

# DISCOVERY

## FINDING A NEW TRAIT



STAGE:  
STEP 1 - DISCOVERY

IN TESTING:  
TENS OF THOUSANDS OF GENES

DURATION:  
24-48 MONTHS

When it comes to creating new Bayer trait technology, we start by first identifying the challenges our farmers face. Then, we look to nature to find solutions to their problems. We search other plants, algae and bacteria for traits that can help maximize yields despite pressures from insects, weeds and other stressors.

We start by looking at tens of thousands of genes before we select a fraction that seem to be displaying the traits we're looking for.

## BAYER SUCCESSES

### PRODUCTS

#### INSECT MANAGEMENT



**SmartStax<sup>®</sup> PRO**  
TECHNOLOGY

#### Challenge:

Controlling corn rootworm (known as the billion-dollar bug), which can have devastating effects on yields, especially in continuous corn fields.

#### Solution:

Bayer is the first to develop RNAi Technology to combat corn rootworm, which offers a third mode of action against the pest. By interfering with a corn rootworm's ability to create a specific protein critical to its own survival, RNAi Technology effectively causes mortality after ingestion.

#### Result:

SmartStax<sup>®</sup> PRO Technology protects corn from corn rootworm.

#### WEED MANAGEMENT



**XtendFlex<sup>®</sup>**  
SOYBEANS

#### Challenge:

Farmers need additional tolerance to glufosinate for more flexibility and herbicide choices to manage their unique weed control challenges.

#### Solution:

Our scientists created a stack containing MON 87708 x MON 89788 x A5547-127, which provides soybean plants tolerance to dicamba, glyphosate and glufosinate.

#### Result:

XtendFlex<sup>®</sup> soybeans provide farmers with yet another option to drive and protect their yield potential with triple-stacked tolerance to dicamba, glyphosate and glufosinate.

#### YIELD AND STRESS



**DroughtGard<sup>®</sup>**  
HYBRIDS

#### Challenge:

Drought-stricken corn limits a plant's ability to produce the proteins necessary to develop healthy kernels.

#### Solution:

Our scientists found a soil bacterium called cspB, which allows stressed corn plants to use water more efficiently in drought conditions.

#### Result:

DroughtGard<sup>®</sup> Hybrids are selected to offer high yield potential in well-watered conditions and to protect against the risk of yield loss when drought stress occurs.



# PROOF OF CONCEPT

## EXPLORING AND TRANSFERRING GENES

STAGE:  
STEP 2 - PROOF OF CONCEPT

IN TESTING:  
THOUSANDS OF GENES

DURATION:  
12-24 MONTHS

**Once we've identified the trait we want, we start exploring the genetic makeup of biological sources responsible for expressing that trait.** We use a Pacific Biosciences machine, which can sequence 150,000 genes in as little as 30-180 minutes, to rapidly identify the gene on the DNA sequence.

Next, we take the identified gene and transfer it into the genome of the seed embryos using a soil bacterium known as *Agrobacterium tumefaciens*. The gene will be placed with many different markers on each candidate's DNA strand to identify the location that best expresses the desired trait, taking extra care not to let the placement interfere with other desired traits already existing in the plant. Then, the *Agrobacterium tumefaciens* DNA inserts itself along with the new trait DNA into the seed embryo's DNA.

After the gene is transferred, we begin replicating the cells. Just one cell from each seed containing the new gene is enough to make more cells. Naturally occurring plant growth hormones induce each cell mass to grow leaves and roots, creating new transgenic plants containing the new gene.

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# EARLY DEVELOPMENT

## GROWING AND TESTING TRAITS

**STAGE:**

STEP 3 - EARLY DEVELOPMENT

**IN TESTING:**

FEWER THAN 100

**DURATION:**

12-24 MONTHS

**Once transgenic plants with the desired gene are successfully grown, they are moved to one of over a hundred growth chambers we have for observation.** The growth chambers house thousands of candidate plants that are tested for viability, with the most viable seedlings moving to greenhouses for continued research.

In the greenhouses, the plants are monitored to see which candidates perform best. Because each variety is adapted to different growing conditions, we outcross the most successful candidates with other crop varieties that might benefit from this trait. This natural breeding process is used to generate plants with the new trait without having to go through the transformation process each time.

Throughout the whole genetic transformation process, quality assurance is a crucial step performed on the candidate plants to ensure the gene is expressing as expected. In the growth chambers, our manufacturing quality control takes samples from the mature plants to test them against already collected expression data.

