CropLife INTERNATIONAL

PLANT BIOTECHNOLOGY 101

Answering Your Questions

CropLife INTERNATIONAL

BIOTECH BASICS

Do you have questions about plant biotechnology? If you do, you're not alone. Many people find that they need to visit multiple sources or decipher scientific jargon for complete, accurate answers.

This booklet will answer many of your questions in one place. It is an easy-to-understand collection of infographics that will increase your knowledge of the basics of plant biotechnology and help you understand some of the more complex questions you often hear.

WHAT IS PLANT BIOTECHNOLOGY?

Plant biotechnology is a sophisticated breeding technology that allows plant breeders to precisely introduce beneficial traits into plants. Biotech crops approved for use today have been improved to help farmers tackle insects, disease and weeds in their fields and in the future could offer foods with higher vitamin levels, longer shelf life or the ability to grow even in the face of climate change.

Genetic modification (GM), genetic engineering (GE) and genetically modified organisms (GMO) are a few other terms that are also often used to refer to plant biotechnology.

Plant biotechnology will be a key tool to

HELP FARMERS PRODUCE

70% MORE FOOD

that will be required to feed this growing planet.

7 BILLION PEOPLE populated the world in 2012.

9 BILLION+ PEOPLE will populate the world in 2050.

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ABOUT CROPLIFE INTERNATIONAL

CropLife International is the voice of the global plant science industry. It champions the role of agricultural innovations in crop protection and plant biotechnology in supporting and advancing sustainable agriculture; helping farmers feed a growing population while looking after the planet; and progressing rural communities. The world needs farmers, and farmers need plant science. CropLife International is proud to be at the heart of helping farmers grow.

Still have questions? VISIT CROPLIFE.ORG TO LEARN MORE.

Why do farmers need to control weeds and insects?

The majority of weeds and insects are unwelcome in a farmer's field. Left uncontrolled they can reduce plant health, robbing a crop of yield and quality. This also impacts a farmer's bottom line. It's in everyone's best interest to limit weeds and insect pressure to help achieve a harvest of safe, affordable and abundant food.

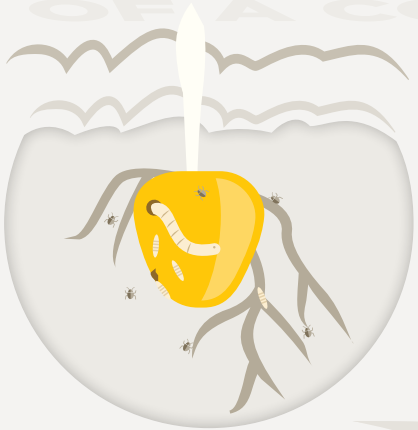
[1] James, C. 2003. Global Review of Commercialized Transgenic Crops: 2002 Feature: Bt Maize. ISAAA Briefs No. 29. ISAAA: Ithaca, NY
[2] Oerke, E.C., 2006, "Crop losses to pests," Journal of Agricultural Science, vol. 144, pp. 31-43
[3] Graham Brookes and Peter Barfoot. Economic impact of GM crops: The global income and production effects 1996–2012. www.landesbioscience.com/journals/gmcrops/article/28098/

THE LIFE OF A CORN COB

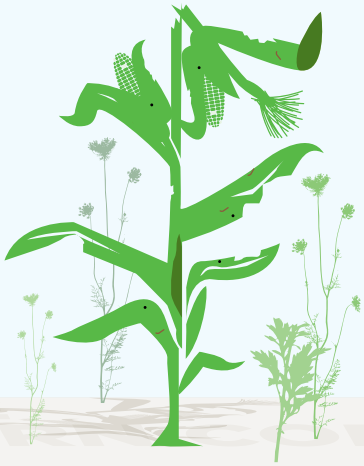
PLANTING

A CORN PLANT WILL FACE CHALLENGES THROUGHOUT THE GROWING SEASON, BEGINNING WITH WEEDS, INSECTS AND DISEASES THREATENING THE CROP BEFORE IT EVEN HAS A CHANCE TO SPROUT.

Biotechnology can provide built-in protection against insects and weeds, giving a corn plant a strong, healthy start.



GROWING



Weeds compete with corn plants for nutrients, moisture, sunlight and space, and provide the ideal hiding place for pests and diseases.

