facilities. So we started to see the use of the rail car, and the rail car was used more commonly to transport livestock to and from market facilities.

Rail cars soon developed into a refrigerated rail car, which then evolved into the refrigerated trucks used to ship meat in modern society.

Swine. Swine did surprisingly well during the beginning of the New World. As omnivores, and being known to eat practically anything, they would scavenge around the land trying to find food. The American breeds we are familiar with came from two wild ancestors, the European wild boar, Sus scrofa, and the East Indian pig, Sus vittatus.

The use of swine for meat did not occur till the New Stone Age. Pork and lard were used for export trade in return for other goods. The main concentration and expansion of swine production occurred in the Corn Belt

states, because the feed for finishing the hogs was largely produced in this area.

Sheep. Sheep were the only animals that required constant care and were maintained by a shepherd to keep predators away, as well as help keep them herded together. They were the first livestock animal to be tamed by humans because of their timid and defenseless characteristics.

There are over 200 breeds of sheep in the world today. The present day sheep came from wild sheep called moufflons and the Asiatic Uria, as well as the wild big horn sheep of Asia. The only sheep native to North America includes the big horn or Rocky Mountain sheep. The present day sheep came from imports from the beginning settlers. Sheep were generally used for their wool production by the settlers, and were predominantly found in the northeastern part of the United States.

Goats. Goats were imported from Switzerland and were mainly used for their mohair and milk. They are descendants from the pasang or Grecian Ibex found in Asia Minor, Persia, and other countries.

The main differences between goats and sheep are that goats have a less stocky body with shorter tails. Sheep tails always go down, whereas goat tails always go up. Additionally, the horns on goats grow upward, backward, and outward, versus a spiral twist of horns on sheep. Furthermore, male goats have a beard and give off a strong odor during breeding season.

The main difference between the two is that goats are more intelligent and can fend for themselves while sheep cannot. If goats were to be wild again, they would be able to survive, whereas we could not say the same about sheep. Most goats are found in the western part of the United States, and Texas possesses the largest number of goats in the United States.

Horses. Horses are native to North America, but they disappeared before Europeans came to the New World. Therefore, Christopher Columbus

reintroduced the New World with horses during his second journey over to the United States in 1493.

Horses evolved from a foot-tall swamp-dwelling four-toed drawn horse, Eohippus. Since oxen were more commonly used as draft animals, horses were mostly used as pack animals and for riding. Now, horses are primarily used for racing and riding.

Poultry. Poultry and eggs were used for food for quite some time, but it is only recently that the poultry industry has become a major commercial entity. The chicken originated from the Gallus-gallus, which was found in India.

Chickens were brought to the New World by the early colonists and explorers. In the 1850s, poultry shows began to exhibit and recognize the different breeds. The poultry industry is prominent in the southern United States, and small flocks are virtually non-existent. This vertically-integrated industry is trying to keep up with the high demand from the consumers. Chicken consumption is the only one set to increase over the next 10 years.

4. Livestock Industry: Then and Now

Livestock industry-- then and now. During the Civil War, the livestock industry began to see changes. Instead of slaughtering animals on an as-needed basis, animals began to be slaughtered in excess during the winter months. They did this because they would not be able to maintain them due to harsh winters, and they would preserve the meat into jerky.

TEXT ON SCREEN - [Chance Brooks, Ph.D. – Associate Professor, Meat Science – Texas Tech University]

Meat has always been used as a morale builder among army units because it's a perishable item, and so it's not readily available. And so if you were going to provision troops with meat, it was a rare occurrence, and it was actually a unique opportunity for them that helped build morale.

And so there was a packer by the name of Sam Wilson, and he actually provisioned troops by sending over meat packed in barrels. And they stamped on the outside of the barrels "US." And so when the troops saw the barrels packed and marked with "US," they knew that they were getting a care package from Uncle Sam Wilson. And so Uncle Sam actually became a spokesperson for the United States because of that. Additionally, technological advancements such as barbed wire helped shape the livestock industry to what it is today. These new inventions helped improve the efficiency of their herds by keeping them contained in certain areas, protecting them from predators, and making the best of the lands they are grazing on.

Furthermore, science advancements, such as artificial insemination, helped farmers and ranchers increase their herd size, which would increase their production and income for the years to come. Also, with the use of artificial insemination, the process of breeding animals can help prevent injuries from the bull, boar, or ram mounting the cow, sow, or ewe.

There are also cases where there is a surrogate female used to give birth to the animal after an embryo transplant has occurred to protect the health or stability of the female who provided the egg. This procedure is also known as embryo transfer. Another scientific advancement that has helped the livestock industry is an ear implant.

TEXT ON SCREEN - [Gary Smith, Ph.D – Monfort Endowed Chair in Meat Science, Colorado State University]

Well, usually if you hear someone in the industry talking about growth promotants, they talk about growth hormones. And of course, we don't ever use growth hormones. We don't administer those to cattle. We do administer some hormones that are growth promotants, but they're not growth hormone because that happens to be bovine somatotropin, which only the animal produces and only the animal can really use.

So what you're talking about is we're using estrogen or testosterone or progesterone in different forms to cause the animal to do a tiny bit faster

growing process and to increase the amount of bone and muscle as opposed to fat deposition as they're growing.

Now, the livestock industry ranges anywhere from small ranches, which are characterized to consist of animals ranging from five to 100 head, to concentrated animal feeding operations, CAFOs. CAFOs are largely operated facilities that raise animals in a confined area and provide management over the animals, such as feeding them, cleaning their environment, as well as taking care of the animals' health by providing vaccinations and disposing of the dead animals.

The animals being raised in CAFOs get their food brought to them rather than them grazing and roaming to find food. Also, CAFOs provide a high number of animals produced to assist in meeting the demands and needs of society for food.

TEXT ON SCREEN - [Gary Smith, Ph.D – Monfort Endowed Chair in Meat Science, Colorado State University]

Concentrated animal feeding operations are simply any place where you assemble a large number of animals so that the workers' inputs can be directed toward more animals in any given period of time. And again, it's one of those things that we try to do to increase production efficiency and also to provide a place for those animals to do whatever they're supposed to do-- lay eggs, produce meat, produce offspring-- in as effective means as we can, protecting them from the effects of the environment.

The livestock industry faces criticism on their practices, such as treating their animals with antibiotics and hormones to increase their animal production and receive a larger sum of money for their animals. These practices are done as part of animal welfare and are used to prevent and treat diseases or infections from occurring throughout their stock.

With ranchers vaccinating their animals to prevent future diseases, they are promoting their stock's health by proactively taking action and not allowing

the disease to become an epidemic outbreak and potentially harming every animal.

With the animals being managed closely by the operators, the quality of the animal's health will improve since there is always someone monitoring their activity. This, in turn, solidifies the fact that the animals are being well managed and safe to be processed to meat for consumption.

5. Marketing Livestock

Whether it was taking their animals around behind the house to slaughter or driving them thousands of miles to the market, many ranchers found a way to get their product used or sold. Cowboys came about because many ranchers hired these men to take their herds to market instead of paying the rather pricey cost of using the railroads. With the idea of Manifest Destiny, settlers began moving west. Over the years, the methods in which livestock were marketed have changed.

TEXT ON SCREEN - [Chance Brooks, Ph.D. – Associate Professor, Meat Science – Texas Tech University]

The industry became to be more commercialized. We actually saw that it was very centralized. And it was very centralized around the major markets, one of those being Chicago. If you look at Cincinnati, it was actually nicknamed Porkopolis, because so many pigs were actually marketed and harvested in Cincinnati. So those markets were very centralized. And that's why the cattle and the pigs had to be taken to those markets for harvest.

But as the population began to grow around those areas, space became a precious commodity. And so most of the processing plants were built up. And it was not uncommon during that time for plants to harvest multiple species. And they would actually segregate those carcasses by putting them on different floors of multistore processing plants, just because space was a commodity. But as the industry evolved and we began to decentralize the industry, the processing industry moved away from those centralized areas and established itself in areas where cattle were more

predominant, where pigs were more predominant, where feed sources were more predominant, so we saw a decentralization of the area. And that's when we started to see larger processing plants, and that's when we also started to see plants focused on one single species in their harvest facility, because they basically wanted to specialize so that they could do one thing and do it well.

With the population increasing, the demands for food also began to increase. The producers had to keep up with this newfound demand. And ranchers began cooperative markets, where they would join forces with fellow ranchers to split costs and hopefully achieve a larger profit. Fairs and shows began to allow producers to sell and show off their animals. Now, these fairs and shows have changed to exhibit these animals for their superiority compared to the others in the show. The winners are now auctioned off to the highest bidder, receiving the slaughtered animal for their consumption.

Also, with a different goal in mind, there are auctions where the animals are sold to breeders and people interested in improving their stock. Breeders take their new animals back to their ranches and use them to increase the number of animals, as well as the productivity of that animal. In addition to selling and harvesting animals, there are initiatives present that provide funding for research and promotion for every product sold.

There actually are incentive programs that are in place that are used in the industry. The most common are the Checkoff programs. And the way these are designed is that $1 of the sale of an animal actually goes into a fund that is regulated by USDA that is used to support the promotion and research, development, and marketing of meat products. And so those monies are actually regulated by industry boards, also known as National Cattlemens Beef Association and the National Pork Board, and also administered through the Cattlemens Beef Board, where monies are actually allocated for the promotion, as well as the research, to ensure the safety and quality of meat products so that we have a viable industry that

continues to move forward and is technologically advanced and on cutting edge to provide a safe and satisfying product to consumers.

Marketing meat and meat products. Once the animals are fed out for the proper amount of time for production, they are hauled to the market, sold, and then sent to the processing plants.

