RESEARCH & DEVELOPMENT PIPELINE

farming innovation
WHAT’S IN IT

for all of us
we’re working with farmers
to meet growing global demands

With the population expected to grow by 40 percent in the next few decades, farmers will need to grow as much food in the next 50 years as they did in the past 10,000 years combined—all while dealing with limited resources. While it may seem like a daunting task, it’s our mission to deliver agricultural innovations that can help farmers do just that! That’s why our 4,800+ research and development-focused employees around the world are working each day to discover and deliver products to help farmers produce more crops while conserving more natural resources for future generations.
Our robust pipeline of innovative agricultural products spans more than a dozen crops in different stages of development, or phases. Some of our pipeline products are brand new concepts in discovery that may not be commercially available for farmers to plant for over a decade. Others are in pre-launch, or phase four, and are expected to become a reality for some farmers in a few short years. Regardless of what phase each of our pipeline products is in, every single one aims to make agriculture more productive, more profitable for farmers and more efficient and sustainable for our planet.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Average Duration</th>
<th>Probability of Success</th>
<th>Candidates in This Phase</th>
<th>Phase Activities</th>
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<tbody>
<tr>
<td>discovery gene/trait identification</td>
<td>24 to 48 months</td>
<td>5%</td>
<td>tens of thousands</td>
<td>high-throughput screening and model crop testing</td>
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<tr>
<td>phase 1 proof of concept</td>
<td>12 to 24 months</td>
<td>25%</td>
<td>thousands</td>
<td>gene optimization and crop transformation</td>
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<tr>
<td>phase 2 early development</td>
<td>12 to 24 months</td>
<td>50%</td>
<td>tens</td>
<td>trait development, pre-regulatory data and large-scale transformation</td>
</tr>
<tr>
<td>phase 3 advanced development</td>
<td>12 to 24 months</td>
<td>75%</td>
<td>less than five</td>
<td>trait integration, field testing and regulatory data generation</td>
</tr>
<tr>
<td>phase 4 pre-launch</td>
<td>12 to 36 months</td>
<td>90%</td>
<td>pre-commercial product</td>
<td>regulatory submission, seed bulk-up and pre-marketing</td>
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market launch
We believe increasing yield potential doesn’t just happen in the lab. It is the combination of advanced breeding, biotechnology and the agronomic practice improvements farmers employ that help drive yield sustainably. Agronomic practice improvements include precision agriculture, conservation tillage, seed treatments, planting patterns and many other tools.

breeding + biotechnology + agronomics = sustainable agriculture
Our advanced technologies, such as seed chippers, enable breeders to know what characteristics plants will have before the seed is even planted. This enables Monsanto breeders to more efficiently conduct research trials in the field each year, helping us to get the best seeds to farmers faster. The seed chippers are a revolutionary way of testing seed genetics because other testing methods destroy the seeds’ viability.

The small chip that is removed from the seed by the chipper can be analyzed for its genetic code while maintaining the seed’s viability so it can be planted and grown in a field test. Because of this technology, we are able to only plant seeds with superior product potential.
Our plant breeders around the world are challenged each day with finding and developing seeds that have special qualities and can deliver a wide array of benefits to farmers. For example, we might be looking for a seed that has a high tolerance to drought conditions. To streamline and simplify the process, our researchers have created and utilize sophisticated diagnostic tools that allow us to peer into the core of millions of seeds—into their DNA—and locate the traits we need. Our global library of genetic material—or germplasm library—is leveraged by these breeders at numerous locations around the world and enables them to combine genes from distant locations to create valuable new seed products for growers. For example, a leading North American corn hybrid may have in its ancestry germplasm that is native to Argentina and Brazil.
Breeding technology today allows our plant breeders to make more informed decisions earlier in the process. So, by the time breeders get into field research trials, they have already pre-screened and eliminated the least powerful breeding stock. That allows us to focus on the germplasm that has the best potential for offering a commercially viable combination of desirable traits to the farmer, faster. Compared to conventional breeding, our breeding program today is doubling the rate of improvement in key genetic characteristics such as yield and important agronomic traits, which can help agriculture be more sustainable.
The difference between plant breeding and plant biotechnology comes down to the way plants are improved. In breeding, new and better combinations of existing genes in a crop are created by crossing plants together. With biotechnology, key genes are inserted directly into the DNA of a single plant to make improvements. This can result in the plant being able to do something that normally would have been very difficult or nearly impossible to achieve through breeding. Often we can investigate a potential product target through both biotechnology and breeding. Then, depending on what we are hoping to accomplish and which particular research pathway shows more promise, we may choose one platform to pursue. We may also choose to use both—combining specialized germplasm developed through breeding and a biotechnology trait. Together, biotechnology and advanced breeding are what make it possible for Monsanto to deliver the crop improvements farmers need to sustainably meet growing global demands.
We recognize that Monsanto is not the only company discovering ways to improve crops. That is why at the close of our 2010 fiscal year we had more than 3,500 active technology-related agreements with private and public partners around the world. Our extensive network alliances—which include partnerships with academic institutions and companies such as BASF and Dow AgroSciences—are helping bring crop improvements to farmers, faster. For example, our latest corn product, Genuity® SmartStax®, takes the best insect control and herbicide tolerance traits from Monsanto and Dow AgroSciences and combines them into the first ever eight-gene stacked corn plant with the most comprehensive weed-control system and protection against above- and below-ground insects available to farmers.
The fact that so many farmers are able to access and benefit from our innovative crop technologies can be attributed to the breadth and depth of our research and testing. Not only do we have over 275 locations around the world supporting breeding and biotechnology research, but also if one were to take every single Monsanto research trial in the field and place them end-to-end, they would span the globe over two and a half times. This comprehensive testing in multiple geographies ensures our crop technologies meet the needs of farmers in areas with similar environmental characteristics such as soil types, insect pressures and moisture levels.
These products have not been commercialized. Commercialization will be dependent on many factors, including successful conclusion of the regulatory process. For more information on our R&D pipeline, visit www.monsanto.com. ©2011 Monsanto Company.
Every corn farmer around the world faces various challenges while producing their crop, such as adverse weather, damaging insects and yield-robbing weeds.

