

# IOWA ag TODAY

SCIENCE & AGRICULTURE

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**S**cientists and world leaders estimate the world's population will reach nine billion by the year 2050. That is two billion more than today! Imagine how much more food will be needed for two billion more people. Imagine how many clothes they will need. Imagine how much fuel and medicine they will need. The agriculture industry is responsible for growing plants and raising livestock that will become our food, clothing, shelter and fuel. Farmers need to do this in a sustainable way.

So, what is **sustainability**? To be sustainable, we must meet the needs of the present without compromising the needs of the future. This includes protecting the environment. It includes making sure farmers can earn a profit. It includes meeting the social needs of the community. In agriculture, farmers use best management practices and technology to grow the most food on their land. These practices help ensure economic, social, and environmental success.

Scientists, engineers, and others in food and fiber industries are using technology. This allows them to produce more with less.

- Animal geneticists study **heredity and genetics** and then work with farmers. Farmers select the most desirable traits in their animals. With improved genetics, they can produce more meat, milk and eggs.

- Soybean plants and other **legumes** have nodules on their roots. These nodules host bacteria that convert nitrogen from the air into a plant-usable form in the soil. This process is called **nitrogen fixation**. Farmers take advantage of this by alternately planting corn and soybeans each year. Nitrogen left in the soil from the soybean crop can be used by corn plants the following year.

- **Ethanol** is a renewable fuel made from corn and other crops. These crops have a high starch or sugar content. Through the process of **fermentation**, starch is converted to sugar and then to ethanol.

- **Distillers grains** are a by-product of ethanol production. They can be used by cattle farmers as an inexpensive and nutrient-rich feed. Cattle have **ruminant digestive systems** and can digest grass, distillers grains and other plant materials.

These are just a few examples of how science and technology are helping us produce more with less land and resources. Scientists and farmers work together to make agriculture even better!

**THINK AND DISCUSS**  
**What will farms look like 20 years from now? List, sketch, and describe your ideas for how crops and livestock might be raised in the future. Think about how science and technology can be used to produce more while conserving resources.**



# What's the matter?

**I**n nature, **matter** is neither created nor destroyed. This is called the Law of Conservation of Mass, discovered by Antoine Lavoisier in 1785. It means there is a finite amount of matter in the world. The matter just gets redistributed in different ways over time.

Now, picture a **pasture**. It's a large, grassy field with beef cattle grazing on it. They have a water source, and potentially some supplemental grains and minerals. However, they mostly walk around and eat the plants growing on the pasture. How is matter cycling here?

First, let's look at the soil. Soil is an incredibly complex ecosystem of its own. It includes all kinds of living things, like worms, bugs and microscopic organisms. These organisms eat organic materials, like plant matter, manure or other decaying organisms. They help aerate the soil by burrowing and creating tunnels. These organisms also give off waste of their own and eventually die, increasing the organic material in the soil and keeping it healthy.

The soil is also home to lots of nutrients. Things like nitrogen, phosphorus, potassium, and more are all very important in plant and soil health. These organisms and organic material help increase the nutrients in the soil. If these

nutrients start getting low, farmers can apply more with **fertilizers**.

Soil nutrients are very important for plant growth. A plant's seed has lots of energy inside, but only really enough for the seed to **germinate**. After that, the plant needs to absorb nutrients from the soil to help create the proteins that build the plant's structure.

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As the plants grow, cattle eat them. **Cattle are ruminant animals**, so they can digest plant material very efficiently. Their bodies break down the proteins in the plant's structure and repurpose them to build muscle in their own bodies. This muscle becomes our **beef!**

The manure from the cattle and any dying plants then go back to the soil as organic material and a source of nutrients. Then the cycle can start again!



**THINK AND DISCUSS. If you were one nitrogen atom or one water molecule, how many places might you cycle through in a cattle pasture?**



## WHY THINGS ARE GROWN WHERE THEY ARE

(AND HOW HUMANS INFLUENCE GENETICS)

**H**ere in Iowa, we grow and raise lots of things. Iowa is the top producing state of corn, soybeans, pork, eggs, and ethanol. We also grow many other things, like dairy cattle, beef cattle, turkeys, and even apples and grapes! But why do we grow the things we do?

All organisms need a specific set of things in order to thrive. They need the right climate, nutrients, water, space and growing season. For instance, what works well for cranberries would not work well for wheat. What works well for reindeer would not work well for pigs. What an organism needs to survive is coded for in their DNA. Iowa raises lots of corn because we have the right length growing season, plenty of rain, and lots of nutrient-rich soil.

However, humans can alter where organisms are grown through our knowledge of **genetics**. Humans can crossbreed organisms, like two varieties of wheat, to get the genetic benefits from both varieties. We can also improve plants and animals by artificially selecting organisms with superior traits, like drought resistance. More recently, scientists have learned how to genetically engineer plants by adding beneficial traits from other organisms without the trial and error of crossbreeding or **mutagenesis**.