TEXT ON SCREEN - [Chance Brooks, Ph.D. – Associate Professor, Meat Science – Texas Tech University]

Animals can be sold to packers in two ways-- on a live weight basis and on a carcass grid basis. Live weight basis is simply marketing cattle based on their live weight, where a price is paid per pound. When you market carcasses on a grid, you're actually marketing or selling the animal based on its carcass characteristics. So typically, animals are harvested and then presented for grading, at which time USDA grades are assigned. And then the value of that animal is determined based on its weight, as well as its quality grade and yield grade using a predetermined grid or pricing structure that was agreed to between the producer and the packer prior to harvest.

Quality and yield grading play an important role in the marketing of meat products.

TEXT ON SCREEN - [Chance Brooks, Ph.D. – Associate Professor, Meat Science – Texas Tech University]

Meat grading is actually used to market meat products. And so the way the grading is implemented in the industry is, it's used to sort carcasses from a very diverse or heterogeneous group into smaller, more homogeneous groups, so that they can be direct marketed to specific markets. And so basically, the way it works is, in a processing facility, a lot of animals are brought in and they're harvested. And then those carcasses are sorted by USDA grader into smaller, more homogeneous groups, so that then those smaller groups can be taken into fabrication and broken down into smaller pieces for marketing of meat products. So the grading system, in essence,

is basically set up to market animals. And that's why it's administered by the USDA agricultural marketing service.

Yield grades are heavily utilized to determine carcass value among all species of red meat animals.

TEXT ON SCREEN - [Dale Woerner, Ph.D – Assistant Professor – Colorado State University]

We talk about grading systems for each of the individual red meat species. Of course, for beef carcasses, we'd have both quality and yield grading to indicate the value of the overall carcass. The pork industry, we're primarily concerned with the fragments of that animal, but also the amount or percentage of lean that's produced from an individual animal. And then in similar fashion, the lamb industry utilizes yield grades or relies on those very heavily to determine the value of the carcass and does use quality grade to some extent as well. Traditionally, or in the past, but also currently, red meat carcasses are evaluated using human subjective judgments.

We are starting to see instrumentation, or the use of instruments, becoming more common in our industry in order to really equalize the playing field or remove some of that subjectivity or human decision from that process. The most common instrumentation that we see is the use of video image analysis, both for beef carcasses, as well as lamb carcasses, and then also some other mechanical measures for the pork industry, including what we call the Fat O'Meter, which actually penetrates the carcass in order to assess or determine the thickness of fat, as well as the muscling of that animal.

Breeding procedures vary from species to species. Whether the process involves several factors or just a handful of different calculations, the process creates a common similarity amongst the thousands of different carcasses. Beef.

TEXT ON SCREEN - [Beef]

TEXT ON SCREEN - [Chance Brooks, Ph.D. – Associate Professor, Meat Science – Texas Tech University]

Beef carcasses are segregated into two grades-- quality grades and yield grades. Beef quality grades estimate palatability which is the tenderness, juiciness, and flavor of a cooked meat product. Beef palatability or beef quality grades are determined by measuring the physiological maturity of the carcass and matching that with a marbling score, which is the amount of intramuscular fat deposited in the ribeye at the 12th and 13th rib location. Beef yield grades are estimates of cutability and cutability is also defined as yield. Because muscling and trimness are the two biggest drivers of yield, those are the characteristics that are typically measured on a carcass. We measure the fat opposite the ribeye at the 12th rib location. We also measure the weight of the carcass. We estimate the amount of internal fat on the carcass. And then we estimate the size of the ribeye area. And those are then put into a formula to calculate yield grade.

Pork.

Typically, pork carcasses are not graded in a commercial processing facility. There are USDA grades for pork carcasses and they are based on cutability and quality.

TEXT ON SCREEN - [Chance Brooks, Ph.D. – Associate Professor, Meat Science – Texas Tech University]

However, quality is slightly different. Whereas most other quality grading systems are hierarchical nature, where they have a graded series of quality, pork is what we call a bipartite or dichotomous system, where it's either determined to be acceptable or unacceptable. But typically, yield grades are sorted out on a scale of one to four, with one being the most desirable and four being the least desirable. And it is based on a general muscling score and back fat measured at three locations.

Lamb.

TEXT ON SCREEN - [Chance Brooks, Ph.D. – Associate Professor, Meat Science – Texas Tech University]

Lamb carcass grades are divided into two general categories-- yield grades and quality grades. Yield grades are determined based on the external fat cover opposite the ribeye at the 12th rib. So trimming or trimness is the only quality or the only yield indicating characteristic that's currently used to segregate lamb carcasses based on cutability, which is their expected cut out or yield. Quality grades are estimates of palatability, so they are based on quality indicating characteristics of the lean.

One of the largest indicators or one of the largest factors that affects quality is age. And so the joints on a lamb carcass are actually used to determine the physiological age of the carcass, as well as the size and the shape and the condition of the ribs in the thoracic cavity. In addition to that, flank streakings or fat streakings in the flank muscles are also used as indicators of quality. And those are then combined with the conformation or the overall shape of the carcass to determine quality grade.

Packaging.

A lot has occurred in meat packaging in the last 100 years. In fact, we actually did not have meat packaging 100 years ago. Prior to packaging, most products were either further processed with smoke or cured agents or they were actually sold in carcass form under cold conditions before they perished. But the very first form of packaging that occurred was actually wooden barrels. And so meat was packed as tightly as it could be into a wooden barrel. And that's actually how we get the term meat packing industry.

Advancements in technology led to advancements in meat packaging.

The most common form of packaging was paper wrap. And we actually had wax-lined paper. And it's still often referred to as butcher wrap or paper wrap today and you still see it used in some custom butcher shops. But the

meat product was actually wrapped in that package and then the seams were actually taped together and it was marketed in that way. Then we had wax-lined boxes. And boxes were actually coated on the inside with a wax coating to help retard some of the elements, but to actually keep pieces of meat products or subprimals intact until they were shipped to their destination. And then what followed was vacuum packaging. It was much more sustainable. It was much easier to use. It resulted in a longer shelf life. And so subprimals were vacuum packaged and then placed in boxes and shipped across the country. And that's pretty much the method that's still used today.

Fueled by product safety, packaging has evolved over the years. However, product safety is not the only purpose for packaging.

The purpose of a meat package is to protect the product, but it also has other functions as well. And packaging is often used as a marketing agent or a merchandising agent as well. And so because of that, we see a lot of different types of packages that are used at retail. But most of the package types are matched to the product itself. Vacuum packaging is a form of packaging. We typically package meat products for preservation and to protect the products during shipping or retail display.

Vacuum packaging involves the use of a plastic film or pouch in which meat products are placed inside and then the air is removed or vacuumed out of the bag and the bag is sealed before the environment is allowed back into the chamber. So it's basically a vacuum protection or plastic film that is vacuumed around a meat product and sealed and then shipped. It creates an anaerobic environment, which is an environment that is devoid of air around the meat products. And it drastically improves the shelf life of most beef products.

Animal byproducts. Livestock does not only serve the purpose of providing meat to the world. It also provides fiber and skins for the production of clothing. The livestock industry provides conservation to the soil that they are grazing on, as well as fertilizing the land as they go. In many cases, the manure from the animals is collected and then processed to create

extremely nutrient-rich fertilizer. Animal byproducts are valuable to society and can also be used to make perfumes, candles, lanolin, and glycerin.

TEXT ON SCREEN - [Chance Brooks, Ph.D. – Associate Professor, Meat Science – Texas Tech University]

Byproducts can actually be divided into two categories-- edible and inedible. The edible and inedible ratings are actually based on whether or not they are edible and inedible for human consumption. There are some inedible byproducts that actually could be fed to some species, even though that's highly regulated by the industry. But among edible byproducts, we typically break those down into variety meats, which are edible organs and glands, as well as other products that are typically sold for cooking agents, such as fats and oils.

The most common animal byproducts of probably the most value is a hide. Most of the skins or the hides are removed from animals during the harvest process. And they're used for a variety of purposes and probably the most diverse use. We also get-- a number one byproduct of the harvest industry is also fats, tallows, and oils. They can be used as lubrication. They can be used for cooking agents. And then they actually can be broken down into more simple components and used for everything from explosives to leather conditioners.

Additionally, the rendered meat can be made into a stew and used to make tinned dog and cat foods. For the inedible products, the fat is then dried and ground to create meat and bone meal. Paint brushes that artists use are made from the hairs found in the animal's ears. Additionally, the animal's bones, horns, and hooves are used to produce glue, buttons, sandpaper, dice, piano keys, and toothbrushes. Plants that render meat are marked with an offensive odor and are often far away from homes and towns where people would be subjected to the smell.

Furthermore, many medicines used by humans have been made from animal byproducts. Insulin, which is used by diabetics, is taken from the pancreas of animals. Cortisone that is used to treat rheumatoid arthritis,

adrenal insufficiency, some allergies, diseases of the connective tissue, and gout is taken from the adrenal glands of animals. Thrombin is from the blood of animals and is used during surgeries to help make blood clot, as well as in skin graft operations and the treatment of ulcers.

Rennet comes from the stomachs of cattle and is used to make cheese, as well as assist babies in digesting milk. Epinephrine comes from the adrenal glands as well and is used to treat some allergies and relieve the symptoms of hay fever and asthma. Heparin comes from the lungs of animals and is used to prevent blood clotting during operations and helps prevent heart attacks. Corticotropin comes from the pituitary glands of the brain and is used to treat breathing problems, allergies, mononucleosis, and leukemia.

TEXT ON SCREEN - [Jayden Montgomery, Ph.D – Senior Project Director - Targacept]

In the US, new chemical entities are regulated, especially for livestock and the animal industry, through the Food and Drug Administration.

Once the livestock animals have been harvested, they are now a part of the food industry. The livestock and food industry work hand-in-hand with one another to create a quality and safe product.