INSECTS FEED ON CORN PLANTS, CAUSING DAMAGE AND TRANSMITTING DISEASE.

Herbicide-tolerant and insect-tolerant biotech traits can help eliminate weed and insect pressure, allowing a corn plant to reach its full potential.

HARVESTING

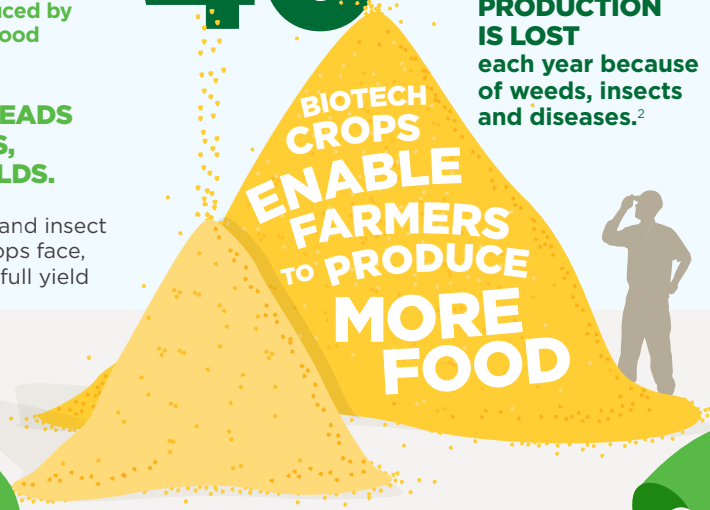
Insect damage lowers the quality of the corn crop, leading to smaller harvests and reduced income for farmers. Insect damage also creates mycotoxins (poisonous substances produced by fungi), which can reduce food quality and safety.[1]

WEED COMPETITION LEADS TO SMALLER COBS, WHICH REDUCES YIELDS.

Without the weed competition and insect damage that conventional crops face, biotech crops can reach their full yield and quality potential.

CONSUMING

UP TO 40% OF THE WORLD'S POTENTIAL CROP PRODUCTION IS LOST each year because of weeds, insects and diseases.[2]



SINCE 1996
biotech crops helped farmers produce
231 million tons more corn.[3]

This provides farmers with a higher income and better quality of life.

How is a biotech crop created?

For thousands of years, farmers and researchers used traditional breeding methods to develop many of the domesticated crops we enjoy today. In the past 100 years though, our global population tripled and plant breeders needed faster and more effective methods to meet the growing demands of our world. Biotechnology provided precise tools that enabled researchers to add a 'trait' or characteristic to a plant. These traits can make the crop heartier and healthier, add higher levels of vitamins, or provide a longer shelf-life after harvest – the opportunities are endless.

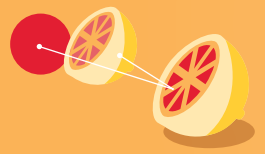
www.irs.gov/Businesses/Biotech-Industry-Overview---History-of-Industry
www.gmoanswers.com/explore
www.nature.com/scitable/knowledge/library/history-of-agricultural-biotechnology-how-crop-development-25885295
www.croplife.org/biotech-crop-development/

BIOTECH CROPS

AN IMPORTANT MILESTONE FOR AGRICULTURE AS IT CONTINUALLY IMPROVES TO KEEP PACE WITH THE GROWING DEMAND FOR FOOD.

FARMERS AND PLANT BREEDERS HAVE BEEN MODIFYING PLANT GENES FOR MORE THAN 10,000 YEARS in order to develop higher-yielding crops and foods with improved nutrition and taste. Plant breeding has evolved over centuries and biotechnology is a continuation of this time-tested process.

1700s
Cross-breeding: farmers and scientists cross-breed plants within a species (e.g. rutabagas are a cross between turnips and cabbage).



1940s
Seed breeding: plant breeders use radiation or chemicals to generate seeds with desirable traits. These random mutations lead to new and useful plant characteristics such as size, sweetness or color (e.g. red grapefruit).

1973
Scientists Stanley Cohen and Herbert Boyer perfect recombinant DNA development – the technique used to cut and paste DNA and reproduce the new DNA in bacteria. This signalled the birth of genetic engineering or modern biotechnology.