Take cattle, for example. There are two groups of cattle in the world; **Bos Taurus**, like Angus and Hereford cattle, and **Bos Indicus**, like Brahman and Zebu cattle. Bos Taurus breeds are largely European in origin and are well-suited for cooler climates. They have thicker hair, more muscle mass, and good meat quality. Bos Indicus breeds are more tropical and are better adapted to warmer climates and insects associated with those climates. They have thinner hair, droopier ears, and have a hump on their shoulders.

So, if you were a cattle producer in Texas or Australia, what type of cattle would you choose to raise? Would you choose Bos Indicus cattle that are well suited to the temperature extremes and insects? Would you choose Bos Taurus cattle that provide more and better-quality meat?

Modern producers have said yes to both questions by breeding these two groups of cattle together. One of the most popular crosses is between Brahman cattle and Angus cattle. These "Brangus" cattle can handle the hot temperatures, but still provide good meat for the ranchers in these areas.

**THINK & DISCUSS. What other factors could influence where crops or livestock are raised? Are all factors environmental, or are some economic?**

**KEY TERMS: Mutagenesis is a practice where seeds are exposed to radiation and are then grown and observed to see what mutations have occurred. This is how we got ruby red grapefruit!**



# CAREER CORNER

**1 IN EVERY 5 JOBS IN IOWA IS IN AGRICULTURE. MAYBE YOU COULD HELP FEED AND FUEL AMERICA WITH A CAREER IN AGRICULTURE!**

## Weston Dittmer, Soil Conservationist

Helping local farmers care for their land was one reason Weston Dittmer went to work for the Natural Resources Conservation Service (NRCS) with the United States Department of Agriculture.

"With my background in agriculture production and an education in agronomy and environmental science, the NRCS was a natural fit for me," he said.

Approximately one third of his job is meeting with land owners discussing their fields. He scouts out areas where improvements could be made. The goal is to help keep valuable soil from eroding or running off the farm. He might suggest that the farmer build terraces to slow the flow of water. He might suggest creating strips of grasslands to filter runoff. Discussing conservation tillage practices can also help maintain the soil on a farm.

The rest of his time is spent in the office working closely with his team.

They examine soil maps and report back to farmers. But his job is more than soil conservation. He provides guidance for other natural resources, too. He monitors water quality and flood control. He monitors air quality. He monitors crops and pastures, native prairies and wildlife habitat. He even helps with livestock production.

Weston realizes that we have a limited amount of land and we must work together to preserve it.



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## Tyler Marion, Product Engineer

Tyler Marion is an engineer at Hog Slat, Inc. He designs ventilation and cooling systems for pig barns. Maintaining comfortable temperatures is very important in pig production. Tyler designs new products or improves existing products. This helps pig farmers take better care of their animals. He works with others to evaluate products, create designs, and find partners to help create end products.

Tyler attended North Carolina State University, where he learned about many types of engineering. He studied mechanical engineering and electrical engineering through the lens of agriculture. He says this program allowed him to gain an understanding of many concepts. This prepared him well to be an agricultural engineer.

The best part about his job, Tyler says, is seeing a project go from inception to completion. In many engineering roles, individuals only work on part of a project and have to pass it on to someone else.

"Our industry offers a unique opportunity to see it start to finish," he said.

For students thinking about being an engineer, Tyler has some advice. First, an interest in learning more about math will help a lot. Math is important in engineering.

"Pay attention to detail," he added, saying that problems come up when details are missed. "If you make it a habit now to pay attention to detail, it will help later."



## Candice Engler, Agricultural Engineer

Candice Engler is an agricultural engineer for John Deere. She started her career as a manufacturing engineer, where she worked to streamline the production process of grain drills. She soon gained interest in software and systems engineering.

"Farmers don't buy a single piece of equipment. They want an entire system in which all of the machines work well together," Engler said.

In her current role, she leads a team that improves the diagnostic capabilities of John Deere's products. This helps farmers figure out what is wrong, so they can fix it quickly.

Candice was good at math and science in school. She also developed an interest in figuring out how things work as she



worked alongside her dad on the family's farm. When she was 12, she helped him build a sprayer to help control weeds and insects in their corn and soybean fields. This was her first

experience developing something that helped a farmer.

"As an engineer, I apply math and science concepts to help farmers be more effective," she said. "And by helping farmers, I am helping to feed the world's growing population."

## John Patience, Animal Science Professor

Every day John Patience gets to think about animals and often works with them. As a professor of animal science at Iowa State University, his career has allowed him to help the swine industry. He works with students and designs experiments that will improve pig health. He then works with industry professionals to help them apply the results of the experiments within their herds.