TEXT ON SCREEN - [Mindy Brashears, Ph.D – Professor, Food Microbiology and Food Safety – Texas Tech University]

The livestock industry and the food industry are very much related to each other. Livestock, whether it be cattle or poultry or dairy animals, actually provide much of the food that we eat. So the livestock industry and the food industry have to work together to make sure we have the highest quality and the safest food supply that we can possibly have.

The livestock and food industry have faced and overcome challenges over the years, whether the concerns were with food safety or with the correct

sanitary procedures from the processing plants. The two industries continue to pave the way for a better, safer food supply for the public.

Some of the major events that have affected about the food and the livestock industry are things like foodborne pathogen outbreaks. Whenever we have an outbreak-- a large outbreak of a foodborne pathogen-- it will negatively affect cattle prices if it's related to beef or the price of eggs if they're associated with eggs. So these things are very important. Another thing that comes to mind is the relationship between the livestock industry and antibiotic resistance. Now, we have no data that say that feeding antibiotics in cattle at low levels actually impacts the amount of resistance in humans. But there is a perception that that could happen. So we have to be very careful about what we do in the livestock industry and make sure that it doesn't have an impact on the food and ultimately on our human food supply.

Even with interventions and efforts made to keep outbreaks to a minimum, unfortunately, mistakes still happen.

In 1993, we had a major foodborne outbreak with E. Coli 0157:H7. And this was linked back to undercooked hamburgers. And this completely changed the face of the food industry, because we implemented more regulations at the food industry level to prevent pathogens from getting into the food supply. And this includes implementation of HACCP and also testing programs. Also, processors took extra care to make sure their product was safe and started processing under different conditions where they could track and trace the product and have an easier recall to make sure that the consumers were protected from another outbreak, so that it wouldn't happen.

The livestock and food industry are constantly striving to improve the quality and wholesomeness of their products. With advancements in technology and new standards being created, the livestock industry can take preventative measures themselves, reducing the risks for future problems.

TEXT ON SCREEN - [Mindy Brashears, Ph.D – Professor, Food Microbiology and Food Safety – Texas Tech University]

The livestock industry can be proactive, because we know that there are things that can be done in the live animal, and this is referred to as pre-harvest food safety. And some of the things that are available are vaccinations for cattle for a coli or feeding of direct fed microbials. And both of these options can actually reduce the number of E. Coli in the animal before they go to slaughter or harvest. And there's also vaccinations in poultry for Salmonella. So implementation of these types of interventions or using best practices, which are just guidelines to keep your farm clean, the housing clean, the bedding, those types of things, those can also go a long way in improving food safety.

6. Career Development and Entrepreneurship Opportunities
The livestock industry is a broad and important industry with several different career opportunities as well. Whether you are interested in science or business and have a passion for the livestock industry, there is an opportunity to develop a career and potentially your own business.

TEXT ON SCREEN - [Dale Woerner, Ph.D. – Assistant Professor – Colorado State University]

There is a lot of careers that are developing in our livestock industry that revolves around the use of technology and information sharing. I see a lot of jobs in computer design, software design. Those would be non-traditional jobs.

But in the food industry, we'll still have to have the traditional jobs. We'll always have the need for agricultural producers, whether they're farmers or ranchers or feedlot operators. We'll always have the need for those types of jobs. But certainly those people entering those jobs will have to have a great deal of background in technology management and have a great understanding of computer systems specifically.

Potential careers can include, but are not limited to, positions as a public relations specialist, geneticists, agribusiness manager, college professor, veterinarian, animal economist, and government administrator. In most cases, careers in the livestock industry require a minimum of a bachelors degree. And in certain careers, it is required to have furthered your education to receive a doctorate or law degree.

TEXT ON SCREEN - [Hugo Irizarry – Director of Value-Added Products, Category Manager of Swift & Co. – Greely, CO.]

When I first got to Excel Corporation, or Cargill, I was a little frustrated because having a Master of Science I was on the same level as some of the supervisors that had come up through the ranks. But quickly, I learned that there is a lot more to learn when you get out in the real industry besides what you learned in college.

TEXT ON SCREEN - [Brad Johnson, Ph.D. – Gordon W. Davis, Regent's Chair in Meat & Muscle Biology – Texas Tech University]

The best part of my job-- and I've been in academics my whole professional career-- I really enjoy the students, and not just graduate students, but also undergraduate students. I currently advise and teach undergraduate classes as well as advise many graduate students and teach graduate level classes.

But you know, one of the best things that I like about my job-- and I have many students come through my door and asked me for a reference letter, for example. And they kind of do it a little bit sheepishly like, well, Dr. Johnson, I really need this letter, but I know it's a lot of work for you.

And I have the same message to an undergraduate student that's applying for a scholarship or one of my doctoral students that's trying to get an academic position at another university. That is the part of my job that I enjoy the most because that's why I went into academics is to educate young people. And the capstone of that is being able to put those thoughts on paper about young men and women and how well they did.

As you can see, the livestock industry is an integral part of agriculture and is as complex and diverse as the people and animals involved in it. The livestock industry has come a long way from letting animals roam and graze freely to concentrated animal feeding operations. Additionally, the uses of the animals have also changed, and now the byproducts are helping humans medically as well as meeting their wants for items such as makeup, candles, and clothing.

Methods of how we get these animals to market have also changed, along with the high demands of meat from the consumers today. This industry will continue to grow and change with the constant advancements in technology and new innovations developed daily.

The livestock industry has been a successful industry, withstanding countless obstacles. Questions have arisen concerning whether or not the agricultural industry will continue to be maintained and supported by environmental resources and human labor.

TEXT ON SCREEN - [Chance Brooks, Ph.D. – Associate Professor, Meat Science – Texas Tech University]

One of the issues that we have to deal with, that's often asked, is the agriculture industry sustainable? We typically define that in simple terms as this-- are we going to be able to produce enough meat in a safe and efficient way to be able to feed the increasing population? And so one of the things that we have to contend with is are we a sustainable industry? We don't want to be able to produce meat products at a detriment to the environment or to society.

And I'm proud to report that in agriculture, we are a very sustainable industry. What we find is that we have the ability to utilize technologies that have been developed so that we can efficiently raise animals for meat production to feed not only our country but other third world countries. And so one of the things that we really have to focus on is that we have to be environmentally friendly and conscious.

A lot of people often think that that means going back to the old ways. But if you actually look at what technology enables us to do, we can actually produce much more beef now using technology than we could 20 and 30 years ago. And it comes at a saving in grain. It comes at a saving in water because animals are actually more efficient, and they actually produce more pounds. So that means that we get more pounds of beef per animal marketed than we could 30 years ago. And that is the only way that we are going to be able to sustain this industry for future growth in population.

Instructions for Day 2, Feed the World

If you have access to iCEV sign on to watch the videos or at least read the video transcript.

After reviewing the materials, research distribution patterns and costs for a farm or ranch. Follow all the instructions for the project “Distribute to the World.”

Global Agriculture: Feeding the World

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Part 1

Global Harvest Initiative is five different companies right now, most of them agribusinesses, or associated with agribusiness. And it's John Deere, Monsanto, DuPont, IBM, and Elanco. And we've come together to look at some of the challenges of feeding the growing population between now and 2050. And we believe that to do that, agricultural productivity needs to increase. And so we look at different policies that really promote or foster development and agricultural productivity growth.

Most of these businesses have a long tradition in agriculture and really understand what it takes. And so they just really want to be kind of the think tank of the private sector to say, here's our point of view on policies that are successful in promoting development. And agriculture development has shown that that's what brings people out of poverty in these developing countries, because of a lot of the people that are malnourished or in poverty are also farmers. They farm a small plot of land. And developing and giving them tools and showing them a sustainable way to farm helps them help themselves.

Things are better when they're in a competitive situation. And I think in the end, that competition will make things better. Things will work out such that wherever the comparative advantage is, whether that's in America or whether that's in Europe or somewhere else, that competition, I think, is good. It makes both countries better.

There's just going to be a lot of change, a lot more people moving to middle class. And so I think there's plenty of demand that could be met by everybody. I really do believe that it's going to be everybody's productivity needs to increase to meet these demands. Today we have 7 billion people, and by 2050, we're going to have over 9 billion people. That's 2 more billion people that are going to have different needs than what people born today have. And so they're going to have a bigger impact on everybody's lives.

I do think it is possible to feed the growing population and also keep it affordable. We've seen that when you invest in research and when you invest in and adopt science-based technologies and invest in infrastructure and have trade rules that allow food to move, that those policies work. And we've looked at case studies and examples of different countries where their productivity shot up when they do the investment.

However, as soon as investment stops in any of those, then instead of that gradual increase that you need, then you just kind of see it tapered off. So the more that

Global Agriculture: Feeding the World

people understand that and what drives productivity, and the more that policies continue to reflect that, then I think we can make it. Maybe the easier part is producing the food. The access to food is another issue that still needs to be addressed, because even in America, I think there's 14% of people that are considered food insecure, don't have daily access to food when we export a lot of agriculture commodities and food. And so there's still an access issue all around the world that needs to be addressed at the same time if truly everybody's going to be fed by 2050.

Worldwide, our problem is not the food supply. We have enough food to feed everyone. Our problem is in distributing it. Do we just give everybody, North Korea and all the countries in Africa that are suffering drought, do we just give them the food? Well, 100 years ago, we decided no, we'll go teach them how to farm and ranch. And that has not worked.

And so we still find ourselves trying to ship the food. And then it becomes a matter of, are you really helping people by continuing to send them food? But I think we still sort of cling to the idea that's trying to be promoted by the United Nations, that if we can teach them how to fish rather than giving them a fish, we'll ultimately help them and the next generation. So somewhere in between is that balance of getting the food supply distributed to the right people.

I think in the future, primarily because we have to feed 9 billion people by the year 2050, there are going to be a whole bunch of people who were critical in 2012 of the way we do it. In 2050, people won't care how we did it. And so we are going to have to be very, very careful about what we do, because the overwhelming need to prevent malnutrition, the overwhelming need to just have something for people to eat could very easily lead us and many other countries to the point that we say, well, let's just produce it. To heck with whatever the outcome might be. Can I produce this food by using these technologies without, in fact, endangering public health? And so I think it's going to be a great challenge for us to do that. But feeding 9 billion people is just almost an unbelievable task.