1996
First biotech staple crops are commercialized and available for planting.

2015 and beyond
Plant biotechnology continues to evolve with new techniques that will advance food production for farmers and meet the needs of consumers (e.g. genome editing, gene silencing, plastid transformation and inducible genes).

CREATING BIOTECH SEEDS

BC 8000
Simple selection: farmers select seed from top-performing plants. Many "modern" or familiar vegetables and fruits were domesticated through breeding programs.

Scientific discoveries dating back to the 1800s have paved the way for modern plant breeders to use molecular biology to remove the guesswork and imprecision of conventional breeding methods.

1865
Scientist Gregor Mendel's pea-breeding experiments prove heredity and the field of genetics is "born."

1953
Scientists James Watson and Francis Crick discover the double helix structure of DNA.

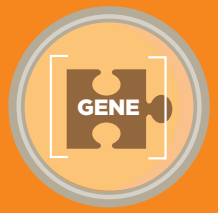
1980s
Insulin is the first approved product of modern biotechnology. Plant breeders apply new techniques of biotechnology to plants.

1996-2014
Researchers introduce biotech corn, soybean, cotton, canola, papaya and more to farmers around the world.

Plant biotechnology is the process of copying a gene for a desired trait (such as insect resistance) from one plant or organism and using it in another plant. Methods for achieving this are continually evolving, but one of the most common ways is:

1. IDENTIFICATION

Identify the gene or genetic material that will make the plant more nutritious, heartier or less susceptible to diseases or pests.



2. TRANSFERRING

Genetic researchers use a revolutionary method that utilizes agrobacterium, a natural organism discovered over 100 years ago, to pass on genes to plants.
The agrobacterium acts like an automobile, carrying its passengers (the genes) into the seed, where they integrate into a precise area of the plant's genetic material.

The agrobacterium then exits the seed, leaving behind the new, beneficial trait.

3. PLANTING

The new seed is then tested for safety, reliability and effectiveness. Once it receives approval by regulators, farmers are able to plant and reap the benefits of this new technology.

Are biotech crops safe?

Yes. Health authorities, scientific experts and governments around the world have all found biotech crops to be one of the most rigorously tested products on the market with a proven safety record for our food and our health.

[1] Critical Reviews in Biotechnology, March 2014, Vol. 34, No. 1
[2] ISAAA Brief 46-2013
[3] Agricultural Biotechnology Council

BIOTECH CROP SAFETY IS OVERWHELMINGLY ENDORSED BY:

HEALTH AUTHORITIES

"No effects on human health have been shown as a result of the consumption of GM foods by the general population in the countries where they have been approved."
- WORLD HEALTH ORGANIZATION

WORLD HEALTH ORGANIZATION (WHO) • AMERICAN MEDICAL ASSOCIATION (AMA)
ROYAL SOCIETY OF MEDICINE (UK) • BRITISH MEDICAL ASSOCIATION • HEALTH CANADA

SCIENTIFIC EXPERTS

"The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe."
- AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS) • NATIONAL ACADEMIES OF SCIENCE OF MANY COUNTRIES
NETWORK OF AFRICAN SCIENCE ACADEMIES (NASAC) • EUROPEAN ACADEMIES SCIENCE ADVISORY COUNCIL (EASAC)
INTERNATIONAL COUNCIL FOR SCIENCE • PONTIFICAL ACADEMY OF SCIENCE

GOVERNMENT ORGANIZATIONS

"The use of more precise technology and the greater regulatory scrutiny probably makes GMs even safer than conventional plants and foods."
- EUROPEAN COMMISSION

EUROPEAN COMMISSION • FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO)
US-FDA • FOOD STANDARDS AUSTRALIA NEW ZEALAND • PHILIPPINES FOOD AND DRUG ADMINISTRATION
FRENCH FOOD SAFETY AGENCY • CANADIAN FOOD INSPECTION AGENCY
U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID)

1,000+ scientific studies over the past 30 years[1]

NEARLY **20 years** of biotech crops in our food supply[2]

3 trillion meals & snacks consumed containing biotech ingredients[3]

0 FOOD SAFETY OR HEALTH ISSUES[3]

Where are biotech crops grown?