"People who are good with livestock are observational," he said. "They read their pigs. That's how they keep animals happy and healthy."

He is constantly looking for problems the industry is facing that he can help solve. Many swine farmers are trying to reduce the need to use antibiotics. This is a trend that consumers are asking for. Some of

John's research projects are focused on creating diet ingredients that will help pigs ward off disease and stay healthy.

"Research is a means to an end," he said. "Before we plan an experiment we ask, 'what problem is this solving for the industry?' and 'how is it going to help the environment, the pig, or the consumer?'"

For students interested in pursuing careers working with animals, he encourages them to visit a farm and see the animals. He says there are so many job opportunities working with animals – beyond veterinarians. He says pigs have very similar digestive systems to humans. Sometimes his research even helps improve human health!



## Mark Allan, Geneticist

The study of this DNA and the heredity of traits from one generation to the next is called genetics.



There are many careers within agriculture that work with genetics. There are plant breeders, crop geneticists, livestock breeders, statisticians, genetic

engineers and more.

Mark Allan is one person who works with livestock genetics through his work as Director of Genetic Technology at TransOva Genetics. Mark primarily works with the cattle industry. Cattle farmers are very aware of the genetics in their herd. They want to breed healthy, hardy, happy animals. Mark helps these farmers reach their goals through his work.

There are many different technologies Mark uses to help his customers. He works to develop new products for genetic companies and farmers. Staying current with modern technologies can take him across the country to meet with many different people. This is Mark's favorite part of his job.

"I'm on my way to a meeting in Lubbock,

Texas at Texas Tech right now," Mark said.

There are a few skills Mark has that have helped him. He is detail-oriented and enjoys working with data. He says his ability to communicate technical ideas has also helped.

If you are interested in genetics, Mark says you should pay attention in science and math classes. Chemistry and biology are very important in genetics. Math plays a large part in science, too. Mark points out that new technologies are important in agriculture.

"Whatever the current technology is, it's being done on a large scale in animal agriculture," he said.

Maybe your future job will be as a geneticist in animal agriculture!

# USING IOWA CORN TO POWER VEHICLES

**T**he great thing about corn is that it has a lot of different uses. **Field corn**, the type of corn primarily grown in Iowa, is harvested after it has dried in the field. The kernels can be used to feed livestock. They can be ground and turned into food for humans, like tortilla chips. The kernels can also be turned into an alcohol called ethanol that can be used to power our vehicles – just like gasoline.

Each little kernel of corn represents stored energy. That energy can be used for animals and humans to eat or it can be used to power cars and trucks. Because corn is dry when it is harvested, it can be stored in **grain bins** until it is needed for use.

**THINK & DISCUSS.** In a car engine, fuel is burned creating miniature explosions that push pistons. The pistons in turn propel a drive shaft that transfers power and energy to the wheels. This makes the car move forward. Can you diagram this transfer of energy?

added to the mixture. The yeast eats the sugars and has two by-products: carbon dioxide and ethanol. The ethanol is removed from the mixture and **distilled** down until it is pure.

The rest of the corn meal mixture can be used for animal feed called **distillers grain**. The ethanol will be mixed with gasoline to help power cars and trucks. Biofuels are considered a **renewable resource** because they can be replenished quickly. Gasoline made from oil and extracted from the earth is considered a nonrenewable resource because it cannot be replenished quickly.

Ethanol has many positive benefits, but one problem is that it burns hotter than gasoline. Pure ethanol cannot be used in a standard car engine. Mixtures of gasoline and ethanol like E10 (10% ethanol and 90% gasoline) are available at most gas stations. Engines need to be modified to use a higher mixture of ethanol. The E85 blend is 85% ethanol and 15% gasoline. Engineers design specific engines that are more efficient at cooling and can withstand the higher burning temperatures of E85.

**DID YOU KNOW?**  
A bushel of corn (roughly 56 pounds) can produce 2.8 gallons of ethanol.



# POWERFUL PLANT STRUCTURES

**P**lants are amazing! They provide us with oxygen, food, fiber and medicine. They grow in all regions of the world. Each species has leaves, stems, flowers and root structures adapted to its habitat. These specialized plant parts ensure they can acquire their basic needs. It helps them protect themselves against predators and reproduce.

Flowering plants reproduce by seed. To produce seeds, **pollination** must occur. Flowers have evolved over millions of years to ensure that tiny grains of pollen are carried from the male flower part to the female flower part. Without this transfer, fertilization does not happen, and seeds are not produced. Most plants rely on receiving pollen from another plant of the same species. But, some plants can pollinate themselves.

Soybean plants are **self-pollinated**.