Distribute Your Product

Directions:

For this project you will research distribution patterns and costs for a farm or ranch.

1. Imagine you are the owner of a farm or ranch and you want to distribute your produce to somewhere other than North America. You will need to research the best way to distribute your food product in the most cost effective manner to another continent.
    A. Steamship
    B. Airplane
    C. Train
    D. Combination

2. Write a one-page report explaining your product, the continent you selected and the distribution method. Remember to cite all sources.

3. Present your business, product and where it will be distributed as well as how it will be shipped. You can construct a poster, PowerPoint® presentation or brochure with the information.

Instructions for Day 3, Intro to Biotechnology

If you have access to iCEV sign on to watch the videos or at least read the video transcript.

After reviewing the materials, you may collaborate with another student or work by yourself to complete the project. Follow all the instructions for the project “Biotechnology: Company Presentation.”

Introduction to Biotechnology

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Part 1

CEV Multimedia presents Introduction to Biotechnology, a video active presentation. The goal is to offer an overview of some of the capabilities and potential of biotechnology. The objectives are to understand basic principles of molecular biology, to understand some of the applications of biotechnology in plants, to understand some of the applications of biotechnology in animals and medicine. Biotechnology is a rapidly expanding field. Scientists are continually learning about the fundamental unit of life, the cell, and the way it forms an interactive web with other cells.

What we're talking about is the use of the techniques of molecular biology to manipulate genes and gene products in medicine, and also, in the field of agriculture.

Depending upon the imagination of the people that are involved, there are so many things that could theoretically be done.

New technologies are advancing so quickly. In a very short period of time, we should be able to transfer a gene from one animal to another with relative ease to affect things, like human health, animal health, animal performance, survival in hostile environments, et cetera.

Part 2

The smallest unit of life capable of independent existence is called a cell. The genetic instructions needed to make an entire organism are located in chromosomes within the nucleus of a cell. Chromosomes are made of a molecule called DNA.

Each specific building instruction of an organism is recorded as a gene within the DNA. Genes control traits within the organism. Everything from eye, hair, and skin color to the inherited disabilities and diseases such as hemophilia, cystic fibrosis, or cancer.

So genes are responsible for the differences between individuals. The corn on the left is genetically different from the corn on the right. They're the same species, they're the same corn, they just differ in one or two genes, as much as people with different eye color, skin color can differ in just one or two genes, and this diversity is critical for plant breeding, because that's what provides the genetic basis for selecting plants with new traits.

In nature, there are two ways life reproduces and passes on genes, meiosis and mitosis. Fertilized eggs undergo mitosis to produce a completed organism. In mitosis,

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body cells duplicate. This is how virtually everything in the human body develops and is maintained. In plant tissue culture, mitosis can be used to produce cells with the capability to generate identical clones from the cutting of a parent plant.

Meiosis results in cells having only half of the required set of genes. During fertilization, a male haploid cell or sperm fuses with a female haploid cell or egg to produce a cell that has a complete set of genes. This is called sexual reproduction, and it occurs in nearly all multicellular organisms. If a breeder wants two particular traits to appear in the same organism, the breeder would breed two organisms together, each parent's having one of the desired traits. For example.

If a breeder wanted to transfer some of the stress tolerance from this line of corn to this, then pollen from the tassels could be transferred to the cells on the ears at this point and then the offspring could be selected for increased stress tolerance.

Distantly related organisms cannot breed. Under natural conditions, crossing genes of an animal and a plant is impossible. The biotechnology in transgenics are offering new tools to scientists.

But they would be very interested in inserting into grapes the genes for called hardness of those could be found. There are fish that survive under extremely low cold temperatures and those genes have been taken out of fish and there is interest in putting those into various crops to see if they also can confer cold hardiness on those crops.

When an organism receives a new gene such as a great plant receiving the fish gene, that organism is said to be transformed or transgenic.

Transgenics can be simply explained as the transfer of a gene into another organism. Whether that be taking a gene from one bacteria and putting it into another bacteria or a gene from one mammal, such as a cow, into a different mammal like let's say a pig. When we add transgenic genes to bacteria or single cells, such as a muscle, we have no way of telling if that muscle cell or that bacteria is different from a normal bacteria because a transgenic cell will look just like a normal cell, so we incorporate what are called marker genes.

Marker genes are genes that are incorporated into the animal to identify-- visually identify-- a transgenic animal. They can be everything from coat color, fluorescence, and antibiotic resistance. When we talk about single cells or bacteria, that's usually a fluorescent marker. When the gene of interest in our marker gene or both incorporated into that cell, it'll show a fluorescent color, be it green or red, that is a protein that's been isolated from a jellyfish. So we've taken jellyfish gene and put it into a pig cell or bacteria cell and had that jellyfish green fluorescent expressed in a

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non-jellyfish animal.

So under a microscope, we can immediately say, yes, this cell here has our transgene or this cell does not have a gene.

Part 3
Genes for specific beneficial traits can be isolated and inserted into a plant species, creating a transgenic organism by adding to its genetic code.

The most commonly used method is agrobacterium.

Ordinarily, this bacterium infects plant cells by injecting some of its genetic material into a cell, and using the cell to create its food.

We've replaced the bacterial genes with the genes we want to put in the cells.

When these bacteria infect cells, they transplant the gene of interest into the cell's chromosomes among the cell's original genes.

There are mechanisms which aren't understood that get the DNA from the bacterial cell into the plant cell, and once into the nucleus, into the chromosomes. I'd say the overall goal of plant biotechnology is to improve agriculture, whether that means through reducing the costs of allowing crops to grow under more marginal areas, increasing the quality of the crops.

Some agricultural qualities scientists would like to enhance in plants include resilience, herbicide resistance, harvestable quantity, flavor, nourishing quality, and spoilage resistance. There are many benefits to growing crops in places where it was previously not possible.

We're actually doing grape varieties that are tolerant to salt, which is a big issue for areas in which they grow a lot of grapes that have limited water, and the water that you do have may be very salty, and maybe very low-quality water, yet, you could still be able to grow the grapes that are very good and have high quality.

As agriculture gets pushed further and further, we're going to have to use more marginal areas, areas that maybe are traditionally too dry.

If genes could be found that defend a plant from insect, fungi, viruses, and bacteria, then losses could be greatly reduced.

Already existing in nature are thousands and thousands of compounds which, for as long as we have been growing plants, have conferred to those plants some selective advantage. What we would like to do is to design plants with those compounds to

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meet our needs, for instance cotton plants, grapes, most vegetables, tomatoes, carrots, in this case, onions. All of those are susceptible to soil-borne pests, which, when they attack them, they can either kill the plant, or they can render it so that it's useless horticulturally, and then we can't eat that.

There is a corn called BT corn. There is also BT cotton. And "BT" stands for "Bacillus thuringiensis," a soil-borne bacterium. It was found when insects fed on this, they died.

Well, if you can incorporate, into the leaves themselves, this BT gene, then what happens is the insect ingests protoxin, and the larva dies. This means the growers don't have to spray their fields.

I read an article this morning about pesticide use in China on BT cotton, and they've been able to go from 15 pesticide applications to one pesticide application a season, which is incredible.

So it's cheaper in the long run, it's much better for the environment in the long run, and it is good for the consumer.

If we don't use BT, then the farmers are going to have to spray with conventional pesticides. In a few weeks, there'll be a bloom, an increase in aphids. Those conventional pesticide applications will kill the beneficial insects, the insects that eat the aphids, things like ladybugs.

Part 4

Some plants are engineered to be immune to herbicides. This enables the farmer to apply herbicides at more inopportune times, increasing production.

Farmers using herbicide-resistant crops can do much less cultivation. And instead of controlling the weeds with mechanical cultivation, they control them with extremely safe herbicides. Where before, farmers would plow a field, plant the crops, and then have to cultivate that field to get rid of the weeds. And maybe four or five times, they'd have to drive a tractor, burning diesel fuel, through the field, compacting the soil, leading to more soil erosion.

Reduced mechanical cultivation means reduced fuel usage, reduced soil erosion, and increased water efficiency. A key concern is meeting the agricultural needs of an increasing world population. If more can be harvested from the same amount of land and water, humanity will be better equipped to address this concern. Cotton is undergoing research in an effort to increase the amount of cotton fiber produced from each plant.

If you can engineer or you can somehow select plants that have higher rates of

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photosynthesis, again, you can increase productivity on a given amount of land for a given amount of input of water and fertilizer input and pesticide input. And some of these lines, you can see, have a large number of flowers. Here's a large number of flowers and a large number of buds, which is good. Each flower has the potential to result in a bowl, and the bowl is where the cotton is formed. So more flowers can mean higher yield, more productivity.

Some plants can be genetically engineered to produce fruits and vegetables with more flavor and better color, increasing the enjoyment of a food. The reason that when you go to a grocery store and buy a tomato and cut it open and take a bite it tastes like sawdust is because to be harvested by machine, they need to be hard and firm, because the machines can't be gentle with the tomatoes. They have to be harvested green so they don't over-ripen by the time they get on the grocery store shelf.

By introducing these genes that slow down the softening, you can harvest the tomato later, after all the flavors have developed, but they'll remain firm and resistant to spoiling longer on the shelf.

This enables crops to be shipped further distances, stored for longer periods of time, and picked closer to ripeness, decreasing spoilage. Increased flavor is accompanied by increased nourishment.

Now, grapes are an example of a crop that is just packed with the antioxidants that we have heard a lot about lately.

In underdeveloped parts of the world where nutrition is lacking, a stable food can be engineered to supply missing proteins, vitamins, minerals, and other compounds, improving human health.