Biotech crops are grown worldwide, and have become one of the fastest-adopted crop technologies in the history of agriculture. Over 18 million farmers in 28 countries planted biotech crops – from maize to papaya – in 2014 and every year more growers are adopting the technology. In fact, the number of biotech crop hectares planted has increased 100-fold since the first commercialized seeds were sown in 1996. The world's largest maize and soybean exporters, United States, Brazil and Argentina, almost exclusively grow biotech crops. These trends are expected to continue as more countries embrace biotechnology.

[1] James, Clive. 2013. Global Status of Commercialized Biotech/GM Crops: 2013. ISAAA Brief No. 46. ISAAA: Ithaca, NY.

BIOTECH ADOPTION INCREASES ANNUALLY

FARMERS ARE FAST ADOPTERS

18 MILLION FARMERS GROW BIOTECH CROPS

90% of biotech growers live in developing countries where biotech crop benefits, such as better harvests and higher incomes, can transform rural communities.

NEARLY 100% of farmers replant biotech crops year after year.

5 billion people live in countries that are growing, eating or using biotech crops in their everyday lives.

COUNTRIES EMBRACE BIOTECH

28 COUNTRIES GROW BIOTECH CROPS*

Developing countries | Industrial countries

63 COUNTRIES import biotech crops**

7 AFRICAN countries conduct biotech field trials***

9 ASIAN countries conduct biotech field trials****

BIOTECH ADOPTION IS HIGH

SOYBEAN
- **79%** of global acres
- **94%** adoption rate in U.S.
- **92%** adoption rate in Brazil

CANOLA
- **24%** of global acres
- **99%** adoption rate in Australia
- **95%** adoption rate in Canada

COTTON
- **70%** of global acres
- **89%** adoption rate in Sudan in just second year of planting
- **93%** adoption rate in India

MAIZE
- **90%+** The percentage of biotech maize hectares in the U.S., Brazil and Argentina, helping them be the top 3 maize exporters worldwide

PAPAYA
75% adoption rate in Hawaii

SUGAR BEET
95% adoption rate in U.S.

* Argentina, Australia, Bolivia, Brazil, Burkina Faso, Canada, Chile, China, Columbia, Costa Rica, Cuba, Czech Republic, Honduras, India, Mexico, Myanmar, Paraguay, Pakistan, Philippines, Portugal,, Romania, Slovakia, South Africa, Spain, Sudan, U.S., Uruguay

** Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Brazil, Bulgaria, Burkina Faso, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Honduras, Hungary, Indonesia, India, Iran, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Netherlands, Mexico, Myanmar, New Zealand, Norway, Pakistan, Panama, Paraguay, Philippines, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Taiwan, Thailand, Turkey, United Kingdom, U.S., Uruguay

*** Cameroon, Ghana, Kenya, Malawi, Nigeria, Uganda **** Bangladesh, China, India, Indonesia, Japan, Malaysia, Pakistan, Philippines, Vietnam

What are the benefits of biotech crops?

Plant biotechnology enables farmers worldwide to boost the profitability, productivity and sustainability of their farms. This helps create a better quality of life for their community by improving the local economy, provides consumers with high-quality nutritious crops and protects the natural environment around us.

[1] ISAAA Brief 26-2013
[2] Indicus Analytics, 2007. Socio-economic appraisal of Bt cotton cultivation in India. Indicus Analytics Study.
[3] Graham Brookes and Peter Barfoot. Economic impact of GM crops: The global income and production effects 1996–2012. www.landesbioscience.com/journals/gmcrops/article/28098/
[4] www.ncga.com/news-and-resources/news-stories/article/2012/8/our-view-lies-damn-lies-and-statistics
[5] www.madehow.com/Volume-2/Tofu.html#ixzz3ERC318Na
[6] www.statcan.gc.ca/pub/96-325-x/2007000/article/10778-eng.htm#howto
[7] IFPRI tool: http://apps.harvestchoice.org/agritech-toolbox/
[8] http://ars.usda.gov/is/AR/archive/jul97/gcd0797.htm
[9] IFPRI tool: http://apps.harvestchoice.org/agritech-toolbox/

PLANT BIOTECHNOLOGY HELPS OUR WORLD GROW

PROGRESS RURAL COMMUNITIES

In 2013, biotech crops helped increase farm incomes and food security, while

alleviating poverty

for more than 65 million smallholder farmers

&

their family members through higher crop yields.[1]

In India, biotech cotton provides higher incomes and leads to

A BETTER QUALITY OF LIFE.