At Monsanto, we are currently developing a robust corn pipeline filled with innovative products that are designed to help farmers protect their corn crop from these stressors, which would enable them to produce more while reducing inputs like chemical insecticides. In addition to employing biotechnology to create these improved crops, our scientists also apply advanced breeding techniques to develop corn plants that are better able to withstand environmental stressors such as damaging diseases.

**A NEW WAVE OF HERBICIDE-TOLERANT CORN PRODUCTS**

We are pioneering a new wave of herbicide-tolerant corn products aimed at providing farmers more flexibility to manage difficult weed problems and protect their crop from yield-robbing weed infestations. Dicamba- & Glufosinate-Tolerant Corn would build on the Roundup Ready® platform with two additional herbicide tolerances to provide farmers more options in their weed management system. FOPs-Tolerant Corn also builds on the Roundup Ready platform with an additional tolerance to FOPs, low-cost tank mixing partners for post-emergent control of potential resistant grasses.

**A FAMILY OF REFUGE-IN-THE-BAG (RIB) PRODUCTS**

Farmers who use in-plant insect-protected seeds (Bt corn) are required to plant a portion of their field as refuge with the right amount of non-Bt corn. Our Genuity® RIB COMPLETE (Refuge-In-The-Bag) family, which includes Genuity® SmartStax® and Genuity® VT Double PRO™, would eliminate the need for farmers to set aside a portion of their field as a refuge by including the right amount of Bt corn and non-Bt corn in the same bag. This would not only bring farmers convenience, but would facilitate each farmer’s compliance with Environmental Protection Agency standards for insect resistance management.

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**Example of Genuity® RIB Complete (Refuge-In-The-Bag) with 5% refuge.**

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**CORN PRODUCT PIPELINE**

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<td>GENUITY® RIB COMPLETE (REFUGE-IN-THE-BAG) FAMILY</td>
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<td>DROUGHT-TOLERANT CORN</td>
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<tr>
<td>DICAMBA- AND GLUFOSINATE-TOLERANT CORN</td>
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<tr>
<td>NITROGEN-UTILIZATION CORN</td>
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<tr>
<td>HIGHER-YIELDING CORN FAMILY</td>
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<td>CORN ROOTWORM III</td>
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<td>CORN BORER III</td>
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<td>2ND-GEN DROUGHT-TOLERANT CORN</td>
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<td>FOPs-TOLERANT CORN</td>
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<tr>
<td>GRAY LEAF SPOT-RESISTANT CORN*</td>
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<td>GOSS’S WILT-RESISTANT CORN*</td>
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*Denotes breeding product
THE NEXT GENERATION OF INSECT-PROTECTED CORN

Damaging insects such as corn borer and corn rootworm threaten farmers’ corn crops year after year. The next generation of insect-protected corn—Corn Borer III and Corn Rootworm III—aims to provide a wide spectrum of control against key insect pests. These third-generation products would be more durable and would provide the potential for reduced refuge options, thus increasing productivity and simplifying farmers’ lives.

DROUGHT-TOLERANT CORN ON THE HORIZON

Collaboration with BASF

We are simultaneously working on a first- and second-generation drought-tolerant corn product. The first-generation drought-tolerance trait is designed to buffer against the effects of water limitation, primarily in areas of annual water stress. The second-generation drought-tolerance trait is designed to provide farmers in the Central Corn Belt yield stability during intermittent drought, minimize the impact of moisture stress in water-limited environments and potentially provide irrigation cost savings.