Rice traditionally is very, very low in vitamin A, and in fact, it's responsible for malnutrition leading to blindness and death in many poor countries where rice is the staple food. And golden rice is rice into which genes for the production of vitamin A have been introduced.

There is even work to make vaccines in plants, making immunization against diseases in underdeveloped countries more efficient and less expensive.

In the third-world countries, they don't have access to many of the medicines that we have here. And there is real need to provide for them vaccines.

If, on the other hand, you could ship a batch of bananas that carry the vaccine, that express the vaccine in the fruit, you can feed the kids the bananas, and they become vaccinated. This kind of technology certainly could save millions of lives in the third

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world, where childhood diseases, diarrhea, bacterial diarrhea, and things like that kill literally millions of kids every year. If you could vaccinate them by just eating a piece of potato or a piece of carrot or a piece of banana, it would be incredible.

Advances in agriculture offer more solutions to commercial farming businesses. By enabling more possibilities, humanity is better equipped to address concerns of nutrition, hunger, health, and well-being for an increasing population.

Part 5
Gene transfer technology in animals depends on the type of animal. Some of the animals of greatest interest include pigs, cattle, sheep, and goats. Though it is very difficult and costly, an entire organism can be generated from a single cell taken from another animal.

Cloning of sheep is a very important issue in animal agriculture for one primary reason. If we can get an animal that makes a large amount of wool, is a very high quality muscled animal that would help solve our needs of feeding the hungry people in the world, one of the best ways would be to copy that same animal over and over and over again.

Pig cloning was originally started as a way to make animals that had very similar meat quality traits and performance traits so that the expense of managing the pig could be minimized. However, scientists quickly realized, because of the similarities of the pig to the human physiology, that there was a possibility to clone pigs for human organ transplant.

Pig tissues and organs are currently being used in human medicine. For example, they currently take pig skin tissue and actually place it onto severe burns in a human and repairs that skin. They actually currently transplant pig heart valves into humans.

There are some people that have pig arteries and blood veins in their legs and arms that have repaired damaged arteries and veins. Current research is looking at using pig livers and kidneys to repair liver damage and kidney damage in humans.

Cattle, sheep, and goats don't make good candidates for human transplant, organ and tissue transplant, for one primary reason. They're entirely different than us. Their organs are of a different size, located in a different place, and actually perform slightly different functions.

The cow has been heavily studied both in normal agriculture production and transgenics and cloning. We have a significant amount of data and can do cloning relatively easily in cattle compared to the other three species that we talked about.

I think in 10 to 15 years, cloning sheep, cattle or pigs will be extremely affordable, and

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everybody will have the ability to do it, which will decrease the cost of producing animals, producing organs for transplant, producing transgenic compounds for administration to humans for disease. So I think that cloning has a huge potential to improve the overall quality of life of many people around the world.

By inserting genes, animals can be transformed into bioreactors, living factories of important chemicals.

Sheep and goats make an excellent bioreactor system because they have a very large and productive mammary system. It allows for us to add a human gene to their genome, allowing them to produce the protein from that human gene into their milk.

Cattle are also used as bioreactors. Again, the primary advantage to cattle is they have a very large mammary system and can produce thousands and thousands of gallons of milk per year that you can isolate a humanized protein out of. But a problem with cattle, as with the goats, is that it's hard to get human genes into these animals to produce human proteins.

The reason pigs have become a candidate for bioreactors for human compounds is because of how closely and similar their organ tissue and physiological systems are to those of humans. Pig proteins look a lot or are very similar to human proteins. And so while researchers have used larger milking machines like cattle and goats, they've come back to the pig because the proteins that they produce very closely resemble the proteins that a human produces.

So when we isolate a protein from their milk and inject it into a human, there's a far less chance of an immune reaction to that than there would be from cattle or goats or sheep because the pig has the similar reproductive, digestive, and overall physiological systems that humans do.

Perhaps a gene transferred into cattle will enable them to produce enough human blood clotting factor to treat patients with hemophilia or perhaps transplanted organs will be able to produce insulin and cure diabetics. But what about small animals, such as pets?

Every year, the United States spends something like $5 or $6 billion treating diseases in pets, in dogs and cats mainly. If we had accurate information on all the genes in cats and dogs, it would be possible to breathe out these genetic defects that cost so much money and cause pet owners so much grief.

There's a large number of people in the United States who are deathly allergic to cats, and this is mainly because of a particular gene in the cat that makes a protein present in the saliva of the cats when they groom themselves, and this is mainly responsible

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for the very violent reaction that a lot of people have against cats.

Now, it's perfectly reasonable that we could find this gene and remove it from the cat genome. We could breed strains of cats that were not allergenic. And once again, you could look at a tremendous saving of money and grief. Lots of people want to have cats, but they can't have cats because they're so allergic to them.

Colonies of specific types of cells can be produced that ordinarily couldn't be produced so quickly. In the human body, lymphocytes produce antibodies which neutralize bacteria, viruses, and even cancers. These antibodies are key in the body's defense against disease. Cell cultures can produce large amounts of antibodies, which can be tested, studied, and manipulated to treat diseases such as cancers or infections.

There's a lot of effort going on in terms of trying to understand disease processes on the molecular level-- cancer, heart disease, genetic inherited disorders. The DNA of the human genetic constitution has been read. That is, all the letters in the genetic alphabet are being translated.

And it should help us in the long run to understand a lot of genetic diseases. If you understood them, you could probably design drugs and therapies that would act against a debilitated genetic constitution and would predict people who were at risk for heart disease, for strokes, heart attacks, and so forth. And autoimmune diseases are a huge problem in the United States.

Rheumatoid arthritis, of course, is a big blockbuster disease-- diabetes, lupus erythematosus, Crohn's disease, Hashimoto's thyroiditis. So there's many, many different diseases. Autoimmune diseases are going to be one of the big frontiers of research in the coming years. They affect many, many people, and they're not well understood at all.

Part 6

These are just a few of the possibilities associated with biotechnology. Continued research offers a host of possibilities, however this new technology is not without its risks. As with all new technologies, there are controversies. Since biotechnology has such a broad scope, it has an equally broad range of concerns. What if herbicide-resistant genes accidentally make their way into weeds and they grow out of control? Could some of the genes cause the organism to produce toxins that aren't detected? What if new agricultural products kill important insects or other animals in the food chain? Could a hostile terrorist organization use this technology to unleash a worldwide epidemic?

Fortunately, since the technology is still being developed, some of the controversy is

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more science fiction than it is science. So it'll probably be a long time before anyone has to worry about humans being cloned or genetic warfare. Nevertheless, concerns are being addressed by ethicists, politicians, sociologists, and others. It's the other questions that keep the research going. What if we could feed all of the Earth's population? What if there was a way to cure all cancer? Is it possible to eliminate certain diseases in developing countries?

Who knows? With time, dedication, and cooperation, we may be able to find the answers.

Biotechnology: Company Presentation

STUDENT PROJECT

Directions:

You are a design and production team for a small biotechnology company. Your company has developed a genetically altered food product, but does not have the money to pay for the production and marketing of the product to the public. However, your company has been invited to present at an Agricultural Technology Conference. The purpose of this conference is to give small companies a chance to sell their product ideas to large funding companies. The conference has asked you to prepare a two to five minute presentation incorporating at least one poster or major visual aid which describes and illustrates the idea. Before the conference begins, you must complete the following tasks:

Part 1: Create a Company Name and Product

Create a catchy name for your company. Then, brainstorm a list of items you want to genetically change (using the "Possible Products" list as a guide). Analyze the various products and discuss the potential benefits to society. Select which item to change and describe the information on the *Planning Page.*

Part 2: Determine your jobs

Review the four job positions within your biotech company. Discuss which jobs would be best for each team member. Write the group member's name next to the corresponding job title on the *Planning Page*.

Part 3: Getting To Work

Begin working on your formal poster and presentation outline. Assign each group member a specific task and deadline. Discuss ideas as a group and add needed information to the official *Planning Page.*

Part 4: Practice and Prepare your presentation

After your display board has been designed, you are ready to prepare for the formal presentation. The presentation should address the product's benefits and discuss how the company changed the product genetically. All group members, should be prepared to address questions from the audience and be able to discuss what they contributed to the project. It might help to follow these steps:

- Determine how the presentation will be given.
- Predict what questions may be asked and how to answer them.
- Practice and time your presentation, speak clearly and loudly.

Biotechnology: Company Presentation

Possible Products List

- Non-mushy banana
- Carnivorous crops
- Flavored fruits or vegetables
- Mold-tolerant fruits and vegetables
- Crops which can grow in salty water or damaged soil
- Faster growing trees or plants
- Products or flowers which glow in the dark
- Fruits and vegetables with added nutrients
- Medicine producing plants
- Pest-resistant crops
- Plants which grow more food
- Plants or vegetables where every part is useful
- Plants immune to bugs and insects
- Pollution-absorbing plants
- Flavored popcorn cornels

Biotechnology: Company Presentation

Company Positions

Presentation Spokesperson

- Explains in common language how biotechnology works and how the product has been changed, during the formal presentation.
- Discusses why the public will like this product better than the old one.
- Convinces audience member to provide financial support for the product idea.
- Oversees the entire project by delegating responsibilities to team members.

Presentation Supporter

- Acts as an “adminstrative assistant” to each group member.
- Provides support, materials, and ideas for each required activity.
- Helps write and organize the formal presentation.
- Helps finsh any out-of-class work which needs to be completed.

Product Design Manager/Graphic Artist

- Gathers materials and determines a design for the poster display.
- Designs and draws the before and after pictures of the product for the poster.
- Creates additional visual aids and advertisements where needed.
- Organizes and stores visual aid materials for later use.
- Verifies the accuracy of material through research.