This includes improved access to telephone systems, drinking water and economic infrastructure as well as more maternal health care, higher school enrollment and increased vaccination rates.[2]

FEED A GROWING POPULATION

Biotech crops help meet the world's growing demand for food through increased crop productivity. Since 1996,

FARMERS HAVE ADDED

358 MILLION EXTRA TONS

TO OUR GLOBAL FOOD SUPPLY[3]

That's like providing every person on earth with

99 BOXES OF CORN FLAKES,[4] 125 SERVINGS OF TOFU,[5] AND A 14 OZ BOTTLE OF CANOLA OIL.[6]

In the future, advanced biotech traits like nitrogen-use efficiency will improve plant growth. This could **nearly double yields of irrigated maize in Latin America and Sub-Saharan Africa in 2050.[7]**

Nutrition-enhanced foods developed through biotechnology, from vitamin-A enriched bananas to sorghum with **higher levels of essential nutrients, could help the two billion malnourished people in developing regions.[9]**

LOOK AFTER OUR PLANET

Biotech crops protect the environment.

Herbicide-tolerant crops reduce the need for tillage, keeping carbon in the soil.

NO-TILL FARMING PREVENTS ENOUGH CO_2 EMISSIONS – AT LEAST 3.2 MILLION TONS EACH YEAR – to offset home electricity use in the United States for nearly 3.5 years.[8]

By allowing farmers to grow more on less land,

123 MILLION HECTARES

of natural habitats were preserved

between 1996 & 2012.[5]

How does plant biotech impact our daily lives?

We benefit from plant biotechnology from morning until night – from the food we put on our kitchen table, to the fuel we put in our cars, to the fibers that make your favorite shirt.

[1] http://isaaa.org/resources/publications/pocketk/16/default.asp
[2] Graham Brookes and Peter Barfoot. Economic impact of GM crops: The global income and production effects 1996–2012. www.landesbioscience.com/journals/gmcrops/article/28098/
[3] www.ncga.com/news-and-resources/news-stories/article/2012/8/our-view-lies-damn-lies-and-statistics
[4] Barfoot P, Brookes G. Key global environmental impacts of genetically modified (GM) crop use 1996–2012. GM Crops and Food: Biotechnology in Agriculture and the Food Chain.
[5] http://www.tfl.gov.uk/cdn/static/cms/documents/technical-note-12-how-many-cars-are-there-in-london.pdf
[6] www.arborgen.com/biotech-tress/
[7] www.hawaiipapaya.com/rainbow.htm
[8] http://banana.aatf-africa.org/news/media/new-gm-banana-could-help-tackle-uganda%E2%80%99s-nutrition-challenges
[9] www.canolacouncil.org/oil-and-meal/canola-oil/health-benefits-of-canola-oil/
[10] www.plenish.com

BIOTECH THROUGHOUT THE DAY

7 AM WAKE UP

AT THE OFFICE

Biotech eucalyptus trees could soon be used as a sustainable paper source that

SAVES NATIVE FORESTS FOR FUTURE GENERATIONS.[6]

DRIVING TO WORK

Biotech crops mitigate the carbon impacts of your car by reducing on-farm emissions.

In 2012 alone, the amount of CO_2 saved by biotech crops was equal to

REMOVING EVERY SINGLE CAR FROM THE STREETS OF LONDON FOR FIVE YEARS.[4,5]

BREAKFAST

Since 1996, biotech has added 231 million more tons of corn to the food supply or enough corn for approximately

707 BILLION BOXES OF CORN FLAKES – that's nearly 100 boxes for every person on the planet![2,3]

GETTING DRESSED

70% OF COTTON produced worldwide is biotech.[1]

LUNCHTIME

Papayas developed through biotechnology are resistant to a deadly virus that would otherwise devastate a farmer's harvest.

IN THE UNITED STATES, THIS SAVED THE ENTIRE PAPAYA INDUSTRY.[7]

AFTERNOON SNACK

Bananas are being enhanced through biotechnology to provide

MORE ESSENTIAL VITAMINS

and minerals to your mid-afternoon snack.[8]

DRIVING HOME

Biotechnology increases production of crops such as corn and soybeans to meet biofuel demands, giving you access to

CLEANER, ENVIRONMENTALLY FRIENDLY SOURCES of renewable energy.