Learn about products in this phase,  
continued on the following page →

# CURRENT PIPELINE PRODUCTS

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## CORN

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### WEED MANAGEMENT

#### HT5/Fifth-Generation Weed Control

This product would contain multiple herbicide tolerances, offering farmers greater flexibility in effective weed management while producing higher-yielding corn.

### INSECT MANAGEMENT

#### Fifth-Generation Above-Ground Insect-Protected Corn

This product would help reduce the number of pesticide applications farmers must apply, saving fuel and reducing carbon emissions with fewer passes over the field.

## COTTON

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### WEED MANAGEMENT

#### Fourth-Generation Herbicide-Tolerant Cotton

This product could offer farmers greater flexibility in an effective weed management system.

### INSECT MANAGEMENT

#### Fourth-Generation Bollgard® Technology

This cotton product has novel proteins that could guard crops against key cotton pests.

## SOY

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### WEED MANAGEMENT

#### Fifth-Generation Soybean With Tolerance to Six Herbicides

This product would offer six herbicide tolerances, including glyphosate; dicamba; glufosinate; HPPD; 2,4-D; and PPO. It would provide farmers greater flexibility in an effective weed management system.

# ADVANCED DEVELOPMENT

## FIELD TESTING



**STAGE:**  
**STEP 4 - ADVANCED DEVELOPMENT**

**IN TESTING:**  
**FEWER THAN 5**

**DURATION:**  
**12-24 MONTHS**

**Our most successful greenhouse candidates are planted in our test fields and in our research centers for trials.**

We conduct field trials in stages. Testing typically begins with a small number of plants and expands as more information is obtained. The results from our small-scale field trials are used to further screen and select candidates to be tested in larger field trials.

We developed our research centers to provide farmers, dealers and agronomists with the latest information regarding production practices and reinforce stewardship of biotech products to enhance their sustainability.

These trials allow us to generate the necessary environmental safety data required by governmental regulatory authorities that evaluate commercial product approvals. Adherence to APHIS compliance standards is the starting point for our field trial compliance programs. We then implement additional procedures to achieve the highest level of compliance including:

- Comprehensive training for those conducting field trials and all responsible for field-site compliance
- Extensive procedures for all field personnel involved in trial work
- Documentation of critical points for each trial
- Preventative auditing to verify compliance with internal and external standards and to identify process improvement opportunities.

We believe our compliance program is among the most comprehensive and successful programs in the industry, but we are continually reviewing and strengthening our practices.

Learn about products in this phase,  
continued on the following page →

# CURRENT PIPELINE PRODUCTS

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## CORN

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### WEED MANAGEMENT

#### **Fourth-Generation Weed Control**

This product would contain multiple herbicide tolerances that could help farmers protect fields from broadleaf and grass weeds.

### INSECT MANAGEMENT

#### **Fourth-Generation Below-Ground Insect Protection**

This product could provide farmers with multiple modes of action for increased root protection and crop durability against corn rootworm.

#### **Fourth-Generation Above-Ground Insect Protection**

Incremental advancements to resistant systems like this can help reduce the number of pesticide applications farmers must apply, saving fuel and reducing carbon emissions with fewer passes over the field.

### YIELD AND STRESS

#### **Short-Stature Hybrids**

This product will be the next generation of corn production with three key benefits: protection from crop loss potential due to wind damage; season-long access due to shorter height, helping optimize disease, pest and nutrient management; and higher yield stability and yield potential.

## SOY

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### WEED MANAGEMENT

#### **Fourth-Generation Herbicide-Tolerant Soy**

This high yield potential soybean could help farmers manage weeds because of its additional modes of action for control and its tolerance to certain herbicides.

# PRE-LAUNCH

## ON-FARM TRIALS



STAGE:  
STEP 5 - PRE-LAUNCH

IN TESTING:  
FINAL GENE (OR GENE COMBINATIONS)

DURATION:  
12-36 MONTHS

**In the final step of our pipeline, only one gene out of tens of thousands will have made it.**

After years of in-house research and regulatory approvals, one select gene will move to real farms to be trialed by our field trial participants. These farmers will get firsthand experience with our pipeline product under commercial-scale planting conditions. This program combines full-field and small-scale approaches to optimize the farmer's experience, training and education opportunities.

Additional regulatory approvals will continue and are followed by seed bulk-up and eventually marketing preparations for commercialization.