This means that pollen produced within a flower fertilizes the ovary of the same flower on the same plant. Because soybean plants do not need to attract pollinators, their flowers are not showy. Soybean flowers are hidden under the leaves near the plant's main stem. Each flower is only about the size of your pinky fingernail, but there can be 50 to 75 flowers on one plant.

**Cross-pollinated** plants rely on insects, animals or wind to transfer pollen between flowers on separate plants of the same species. Corn plants are pollinated by wind. Corn plants have two types of flowers. The corn silk on the ear is the female flower. The tassel at the top of the corn plant is the male flower. Wind carries pollen from the tassel to the silks at the end of each immature ear. Pollen grains attach to the sticky end of each silk, and travel down the silks to fertilize each ovary. After pollination, the ovary develops into a kernel of corn at the other end of each strand of silk.

Our world is filled with flowers of many shapes, sizes and colors, thanks to the many ways that flowers are pollinated.



**THINK & DISCUSS.** Flowers are a specialized plant structure necessary for reproduction. What are other examples of specialized plant structures that vary from species to species? What is their function?



# BIRDS OF A DIFFERENT FEATHER

**B**oth domestic turkeys and wild turkeys can be found in all shades of color. They can be colors like brown, black, white and more. But most domestic turkeys today have white feathers. Most wild turkeys have dark brown or black feathers. This difference in feathers evolved through farming. Farmers selected and bred the lighter, whiter colored birds.

Wild turkeys need to maintain their dark colors as camouflage so that they blend in with their natural surroundings - usually forests and woodlands. Genes might mutate and cause a variety of feather colors. However, those brighter, more colorful birds are more susceptible

to predators. Therefore, the mutations aren't usually passed on to the offspring. This **natural selection** process maintains the dark-colored wild birds.

Turkeys were first domesticated by Native Americans as early as 25 A.D. Since then, farmers have been using **artificial selection** processes. This process results in the best characteristics for developing meat for human consumption and for the birds to live healthily in large, indoor flocks. Farmers selected for the white feathers for several reasons. One reason is the white feathers are less visible when the carcass is **dressed**. White feathered birds typically have lighter skin color, too, which is more appealing to consumers. **Melanin pigments** that cause colorations are similar in the skin and in the feathers.

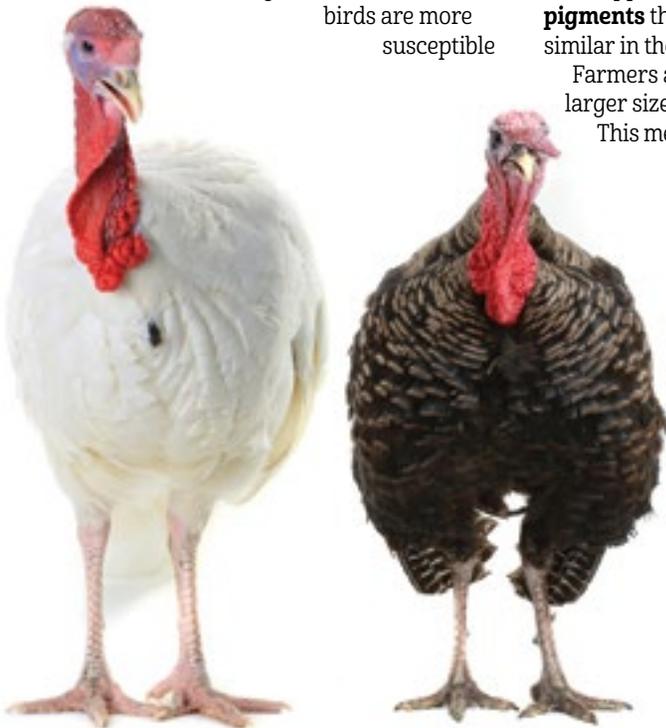
Farmers also selected for traits like larger size and thick, meaty breasts. This means that domestic turkeys

rarely fly because their bodies aren't built for it. Wild turkeys, on the other hand, can fly at speeds up to 55 miles per hour.

Domestic turkeys also have more white meat than wild turkeys. Dark meat is caused by higher amounts of **myoglobin** that carries oxygen in the blood. Birds that are more active, like wild turkeys, need more oxygen in their blood and muscles so they can fly at top speeds. Muscles that aren't used as much will have less myoglobin. Therefore, domestic poultry will often have more white than dark meat.

Domestic turkeys have little fear of humans. They are constantly noisy, constantly clucking. While wild turkeys are known for their gobbles, they spend most of their lives quiet so as not to attract predators. Wild turkeys need to be more wary and stealthy if they are to survive.

All these variations are achieved without genetic modifications or hormones. Farmers use **selective breeding** processes to produce the best turkeys that result in the best meats.



**THINK & DISCUSS.**  
**What other domestic and wild animals have color differences? How are the color differences beneficial or harmful to the animal?**



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