DINNER

New biotech canola and soybean seeds produce new,

HEALTHIER COOKING OILS

with higher levels of omega-3 fatty acids, no trans-fat and lower saturated fat.[9,10]

Biotech corn and soybeans are

USED TO FEED LIVESTOCK ON EVERY CONTINENT, INCLUDING EUROPE,

offering the animals a healthy, nutritious source of protein and calories.

Does the public sector conduct plant biotech research?

Yes, public sector organizations are developing ground-breaking biotech innovations that can help tackle climate change, fight malnutrition in developing regions, improve food security and more. These projects are poised to deliver incredible benefits to farming communities and improve the health of our world.

[1] http://www.hawaiipapaya.com/rainbow.htm
[2] http://banana.aatf-africa.org/news/media/new-gm-banana-could-help-tackle-uganda%E2%80%99s-nutrition-challenges
[3] http://www.goldenrice.org/
[4] IFPRI
[5] http://wema.aatf-africa.org/about-wema-project
[6] http://css.wsu.edu/people/faculty/diter-von-wettstein/developing-wheat-free-of-harmful-gluten-proteins/

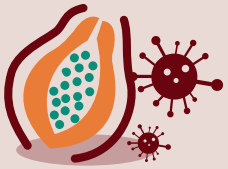
PUBLIC SECTOR RESEARCH DELIVERS BIOTECH SOLUTIONS

Universities, government institutions and non-profits worldwide are working to develop new biotech innovations for farmers and consumers.

Rainbow papaya

with built-in protection against a devastating plant virus **saved the $17 million U.S. Hawaiian papaya industry from collapse.** Today, Hawaii's papaya farmers are flourishing as a result of biotech papaya.[1]

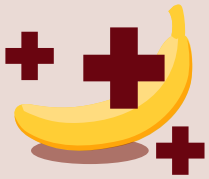
- CORNELL UNIVERSITY, UNIVERSITY OF HAWAII AND U.S. DEPARTMENT OF AGRICULTURE'S AGRICULTURAL RESEARCH SERVICE



Vitamin A-rich bananas

with six times the normal level of nutrients could one day **benefit 52% of Ugandan children under age five whose health suffers** from Vitamin A deficiencies.[2]

- UGANDAN NATIONAL AGRICULTURAL RESEARCH ORGANIZATION (NARO)



Golden rice,

which boasts high amounts of beta-carotene and iron, is expected to **significantly reduce Vitamin A deficiency in developing regions, which is responsible for 500,000 cases of irreversible blindness and up to 2 million deaths** each year.[3]

- SWISS FEDERAL INSTITUTE OF TECHNOLOGY, THE UNIVERSITY OF FREIBURG, GERMANY AND THE INTERNATIONAL RICE RESEARCH INSTITUTE

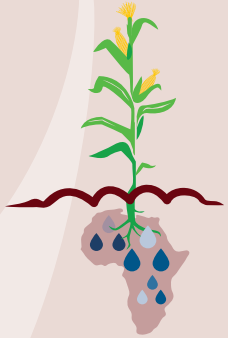
Public-Private Partnerships

Public-private partnerships offer a way for the public sector to pursue collaborative projects with the private sector, addressing local challenges and bringing greater innovation to our world's farmers.

Drought-tolerant maize

with conventional and biotech traits that help farmers in drought-prone Africa maximize crop production will be available in 2017, **benefiting more than 300 million Africans who depend on maize as their main food source.**[4,5]

- WATER EFFICIENT MAIZE FOR AFRICA (WEMA), A COLLABORATION BETWEEN AFRICAN NATIONAL RESEARCH INSTITUTES AND THE PRIVATE SECTOR



Gluten-free wheat

developed through biotechnology will one day benefit people who suffer digestive problems triggered by gluten (a protein found in wheat). This breakthrough innovation will **help provide individuals with wheat allergies and Celiac disease with a wider range of safe food choices.**[6]

- PARTNERSHIP BETWEEN WASHINGTON STATE UNIVERSITY AND THE PRIVATE SECTOR

For more info about each of these innovations, visit:
Rainbow Papaya: www.hawaiipapaya.com/rainbow.htm
Vitamin A-Rich Bananas: http://banana.aatf-africa.org/news/media/new-gm-banana-could-help-tackle-uganda%E2%80%99s-nutrition-challenges
Golden Rice: www.goldenrice.org
WEMA: wema.aatf-africa.org/about-wema-project
Gluten-Free Wheat: http://css.wsu.edu/people/faculty/diter-von-wettstein/developing-wheat-free-of-harmful-gluten-proteins/

What are some biotech crops of the future?