Learn about products in this phase,  
continued on the following page →

# CURRENT PIPELINE PRODUCTS

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## CORN

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### INSECT MANAGEMENT

#### SmartStax® PRO Technology

SmartStax® PRO Technology combines the proven benefits of SmartStax® Technology corn rootworm protection with an additional, novel RNAi-based mode of action, providing improved corn rootworm control over a range of pressures.\*

To prepare for the commercial launch of SmartStax PRO Technology, on-farm trials are being conducted in 2021. Limited volumes of SmartStax PRO Technology products will be available to farmers in 2022, and by 2023 and beyond, volumes will be ramped up to give farmers in areas dealing with the risk of corn rootworm the latest level of protection.

\*Based upon 2019-2020 Bayer internal trials comparing leading corn rootworm technologies in fields with moderate to heavy corn rootworm pressure.

## COTTON

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### INSECT MANAGEMENT

#### Bollgard® 3 ThryvOn™ Cotton With XtendFlex® Technology

Bollgard® 3 ThryvOn™ with XtendFlex® Technology is poised to be the industry's first biotech trait providing season-long protection against tarnished plant bugs and thrips species\*\* and may help reduce the need for insecticide applications.

\*\*ThryvOn™ Technology may help reduce insecticide applications for tarnished plant bugs and thrips species (tobacco thrips (Frankliniella fusca); Western flower thrips (Frankliniella occidentalis); tarnished plant bug (Lygus lineolaris); and the Western Tarnished Plant bug (Lygus hesperus). Scouting is critical to determine which and how many insecticide applications are recommended to avoid economic losses greater than the pest management costs (i.e., when economic thresholds are met).

**Bayer is a member of Excellence Through Stewardship® (ETS).** Bayer products are commercialized in accordance with ETS Product Launch Stewardship Guidance, and in compliance with Bayer's Policy for Commercialization of Biotechnology-Derived Plant Products in Commodity Crops. Commercialized products have been approved for import into key export markets with functioning regulatory systems. Any crop or material produced from this product can only be exported to, or used, processed or sold in countries where all necessary regulatory approvals have been granted. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Growers should talk to their grain handler or product purchaser to confirm their buying position for this product. Excellence Through Stewardship® is a registered trademark of Excellence Through Stewardship.

**SmartStax® PRO corn products** will be commercially available for the 2022 growing season.

**ThryvOn™ Technology** has received full approval for planting in the United States but, as of the date this material was published, is pending approval in certain export markets. Specific plans for commercialization depend upon regulatory approvals and other factors.

**ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS.** It is a violation of federal and state law to use any pesticide product other than in accordance with its labeling. NOT ALL formulations of dicamba, glyphosate or glufosinate are approved for in-crop use with products with XtendFlex® Technology. ONLY USE FORMULATIONS THAT ARE SPECIFICALLY LABELED FOR SUCH USES AND APPROVED FOR SUCH USE IN THE STATE OF APPLICATION. Contact the U.S. EPA and your state pesticide regulatory agency with any questions about the approval status of dicamba herbicide products for in-crop use with Roundup Ready 2 Xtend® soybeans or products with XtendFlex® Technology.

**B.t. products** may not yet be registered in all states. Check with your seed brand representative for the registration status in your state.

**IMPORTANT IRM INFORMATION: RIB Complete®** corn blend products do not require the planting of a structured refuge **except** in the Cotton-Growing Area where corn earworm is a significant pest. **See the IRM/Grower Guide for additional information. Always read and follow IRM requirements.**

**Roundup Ready® 2 Technology** contains genes that confer tolerance to glyphosate. **Products with XtendFlex® Technology** contains genes that confer tolerance to glyphosate, glufosinate and dicamba. **Glyphosate** will kill crops that are not tolerant to glyphosate. **Dicamba** will kill crops that are not tolerant to dicamba. **Glufosinate** will kill crops that are not tolerant to glufosinate. Contact your seed brand dealer or refer to the Bayer Technology Use Guide for recommended weed control programs.

Insect control technology provided by **Vip3A** is utilized under license from Syngenta Crop Protection AG. Herculex® is a registered trademark of Dow AgroSciences LLC. LibertyLink® and the Water Droplet Design® is a trademark of BASF Corporation. Respect the Refuge and Corn Design® and Respect the Refuge® are registered trademarks of National Corn Growers Association. Bayer, Bayer Cross, Bollgard®, DroughtGard®, Respect the Refuge and Cotton Design®, RIB Complete®, Roundup Ready 2 Technology and Design™, Roundup Ready 2 Xtend®, Roundup Ready 2 Yield®, Roundup Ready®, SmartStax®, ThryvOn™ and XtendFlex® are trademarks of Bayer Group. ©2021 Bayer Group. All rights reserved.