Science/Copy Writer

- Writes the background information on what the product looks like and how it functions before genetic altering. (Added to poster)
- Explains how the product was changed and works with the graphic artist to create a DNA model or drawing of the “after” product and helps to produce a poster showing the benefits of the new product.
- Verifies the accuracy of material through research.

Biotechnology: Company Presentation

Planning Stage

STUDENT PROJECT

STEP 1

Company Name:

Selected Product:

Describe how your product will be altered and improved?

STEP 2

Presentation Spokesperson: _____
Presentation Supporter: _____
Graphic Design Artist: _____
Science Copy Writer: _____

STEP 3

Task	Group Member Responsible	Deadline

Group Member Evaluation

Assign each group member a letter grade based on the amount of work they contributed to the overall project, poster and presentation.

Group Members Name	Grade

Instructions for Day 4, Secrets of Soil

If you have access to iCEV sign on to watch the videos or at least read the video transcript.

After reviewing the materials, you will create a presentation to cover a topic of your choosing from the lesson to complete the project. Follow all the instructions for the project.

Presentation

Project Overview:
You will create a presentation to cover a topic of your choosing from the lesson.

Directions:

1. Choose a presentation topic based on topics discussed in the lesson. For example: soil orders, importance of soil, importance of soil texture.

2. Using all available resources, research your chosen topic. Be sure to use credible sources ending in .org, .gov or .edu when doing research.

3. Create an outline of your presentation highlighting major topics and points which will be covered.
    - The presentation should be no longer than five minutes but should thoroughly discuss the topic

4. Turn the outline in to your instructor who will approve the outline or help change the outline to improve the presentation.

5. Create your presentation in any format approved by the instructor.

6. Be prepared to answer questions about the presentation.

7. Once complete, turn in the presentation according to your instructor's directions.

Presentation

Rubric

Description	Possible Points	Your Score
Research & Organization: • Proper research was conducted to complete the assignment • Sources were cited appropriately based on instructions provided • Information was presented in a logical, organized manner	35	
Concept & Understanding: • Understanding of the concept is clearly evident • Effective strategies were used to achieve the end product • Logical thinking was utilized to arrive at the conclusion	35	
Creativity/Craftmanship: • End product is unique and reflects the student's or group's individuality • End product is clearly high quality	15	
Production/Effort: • Class time provided for the project was used efficiently • Time and effort are evident in the execution of the end product	15	
Total Points	100	

Additional Comments:

Field Trip: Dig It! The Secrets of Soil

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1. Introduction

[MUSIC PLAYING]

Dig It! The Secrets of Soil is a traveling exhibit brought to you by the Soil Science Society of America. The 5,000-square foot exhibition reveals the complex world of soil and how this underfoot ecosystem supports nearly every form of life on Earth.

TEXT ON SCREEN - [John Havlin, SSSA Fellow and past President, Department of Soil Science, North Carolina State University]

We wanted to develop K through 12 curriculum materials so that, when the exhibit was delivered to a city, that these materials could be delivered to-- or made accessible to classroom teachers to incorporate in their classrooms. One of the most amazing things to us that we didn't expect was we have a room inside the exhibit that houses what we call soil monoliths.

And they're a slice of the soil profile from the surface, 3 or 4 feet deep. We take those out of the ground and encase them and in a glass enclosure for everyone to see, and we have one of those for every state and a few territories of the United States. And when children walk through that section, and adults, they're mesmerized by the variation in soils.

A lot of the lessons that we've learned from studying past cultures and why they failed seem to be lessons that we still have not learned to that. To get into this passion for soils and now finally understand this was something I

felt very strongly that I had to communicate it. It was my responsibility for the chance to have-- to study to do a doctorate, to give something back.

TEXT ON SCREEN - [Patrick Drohan, Ph.D., SSSA Member and co-founding member of Dig It!, Associate Professor Pedology, Penn State University]

And I felt very strongly that this was the best way to do it. I want them to see that their day is a product of the soil that they interact with, and it's everyone's responsibility to make sure this resource is treated with the utmost respect, and that we manage it in a way that allows those future generations to benefit from the way we have today-- but we leave that legacy even better.

For more information regarding the Dig It! Exhibit and its schedule of exhibition dates, visit www.soils.org.

TEXT ON SCREEN - [Tai McClellan, Ph.D. Student, Washington State University]

Hi. Welcome to the Dig It! Museum. Please join me on our journey today as we learn about the importance, the function, as well as the classification of our world's soils.

Throughout history, humans have depended on soil for their existence, as soil filters the air we breathe and the water we drink. Soil can provide fuel for our vehicles and is used as structural support for the buildings in which we live and work. Without soil, we would not have food to eat or clothes to wear.

Plants are dependent upon soil, as it supplies plants with nutrients and allows them to anchor their roots for proper growth. Soils are very important for life on Earth, yet not every soil is the same. In fact, the world has 12 different recognized soil types, known as soil orders.

Because soil behaves differently, depending on the soil order, knowing the type of soil upon which you work and play is important. We must know the particular soil order to predict its behavior and apply the best techniques for its management.

2. Soil Properties & Formations

[MUSIC PLAYING]

TEXT ON SCREEN - [Dig It! The Secrets of Soil: Soil Properties and Formations]

In just 1 teaspoon of healthy soil, there can be as much as 1 billion microorganisms, and this can account for up to 4,000 different species. So the microorganisms that are found in soil can be both good and bad. The good ones can be used for medicinal purposes, such as the antibiotics that we take to protect our own health as humans. Microorganisms can also be used to make biofuels that reduces our dependence on fossil fuels.

However, the bad microorganisms in the soil can cause diseases in animals, plants, and even humans. So soil microorganisms-- particularly fungi-- are important and decomposing organic matter. So in the process of breaking down organic matter, these fungi can secrete enzymes, which actually break up the carbon compounds and release nutrients back to the soil.

Not all soil microorganisms require oxygen to live and breathe. Some microorganisms can use sulfur, iron, or nitrogen to respire, instead of using oxygen. This allows them to grow in areas with low oxygen or no oxygen available, such as waterlogged soils. In protein-rich foods, such as legumes, the plants have evolved a special way of obtaining nitrogen, which not all plants can do.

These plants can form associations with bacteria and form nodules after they colonize their roots. These bacteria can extract nitrogen from the

atmosphere and turn it into forms which can be used by plants, such as ammonium.

We learn about soils because we want and need clean water, air. We also need to nourish our bodies with food and healthy water. We also need feed, fuel, and fiber, as well as healthy ecosystems. We group soils based on their similarities and their characteristics, such as their texture, their color, and their structure.

It's important to analyze and characterize soils so that we can predict their behavior. And this will help us better manage soils to fit our needs as humans, as well as provide ecosystem services, which are important for our planet. We do this by using many tools and techniques which encompass many, many things, such as digging, smelling, touching, filling.

[MUSIC PLAYING]

Soils are formed in layers, which are known as horizons. These horizons form as you go down into the soil, and they are altered by the five soil forming factors-- parent material, time, climate, topography, and biological factors. Parent material includes rocks and other geological deposits from which soil is formed.

Time describes how long the soil has been developing. Climate refers to the weather in the area where US soil is located. Topography describes the position of the landscape where the soil is found. Biological factors describe the plants and animals which inhabit and affect the soil.

As scientists analyze these layers, they're able to group soils based on their similarities. There may be gradual or distinct changes throughout the layers, depending on how the soil formed. It is important to know that not all soils contain each of these layers, yet there are five basic layers in soil.

The O horizon is made of organic matter, which is comprised of decomposed and partially decomposed plant and animal residues. This horizon is sometimes made of newly deposited leaf debris as well. The A

horizon is known as topsoil, and is made of minerals and organic matter which has been decomposed and dried from the surface. There are many microorganisms in this layer as well.

The E horizon is known as a layer of loss, as it carries materials such as clay, organic matter, and nutrients to the layers below. The B horizon is a layer of gain, as materials wash from higher layers and are deposited here. The movement of materials through these layers is known as weathering.

The C horizon is a mineral layer, which most closely resembles the parent material from which the soil was formed. This layer is less affected by microbial activity and the loss and gain processes than any other horizon.

[MUSIC PLAYING]

The Dig It! Museum is unique because it has on exhibit an example of the monoliths, or the soil profiles, taken from all 50 states, as well as US territories. The soils shown here are these states' or territories' official soil series, basically based on information obtained by the NRCS, or the Natural Resource Conservation Service, as part of the US government. The soil monoliths that are displayed are important either due to their unique or special characteristics, or they are displayed because of their importance in agriculture.

The texture of the soil greatly affects how we need to manage the soil and how the soil function and behaves. There are three types of mineral components that greatly affect soil texture, and these differ in their size. First, you have sand, which is the largest of the soil grains. Then you have silt, followed by clay. So the size of the particles and soil greatly affects how water is able to move through the soil profile.

This demonstration shows that, in sand, since it has larger macropores, the water is able to infiltrate the soil much quicker, compared to that silt. And particularly, you can see here that the porous base inside a clay soil is so small that the water news very, very slowly, if at all. Sometimes this water

is caught up into the soil micropores, and doesn't distribute through the soil profile easily.

A loam soil contains moderate amounts of each sand, silt, and clay. It's good for growing crops, because it does allow for water to move through the soil, but yet it holds enough so that plant roots can take up this water. Soil structure is also important for healthy soils. Microorganisms and organic matter help to protect soil structure and keep soil held up into aggregates, or clumps, or clods. This aggregation is important for allowing water and air to move freely through soil.

Soils develop from parent material, or a rock from which is broken down to form these soils. The parent rocks are the primary source of minerals and soils. The primary minerals include quartz, mica, and feldspar. And to be primary minerals, they cannot change in their chemical structure than that upon first crystallization.

As the parent rock breaks down and forms soil, it can release important minerals, such as potassium, as well as phosphorus, which are important for plant growth. The oldest soils are made up primarily of secondary minerals. As the primary minerals dissolve, they read form new minerals. This is known as secondary minerals in the older soils.

