ARIZONA'S Ag Mag

INNOVATION AND AGRICULTURE

An AGricultural MAGazine for Arizona Students

Agriculture in the Classroom
ARIZONA FARM BUREAU

What is something you use every day and never really think about? Agriculture! Although most people are 4 generations removed from the farm and ranch, agriculture remains one of the most important industries today. From breakfast, to lunch, to dinner, to the sheets you sleep on, the towel you dry off with, the car you drive in, and the clothes you wear, agriculture plays a large part in your day.

Thanks to innovation and technology, farmers are producing more and using less than ever before. Advancements in agriculture from the Green Revolution to now make it possible for less than 2% of the population to provide food and fiber for everyone.

Between 1992 and 2022 US farmland decreased by 104 million acres (an area the size of California). Yet the population rose by nearly 80 million people during that same time.

Green Revolution – Beginning in the 1960's, the goal was to increase agricultural production in developing countries. This was accomplished by integrating pesticides, fertilizers, and improved irrigation technologies into the farm.

INNOVATION THEN AND NOW

1850 — FARMER FEEDS 4 PEOPLE

HORSE DRAWN PLOW

1910 — FARMER FEEDS 7

STEAM TRACTOR

1940 — FARMER FEEDS 19 PEOPLE

TRACTORS AND HYBRID SEEDS

1986 — FARMER FEEDS 77

COMBINES AND BIOTECHNOLOGY

2019 — FARMER FEEDS 166

SATELLITES, ROBOTICS, DIGITAL AG

2025 — FARMER FEEDS 169 PEOPLE

ARTIFICIAL INTELLIGENCE

Numerous innovations have helped farmers improve their efficiency and production over the years, including mechanization, better soil inputs, high-tech and hybrid seeds, improved post-harvest handling and storage, and digital advancements such as automation, artificial intelligence, and data collection and analysis.

Mechanism - Innovations in farming equipment play a large role in farmers being able to have larger farms and produce more food. From hand tools to steam tractors, to diesel tractors, to autonomous (self-driving tractors), tractors continue to play a large role in the success of American agriculture.

Selective breeding - Did you know that vegetables like cauliflower, broccoli, and cabbage all originated from the same wild mustard plant and were developed through selective breeding? By choosing plants that have the characteristics we desire, entirely new plants can be developed through traditional breeding methods.

Genetic modification is faster and more precise than selective breeding. Using advancements in science, scientists can alter the genetic make-up of plants in the greenhouse and the lab. Genetic modification has allowed for increased yields by providing disease and pest resistance, providing tolerance to drought, and can even produce foods of a higher nutritional value.

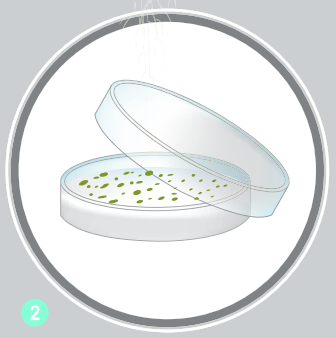
Precision agriculture Uses technology to provide farmers with information and data that can help them account for variations in different fields and even within the same field. GPS, satellites, and sensors allow farmers to make informed decisions about when, where, and how much water, fertilizer, or pesticide might be needed.

THE SCIENCE OF AGRI

Agriculture is the science of growing crops and raising livestock. You can't have agriculture without science. After all, it is called plant science, animal science, soil science, and food science for a reason! Scientific principles and methods are crucial to improving agricultural practices, increasing food production, and ensuring sustainable management of our resources. Because of the advancements in crop science, plants can now be disease resistant, herbicide tolerant, non-browning, insect resistant, drought resistant, and provide more nutritional benefits with each bite. These advancements have been made using both traditional and non-traditional plant breeding techniques.

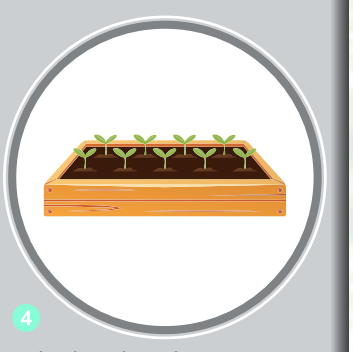
MICROPROPAGATION

1 Tissue sample scraped from parent plant.



2 Tissue sample placed in agar growth medium containing nutrients and auxins

3 Samples develop into tiny plantlets



4 Plantlets planted into compost

MODERN BREE

Modern plant breeding uses advanc resistance, nutritional value, and en productivity and sustainability. It invol controlled breeding programs.

To increase production and meet cro has been used since the 1950's. This t generate a whole new plant. Thousan something that could take a decade i and ornamental plants for your yard o

In 1983 plant breeders inserted DNA from another organism into a plant's DNA creating the first **bioengineered** plant, the Flavor Savor Tomato. Although these tomatoes are no longer on the market, the science that developed them is being used still today and has allowed for the development of plants that are both disease and insect resistant, as well as nutrient dense, and non-browning. This scientific breeding method allows plant breeders to know exactly what is being changed and does not allow for any other unwanted changes in the resulting plant. Examples of crops that have been bioengineered are the Rainbow Papaya, Purple Tomato, Bt Cotton, and more!

FIREFLY PETUNIA

This genetically modified petunia now contains genes from a mushroom that allows for bioluminescence qualities meaning it glows in the dark without the help of special lights, fertilizers, or food.

Why a glowing plant? The glow allows scientists to detect stress within the plant more quickly, the pant can act as an environmental biosensor glowing more brightly when certain pollutants are in the air, water, or soil, among other things.