Plant biotechnology has already provided farmers with agricultural innovations they never thought possible. The future promises even greater advancements. Biotech seeds in the product development pipeline will help farmers better weather climate change and provide consumers worldwide with solutions to fight malnutrition and health issues.

[1] http://croplife.org/wp-content/uploads/2014/09/Climate-Change-Brochure.pdf
[2] http://www.croplife.ca/plant-biotechnology/what-are-the-benefits
[3] http://www.danforthcenter.org/scientists-research/research-institutes/institute-for-international-crop-improvement/crop-improvement-projects/biocassava-plus
[4] http://biosorghum.org/abs.php http://gmoanswers.com/plant-biotechnology-research-can-be-found-more-just-private-sector-universities-government
[5] http://www.croplife.ca/plant-biotechnology/what-are-the-benefits
[6] http://www.okspecialtyfruits.com/arctic-apples/advantages-nonbrowning-apple

FUTURE PLANT BIOTECH INNOVATIONS

FROM FARM

Biotech seed innovations will help farmers continually produce a safe and bountiful harvest in the face of increasingly volatile weather conditions. New varieties on the horizon will help farmers continue to build resilience to climate change, resulting in increased productivity, profitability and sustainability.

Nitrogen-use efficient seed varieties will allow crops to use applied nitrogen more efficiently leading to better growth, increased production and reduced carbon footprints.[1]

Flood-tolerant varieties will provide yield stability in extremely wet climates.

Drought-tolerant varieties will protect harvests and minimize losses in times of severe drought by using water more efficiently.

Advances in herbicide-, disease- and insect-tolerant seeds will provide even greater control of harmful pests.

Saline-tolerant and heat-tolerant seeds will enable farmers to take advantage of land that is currently unusable for crop production.[2]

These technologies will be **MOST BENEFICIAL IN DEVELOPING REGIONS** where farmers are increasingly facing volatile weather and extreme growing conditions due to climate change.

TO FORK

Biotechnology will play an important role in providing DEVELOPING REGIONS with biofortified foods that help tackle malnutrition. In INDUSTRIAL COUNTRIES, consumers will also benefit from biotech food innovations that enhance nutrition, quality and convenience.

More nutritious and higher yielding cassava, the primary source of calories for over 250 million people in Sub-Saharan Africa, will help to reduce malnutrition.[3]

A nutrient-rich and more easily digestible sorghum, containing increased levels of essential amino acids and vitamins, will improve the health of millions of people in Africa who rely on the staple as their primary diet.[4]

Foods with disease-fighting properties such as tomatoes rich in antioxidants, pink-fleshed pineapples with higher levels of lycopene, corn and soybeans with increased vitamin C and E, and oilseeds that produce heart-healthy oils.[5]

Apples and potatoes that don't brown when sliced, leading to increased consumption for better health and less food waste.[6]

THE FUTURE POTENTIAL OF PLANT BIOTECHNOLOGY IS LIMITLESS

– from crops that enable farmers to maximize productivity and ensure food security to foods that enhance consumer diets and reduce health risks.

How do farmers stay ahead of pest resistance?

Pests have always been a fact of life for farmers. For thousands of years, they have adopted countless methods to fight them off and protect their crops. However, all pests will inevitably fight back and can develop resistance to these methods. Farms around the world, from biotech to conventional to organic, must work to manage potential resistance and ensure technologies that control yield-robbing pests remain effective.

STAYING AHEAD OF PEST RESISTANCE

Resistance is when a weed, insect or disease evolves to withstand the farmer's pest management strategy. It is inevitable and happens in every crop production system – from conventional to biotech to organic. Farmers are able to delay the onset of resistance and maximize the effectiveness of the technology by implementing resistance management plans tailored to their field and pest pressures. Three common approaches to resistance management include: crop rotation, refuge planting and stacked traits.