Secondary minerals consist of silicate clays, as well as oxides. Soil is comprised of many materials, including minerals, water, air, and organic matter. 45% is mineral, 5% can be organic matter, whereas 25% is air and 25% is typically water.

[MUSIC PLAYING]

3. Soil Orders

[MUSIC PLAYING]

TEXT ON SCREEN - [Dig It! The Secrets of Soil: Soil Orders]

Soils play a critical part in each and every one of our lives, from the clothes that we wear to the food and water that we eat and drink, to sometimes the fuel that we use. Soils provide structural support for plant roots so that they can take hold and grow. They can filter the water and remove pollutants from the water, as well as clear the air that we breathe. Soils also provide mineral nutrients to plants, such as nitrogen, phosphorus, potassium, among others.

[MUSIC PLAYING]

In order for us to predict and manage soil behavior, we must be able to identify soil types. We can do this by learning about distinctive soil properties that provide tools for soil classification and identification.

So this world map depicts the 12 soils of the world. Now, scientists have developed these soil orders based on properties, which include color, texture, their type of minerals, as well as the organic matter content.

You can see here that there is some great variation amongst the different soils in the world. You can see that each country has very, very, very many different types of soils that differ greatly in their diversity. The 12 types of soil orders that scientists have characterized include andisols, entisols, inceptisols, alfisol, spodosol, gelisol, ultisol, histosol, oxisol, vertisol, aridisol, as well as mollisol.

Now, I'd like to first start with describing andisols. You can see here in the map of this world, andisols are the dark purple color. They are known as volcanic soils. And they were developed from ash, as well as cinders, during volcanic eruptions.

Andisols are extremely fertile. And they are known to have a very high water-holding capacity, meaning that they can hold more water than their actual weight. And this is because they contain minerals, such as allophane, which are amorphous. And their structure allows the soils to expand.

The second soil I would like to highlight would be the entisols. You can see here that they represent the orange color. Now, these soils are undeveloped, meaning that they don't have a distinctive layer formation. Either they're very young soils, such as what you would find maybe along a beach, or they're old soils where their top layer has been weathered away due to erosion.

So the third soil that I would like to highlight would be the inceptisols. Now, these soils are more developed than the entisols. And they show the first signs of soil formation, where you can actually see organic matter starting to accumulate in a top layer.

Alfisols are moderately developed soils, which are commonly found in forests where plant litter has accumulated in the top layer. These soils are good for farming.

Spodosols are found in cool, temperate climates, and are typically unfertile. Characterized by their bright color and acidity, these soils are typically very sandy, which allows soil water to carry organic matter through the soil.

Gelisols are frozen soils which are associated with permafrost. They are frozen for most of the year, yet the top layer can thaw in the daytime during summer months.

Ultisols are weathered soils of the tropics and the subtropics. These are common in forests and savannas, but are not naturally fertile for crop production.

Histosols are organic soils associated with wetlands. They are found in places where we consider to be peatlands, bogs, and marshes. They're characterized by a high amount of organic material that is partially decomposed.

Histosols are found in temperate, tropical climates, as well as cool climates.

Oxisols are highly weathered tropical soils. They are probably the most developed of all the soils. They have no obvious horizon differences and are characterized by their bright orange and red color. These soils have developed in hot, humid climates, such as the tropics, and are not naturally fertile.

Vertisols are soils which shrink and swell, and are known for high fertility. These soils pose many problems in construction and their management, as they crack when they are dry and swell when they're wet.

Aridisols are dryland soils, which occur in regions with little rainfall, yet irrigation allows these soils to support crop production. These soils support crops and microorganisms which are accustomed to long periods of drought.

Mollisols are the most fertile soils in the world and support grasslands and savanna prairies. These soils are known for their deep topsoil layer, which is rich in organic matter.

[MUSIC PLAYING]

4. Functions & Management

[MUSIC PLAYING]

TEXT ON SCREEN - [Dig It! The Secrets of Soil: Functions and Management]

How do we want the soil to function? What services can soil provide? Soil not only helps to provide humans with food, feed, fiber, and fuel, but also filters our water and air. Our drinking water is cleansed as it moves through the soil profile.

Contaminants can be absorbed by soil, or prevented from entering the air that we breathe. However, we must be careful of what and how much we add into soil. Even those soil acts as a great buffer and filter, inputs can lead to environmental pollution.

Throughout history, humans have learned a lot about soil and soil fertility. Along the way, humans have also discovered ways to manage soil properties in order to meet their needs for food and shelter. No soil illustrates this better than the terra preta of the Amazon, which was amended with charcoal, among other substances, to enhance the fertility of the otherwise infertile tropical soil.

TEXT ON SCREEN - [Tai McClellan, Ph.D. Student, Washington State University]

As you can see here with the dark earth soils, they're much darker in color, as well as much more fertile than the typical infertile tropical soils beneath. Now these soils are thought to get their fertility from charcoal that has been added by the indigenous people thousands of years ago. And this charcoal is thought to help maintain and hold nutrients that have been added through the addition of compost, which includes green waste material, as well as fish byproducts.

This soil is important, because it represents very fertile pockets within the Amazonian basin, which is surrounded by largely infertile soil. Now researchers are interested in this soil, because they're hoping to mimic these practices, maybe perhaps through charcoal additions, and to enhance the fertility of tropical soils, which are known for their infertility. Particularly they're interested in having soils hold and maintain nutrients that could be subsequently available for plant uptake.

We often think about agriculture and sustaining human populations when we discuss soil management. However, the fertility of the soil must be replenished or built up in order to continue supporting civilizations. Soil amendments provided by humans and processes mediated by soil

microorganisms play important roles in maintaining or enhancing soil fertility.

The quest for a more fertile soil to support agriculture has been a theme of all civilizations, and not limited to the tropics. In early European civilizations, villages were built on fertile soil, known as loess. Loess is a silty soil, which typically is blown and deposited by wind. This soil can be very deep and very rich, but is prone to erosion, and maybe result to eventual loss of farmland.

Civilizations have not only managed soil for agricultural purposes, but also for engineering and construction. The desirable soil properties for engineering and construction might be very different than agriculture. Rather than fertility, engineers might seek soil that serves as a strong foundation for buildings and roads. Some soils, those that shrink or swell or sink when thawed, might pose an enormous challenge to engineers.

Engineers need to know the texture of the soil. For instance, is it sandy? And also, what type of clay it may hold, and whether that clay is unstable.

In soils that experience freezing, ice crystals can form in soil. However, when these soils slump, they can pose risks for the structures that they hold, and potentially break the foundation. This is important, if we think about the permafrost soils, and how building on top of permafrost soils can lead to potential damages to foundations as temperatures rise.

Soil provides the foundation for us to construct buildings, as well as to support and give nutrients to crop growth. And finally, soil provides ecosystem services for which to serve as habitats for wildlife and plants, as well as cleanse water and air.

How we interact with soil is very important in its ability to perform these functions. For instance, putting heavy machinery and equipment can cause soil compaction. And covering this with concrete can reduce its ability to filter water and cleanse this water.

It is also important to apply the proper amount of fertilizer to soil, because applying too much fertilizer can lead to pollution downstream, as these fertilizers can seep into the soil, and then enter the groundwater, and eventually lakes and streams. For instance, mineral fertilizers, pesticides, and even soil sediments can end up downstream from the farm. It can enter groundwater, and eventually lakes, stream, and the ocean. And it can negatively affect the ecosystems.

Also, pollutants can enter the air and have a negative effect on air quality.

Tillage is the conventional farming method used to prepare the soil for planting seeds. Tillage is the manipulation of soil by physical, chemical, or biological causes, and provides many beneficial functions, such as optimizing conditions for germination, seed establishment, and crop growth, weed control, control of plant diseases, nutrient recycling, correcting soil compaction, land leveling, facilitating irrigation, and crop residue management.

Tilling causes a loss of organic matter and soil erosion, yet simple management practices can be applied to reduce the adverse effects of tillage. Practices such as minimum till and no-till farming have been adopted to further aid in controlling soil erosion and loss of organic matter. However, any tillage practice may be utilized as long as appropriate management practices are implemented.

When we grow crops in soil, this results in a loss of nutrients, as the crops take up the-- these nutrients from the soil. Farmers can then return or increase the fertility of the soil by applying fertilizers, whether it be synthetic or organic, as well as growing certain plants, such as legumes, which can actually enhance the soil fertility. New technology is enabling farmers to add the right amount of fertilizers at the right time in order to maximize crop growth, by applying the right amount of fertilizers, while also minimizing potential pollution.

Often, humans have sometimes put more than just a footprint in soil. At times, human activities have led to the formation of anthropogenic soil, or human-made soil, such as backfilling new soil or landfills.

Under natural conditions, soil forms through interactions in time with the climate, as well as microorganisms. However, humans have altered the condition of soil in several ways. For instance, here you can see how soil was backfilled into pre-existing soil, which caused differences in the ability of plants to grow in that area.

Here, you can see a fluffy soil was deposited around the root ball of these cherry trees. However, this caused major drainage problems, and the cherry trees could not tolerate these conditions. So as a result, scientists realized that what they should do in order to enhance soil drainage is to backfill with denser soil, and allow soil in-- soil-water infiltration.

Humans can greatly alter the soil landscape. In this picture, you can actually see how along the Anacostia River, it was once a wetland. But humans soon developed a landfill. Humans have altered the soil in some ways that are disastrous, which means that the soil can't perform its critical functions of filtering the soil water, cleansing the atmosphere, as well as providing appropriate structure for the foundation upon which we live.

In order to maintain healthy, productive soils, we must protect the soils from losses due to wind or water erosion. And soils with a loss of soil fertility, due to either highly-weathered soils or hot, dry climates, or through their overuse, we must learn to restore their soil fertility. This is especially hard in places such as sub-Saharan Africa, where you can have greater uptake of nutrients than that which is returned by farmers.