THE

Thanks to from a inserted plant.

Why a pu change color th and an of antho tomato. known t benefits w

CRISPR is a bioengineering technology but does not always require the introduction of foreign DNA. CRISPR can edit an organism's existing DNA to make changes. Examples include non-browning mushrooms and apples, increased nutrient levels in lettuce and cassava, among others.

ICULTURE IN THE LAB

TRADITIONAL BREEDING

Traditional plant breeding means choosing plants that have good traits, such as high yield or disease resistance, and then crossing them so they pollinate each other. From their offspring, breeders pick the plants that show the best traits. This process uses natural reproduction and does not add any genes from unrelated species, just mixes the genes already found in similar plants. The improved offspring produced through this process are called hybrids.

Traditional breeding can use technology to help. Bayer Crop Sciences has a greenhouse in Marana, Arizona that specializes in research and development of corn for arid climates. Although the breeding is traditional, motorized trays, seed chipping, and several other technologies are implemented to assist in their breeding program.

DING

ced technologies to improve crop traits such as yield, disease nvironmental tolerance, with the goal to increase agricultural lves creating and selecting for desirable traits in plants through

ps demands, **micropropagation**, also known as tissue culture, technique allows breeders to use any part of an existing plant to nds of plants can be produced from a single leaf in tissue culture, n the field. This is used in the nursery industry to produce flowers and other landscapes.

Many wholesale nurseries use micropropagation to grow plants.

E PURPLE TOMATO

an agrobacterium, 2 genes snapdragon flower were into the DNA of a tomato

rple tomato? This genetic allows for the purple hroughout the tomato increase in the amount cyanins produced in the These antioxidants are o have several health when consumed.

ARCTIC APPLES

This non-browning fruit was developed by using biotechnology to silence the gene responsible for producing the browning enzyme. Available in Golden Delicious, Granny Smith, and Fuji varieties in pre sliced or dried fruit.

Why a non-browning apple? The idea was to help eliminate food waste and save some of the 1 billion pounds of apples wasted each year due to artificial browning.

RAINBOW PAPAYA

Since 1990, the Rainbow Papaya has been a staple of the Hawaiian papaya industry. Using biotechnology, a protein from the papaya ring spot virus (PRSV) was inserted into the papaya's DNA giving it resistance to the virus.

Why a disease resistant papaya? The PRSV virus nearly wiped out the entire Hawaiian papaya industry. After efforts to use insecticides to kill the bugs spreading the virus, efforts to burn infected trees, and even moving production to a different island failed to control the disease, biotechnology was the only answer.

BIOENGINEERED

Have you seen this label? It indicates that the food contains genetic material that has been through certain laboratory techniques and not conventional breeding techniques. Science shows these foods and ingredients are just as safe as those produced through traditional breeding methods.

THE SCIENCE OF AGRICULTURE IN THE CAB

Tractors and other farm equipment look far different today than they did even 20 years ago. Thanks to technology, precision agriculture is the way of the future for farmers. Although farmers have always collected and analyzed data to make decisions, the methods and the amount of collecting and analyzing has grown lightyears. This information allows farmers to use technology like *Variable Rate Technology* (VRT) to allow for precise application of inputs like fertilizer, water, and pesticides.

Technology like *Auto-Steer* allows tractors to follow a precise path with no overlapping. This assists in cost savings, better environment, reduced soil compaction, improved crop yield, and improved efficiency and safety for the farmers.

TOOLS OF THE TRADE

SOIL SENSORS

Soil sensors provide real time data to farmers that help them make decisions about inputs such as water and nutrients. This information leads to increased crop yields, better plant health, and a smaller environmental impact.

PENETROMETER

This tool is used to help farmers measure soil compaction. Soil compaction restricts root growth, limits water infiltration, and reduces nutrient availability which can lead to lower crop yields. This tool can also be used to test the firmness of fruit which is a parameter in testing maturity of the fruit.

ROBOTS

Robots can complete routine tasks so farmers can focus on more critical tasks and can reduce the need for labor.

Weed zapping robots use hundreds of cameras to identify a weed from a lettuce plant. A laser then zaps the weed.

Harvesting robots, or soft robots, are being used to harvest crops that were traditionally harvested by hand, such as strawberries and apples.

Laser scarecrows use green lasers (not visible by the human eye) to deter birds from damaging crops such as sweetcorn and grapes. Unlike other deterrents, birds do not get used to them, but become more afraid of them with repeated exposure.

Drones are used for aerial surveying, spraying, and seeding and provide more precise application.

Autonomous Mobile Robots (AMRs) use sensors and data to navigate farms and complete tasks

UV LIGHTS

UV-C light is used to disinfect water in agriculture. This technology damages the DNA and RNA of microorganisms such as bacteria, viruses, and mold, inactivating them without introducing chemicals or byproducts.

- REDUCE PESTICIDE USE - by disinfecting irrigation water, uv technology can help reduce the need for pesticides and other chemical treatments, leading to healthier crops and a more sustainable ag system
- IMPROVE CROP QUALITY - by reducing stress on plants caused by pathogens and other contaminants.
- COST EFFECTIVE - UV systems can be a neutral investment as the cost associated with crop and financial insurance can be lowered.

REFRACTOMETERS

This tool is important in testing the Brix or sugar level in fruits, vegetables, juices, and jams. The Brix level is important for food quality and taste. This tool can also be used in identifying plant health. The higher the Brix the healthier the plant.