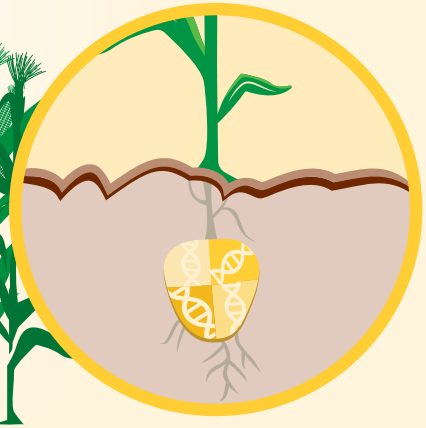
CROP ROTATION

Because different pests attack different crops, **CROP ROTATION PREVENTS A BUILDUP OF CERTAIN DISEASES OR INSECTS** that can become tolerant to the control method. Through crop rotation, a different crop is planted in a field periodically, limiting the development of resistance.

This corn field will be planted with soybeans next year and a different crop the following year.

REFUGE PLANTING

Farmers who plant insect-tolerant biotech crops often plant a refuge area – a block or strip of crop without the biotech trait. **REFUGE PREVENTS FUTURE GENERATIONS OF PESTS FROM BUILDING IMMUNITY BY ENSURING A SMALL PROPORTION OF INSECTS WITHOUT RESISTANCE ARE ALWAYS PRESENT.** If a resistant insect is born, it or its offspring will eventually mate with a non-resistant insect thereby delaying the onset of resistance.



STACKED TRAITS

"Stacked traits" can incorporate **MULTIPLE TRAITS IN THE SAME SEED, PROVIDING DIFFERENT METHODS TO CONTROL PESTS WITHIN ONE PLANT.** If a pest becomes resistant to one of traits, another trait can eliminate the pest and remove its resistance from the insect population.

This quadruple-stacked corn seed provides four different built-in pest controls – two for insects and two for weeds – so farmers can limit resistance well into the future.

RESISTANCE MANAGEMENT PLANS ARE AN ESSENTIAL WAY TO ENSURE NOT JUST A BIOTECH CROP, HOWEVER ANY METHOD OF ELIMINATING PESTS CAN REMAIN EFFECTIVE LONG INTO THE FUTURE. RESISTANT WEEDS AND INSECTS HAVE BEEN FOUND ON BIOTECH FIELDS IN CERTAIN PARTS OF THE WORLD, BUT BY WORKING HAND-IN-HAND ON RESISTANCE MANAGEMENT WITH THE PLANT SCIENCE INDUSTRY, FARMERS HAVE SUCCESSFULLY LIMITED RESISTANCE TO A SMALL NUMBER OF ACRES.

PLANT BIOTECHNOLOGY 101 SUMMARY

CONTROLLING YIELD-ROBBING PESTS

Farmers control weeds and insects with the help of biotechnology to help achieve a successful harvest of safe, affordable and abundant food.

INCREASING ADOPTION

Biotech crops are grown worldwide, and have been one of the fastest-adopted crop technologies in the history of agriculture.

DELIVERING MORE EFFECTIVE PLANT BREEDING METHODS

Biotechnology provides precise tools that enable plant breeders to effectively develop crops that help meet the growing demands of our world.

BENEFITING OUR WORLD

Plant biotechnology helps our world grow by contributing to progress in rural communities, feeding a growing population, and looking after our planet.

CONFIRMING SAFETY

Health authorities, scientific experts and government organizations overwhelmingly endorse biotech crop safety.

IMPACTING OUR DAILY LIVES

We benefit from plant biotechnology from morning until night – from the food we put on our kitchen table, to the fuel we put in our cars, to the fibers that make your favorite shirt.

EXCITING FUTURE INNOVATIONS

Biotech seeds now being developed will help farmers better weather climate change and provide consumers worldwide with solutions to fight malnutrition and health issues.

GROUNDBREAKING PUBLIC SECTOR RESEARCH

Public sector organizations are developing groundbreaking biotech innovations that can help tackle climate change, fight malnutrition in developing regions, improve food security and more.

MANAGING RESISTANCE

Farmers around the world, from conventional to biotech to organic, work to manage potential resistance to ensure technologies that control yield-robbing pests remain effective.

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Helping Farmers Grow