If the soil does not have time to rest and rebuild its nutrient content, then farmers have to find ways to increase the soil fertility. This can be accomplished through the addition of fertilizers, which can also include organic matter, to maintain the organic matter content. So farmers can plant high-yielding crop varieties, and they can combine this with the addition of mineral fertilizers, as well as compost and manure.

Additionally, farmers can grow plants such as legumes, which actually take nitrogen from the atmosphere and add it to the soil. And that then becomes plant-available nitrogen. Farmers can gain greater yields through using crops that are more adapted to their environment, as well as more efficiently using their water and fertilizer resources.

Soils are renewable, but it takes many, many, many thousands, if not millennia, for soils to develop. And this occurs through the alteration of soil minerals, which develop into soils through the interaction of climate, as well as microorganisms and plants over long periods of time. In order to manage soils, we must use new techniques as well as old knowledge in order to prevent the degradation of soil.

So after a fire, the soil surface can repel water. This can lead to surface runoff, which can then cause the increased occurrence of mudslides, as well as flash-flooding events. Humans have responded to this by decreasing the disaster that can be caused by these mudslides. For instance, you can build channels or ditches for which to channel the mudslide and prevent the destruction of homes and houses.

The way we manage soils affects soil function. We need healthy soils for optimal function. This may include maintaining aeration, water drainage, organic matter, diverse microbial communities, and nutrient cycling.

Nutrients that we apply to soil as fertilizer, such as nitrogen, can be taken up by plants, and ultimately become part of our own bodies as we eat these plants. However, we still have to remember to manage the resources properly, because this nitrogen can also end up in lakes and streams and the air.

Thank you for learning about the importance of soil. Because soil is a vital resource upon which life depends, the ability for soil to perform its critical functions is an absolute necessity. This includes supporting plants from which we derive our food, feed, fiber, and fuel, to providing strong foundations for our homes, to improving water and air quality.

Since soil sustains us, we must continue learning about how to maintain or improve soil health without degradation or pollution. Strategies might involve improving the use of fertilizers and other inputs, maintaining soil organic matter, and selecting soils with the best properties for its intended use.

Instructions for Day 5, Intro to Horticulture

If you have access to iCEV sign on to watch power point.

After reviewing the materials, you will complete the project “Medicinal Horticulture: Good or Bad?”. Follow all the instructions for the project.



1

Objectives

- To explain the importance of horticultural products.
- To recognize the aesthetic and recreational value of horticulture.
- To identify environmental benefits and concerns.
- To explore the economic role of the horticulture industry.

2

2

Main Menu

- Introduction to Horticulture
- Aesthetic, Recreational & Therapeutic Value
- Environmental Value
- Economic Value

3

3



4

Horticulture

- Is the cultivation of gardens, orchards or nurseries
- Is the science and art of flowers, fruits, vegetables and ornamental plants



5

5

Horticulture

- Provides many benefits, including:
  - aesthetic
  - recreational
  - therapeutic
  - environmental
  - economic



6

6

Branches of Horticulture

- Include:
  - pomology
  - floriculture
  - olericulture
  - landscape horticulture
  - medicinal horticulture
  - nursery/plant propagation



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Pomology

- Is the production and cultivation of fruit and nut crops
- Includes the development of new fruits and the cross-breeding of various fruits for desired traits, such as:
  - hardiness
  - disease resistance
  - flavor



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Floriculture

- Includes the production, distribution and processing of flowers and foliage plants
- Involves plants, such as:
  - bedding and garden plants
  - foliage plants
  - potted flowering plants
  - cut flowers
  - cut cultivated greens and floriculture material



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Olericulture

- Is the production of vegetable food crops
- Encompasses crop establishment, such as:
  - selection of seeds
  - seedbed preparation
  - establishment of vegetable crops by seed and transplants



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Landscape Horticulture

- Is the production and use of plants to beautify the environment
- Provides:
  - tranquility
  - aesthetic enjoyment
  - sense of enjoyment



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Medicinal Horticulture

- Involves large groups of plants used in medicine and veterinary practice for therapeutic or preventative purposes
- Provides:
  - synergic medicine
  - support of official medicine
  - preventative medicine



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Nursery/Plant Propagation

- Is a place where plants are grown for the sake of being moved or transplanted later
- Is conducted through seed or vegetative practices, such as:
  - cuttings
  - grafting
  - tissue culture



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Plants

- Have aesthetic, recreational and therapeutic value
  - aesthetics are pleasing in appearance; beauty
  - recreational is the means of refreshment or diversion; hobby
  - therapeutics provide or assist in a cure; curative

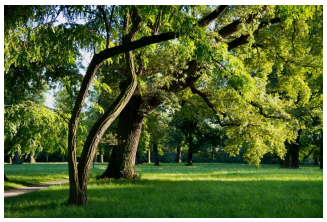


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Plants

- With aesthetic, recreational and therapeutic value include:
  - flowers
  - trees
  - bushes
  - garden plants
  - lawns



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Flowers

- Provide beauty
  - colorful blooms brighten up a room or space
- Express emotion
  - often used as gifts and décor for special occasions



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Trees

- Provide shade
- Can create a large-scale windbreak
  - groups of trees which protects an area from wind
- Reduce pollution
- Improve appearance of homes, parks and other landscape
  - often adds color, aroma and shade



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Bushes

- Allow for a more natural environment
  - provides a place for reproduction and decomposition of birds, wildlife and other living organisms
- Create a windbreak and shade for its surroundings



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Garden Plants

- Are produced by hobbyists and large-scale operators
- Provide food for families on a non-commercial scale
- Impact the environment by:
  - cleaning the air
  - absorbing carbon dioxide
  - releasing fragrance



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Lawns

- Offer aesthetically pleasing backdrops for other landscape plantings as well as environmental benefits
  - preserve and protect soil, air and water resources



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22

Plants

- Have environmental value
  - plants impact the air, water, minerals, organisms and other biotic factors in their surroundings

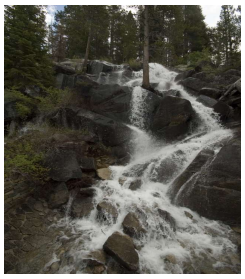


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Plants

- Impact the following environmental factors:
  - air
  - soil
  - animal life
  - erosion
  - run-off



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Air

- Is impacted by horticulture
  - plants produce oxygen and remove carbon dioxide from the atmosphere
  - plants enhance air quality by reducing toxins through a process called phytoremediation



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Plants

- Are often used to improve indoor air quality in homes and workplaces
- Utilized indoors include:
  - ivy
  - ferns
  - potted flowers
  - small trees
  - shrubs



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Soil

- Provides habitat for bacteria, insects, burrowing mammals and other organisms
- Recycles raw materials
- Provides plant benefits, such as:
  - stability
  - oxygen
  - nutrients



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Animal Life

- Is affected by horticulture
  - plants are a food source for many animals
  - plants make up much of the physical and biological environment for the everyday necessities of animals



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Erosion

- Is the process by which the surface of the earth gets worn down



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Erosion

- Is impacted by horticulture
  - plants provide protection to the soil
  - plants slow down water as it flows over the land
  - roots of the plants hold the soil in position
  - plants break the impact of raindrops before they hit the soil



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Run-Off

- Can be described as the precipitation on land which reaches streams



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Run-Off

- Is impacted by horticulture
  - grassy strips in fields help reduce run-off by slowing water rates in vegetated areas
  - plants provide a secure foundation so water will not wash sediment, fertilizers and pesticides into waterways



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33

Horticulture

- Has economic value
  - economics refer to the process in which goods and services are produced, sold and bought



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Horticulture

- Impacts the following sectors of the economy:
  - plant production
  - research
  - sales and marketing related products and services



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Plant Production

- Is the industry responsible for the planting and cultivation of plant products including:
  - foods such as fruits, vegetables, grains, etc.
  - landscape plants
  - plants used in manufacturing, such as cotton
- Generates more than $150 billion in the United States



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Plant Production

- Provides jobs for more than 1.9 million Americans
- Careers in this field include:
  - quality control inspector
  - landscape service
  - garden center management
  - food processing
  - orchard or greenhouse management



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Research

- Conducted through studies allow scientists from around the world to seek new pathways to enhance and document the impact of horticulture
- Also shows the relationships between humans and the plant world



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Research

- Careers in this field include:
  - extension horticulture specialist
  - research associate
  - biological science technician
  - director of research and development
  - irrigation analyst
  - greenhouse research technician
- Generates over $34.6 billion in the United States



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Research

- Provide jobs for more than 300,000 Americans
- Careers in this field include:
  - 4-H special projects manager
  - research assistant and plant testing
  - post doctoral research associate
  - research scientist



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Sales & Marketing

- Of horticulture products are part of a lucrative international business structure
  - the horticulture industry generates more $55.5 billion in the United States

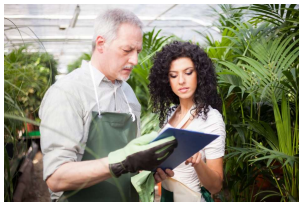


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Related Products & Services

- Provide many other outlets for horticulture to help generate money and add versatility to the industry
- Generates more than $57.8 billion in the United States



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Related Products & Services

- Provides jobs for more than 750,000 Americans
- Careers in this field include:
  - processors
  - distributors
  - garden centers
  - nurseries
  - florists
  - teaching



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Resources

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Resources

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Medicinal Horticulture: Good or Bad?

STUDENT PROJECT

Directions:

1. After learning about medicinal horticulture, conduct further research and develop an opinion about the topic. Consider factors such as cost, effectiveness, morality, etc.

2. Upon forming an opinion on the matter, write a speech no longer than two minutes expressing your opinion.

3. Include specific details as to why you do or do not support medicinal horticulture, what you believe as far as conventional medicine and what stance you believe others should take.

4. Cite all sources used.

5. Present to the class.