INCREASING YIELDS, REDUCING INPUTS

Collaboration with BASF

The Higher-Yielding Corn Family and Nitrogen-Utilization Corn are examples of the many corn products in development that aim to deliver on Monsanto’s sustainable agriculture commitment.

We are currently developing a higher-yielding corn family of products, which aims to boost the intrinsic yield potential of corn hybrids through the insertion of key genes. The nitrogen-utilization trait is intended to help corn plants use nitrogen more efficiently by either boosting yield under normal nitrogen conditions or stabilizing yield under low nitrogen conditions. Using nitrogen more efficiently could also offer corn producers an opportunity for increased profitability, as nitrogen fertilizer accounts for approximately one-fifth of their total operating costs.

BREEDING FOR DISEASE RESISTANCE

Our scientists are currently using advanced breeding technologies to analyze the progression of several damaging corn diseases. They are working to identify the genes in germplasm that can be bred into our elite inbred lines to help them resist the diseases. Diseases can rob the plants of critical photosynthetic leaf area, rot stalks, or have other impacts on several agronomic traits which can all lead to potential yield loss for farmers. Among other diseases being evaluated, some of the breeding products in development include resistance to the pathogens that cause Corn Stalk-Rots (multiple pathogens), Goss’s Wilt and Gray Leaf Spot.

The refuge-in-the-bag concept information provided herein is for educational and technical purposes only. It is not promotion of or the offer of sale of any refuge-in-the-bag product. These products have not been commercialized. Commercialization will be dependent on many factors, including successful conclusion of the regulatory process. For more information on our R&D pipeline, visit www.monsanto.com. ©2011 Monsanto Company. [2006SAPpt] 6B6A115300
A NEW WEED MANAGEMENT OPTION FOR SOYBEANS

Dicamba is an economical herbicide that controls a wide spectrum of broadleaf weed species including tough-to-control and glyphosate-tolerant weeds. The addition of dicamba tolerance to the existing Genuity® Roundup Ready 2 Yield® soybean platform would provide soybean farmers with another important tool for a highly-effective and high-yielding weed management system.

THE NEXT LEVEL OF SOYBEAN YIELD POTENTIAL

Collaboration with BASF

One of the most important priorities to a soybean farmer is higher yield. That’s why our scientists are developing multiple generations of higher-yielding soybeans that are designed to boost the intrinsic yield potential of soybeans through the insertion of key genes. These yield traits are expected to be stacked with Genuity Roundup Ready 2 Yield, dicamba tolerance and other traits in our soybean pipeline, to provide farmers with a significant yield boost over today’s Roundup Ready® soybean varieties on a highly-effective weed management platform.
AN ANSWER TO DAMAGING SOYBEAN PESTS

In some parts of the world, soybean farmers face costly yield losses due to insect damage. We are developing multiple generations of insect-protected Genuity® Roundup Ready 2 Yield® soybeans, the first-ever in-the-seed insect protection for soybeans. Insect-protected soybeans use the same Bt technology widely adopted in corn and cotton. The Bt soybean trait is envisioned to be stacked with Genuity Roundup Ready 2 Yield to provide excellent insect control, weed control and yield enhancement. The second-generation insect-protected trait is designed to enhance the insect spectrum, to provide enhanced durability and to provide the opportunity to reduce the refuge required for the first-generation insect-protected trait.

BREEDING FOR DISEASE AND PEST RESISTANCE

Our scientists use the most advanced technologies available to evaluate the progression of several damaging soybean diseases globally. This helps to identify which soybeans possess disease resistance genes and the specific regions of DNA within these soybeans that can be bred into our elite soybean varieties to enhance resistance to specific diseases. For example, Asian Soybean Rust is a devastating disease that can cause soybean yield losses as high as 80 percent, especially in Brazil. Current management strategies for this disease are limited to multiple applications of fungicides, which can be costly. Asian Soybean Rust-Resistant Soybeans would help farmers reduce the number of fungicide applications required to control this disease while helping them to protect yields. Monsanto is planning to launch our first aphid resistance soybean varieties, developed by advanced breeding, for the 2011 season. In addition, many Monsanto varieties have resistance to soybean cyst nematode and root knot nematode. Our breeders continue to identify additional sources of resistance to both of these pests and are incorporating these resistances into future soybean varieties. We also have a very active breeding program to identify and incorporate resistances to a number of fungal diseases in addition to Asian Soybean Rust.

NUTRITIONALLY-IMPROVED OILS ON THE HORIZON

Soymega™ is a Collaboration with the Solae Company

Consumers and food companies are increasingly demanding better oils and farmers are eager to deliver them. Vistive® Gold high oleic and SDA omega-3 soybeans are two of the soybean products in our pipeline that are designed to help farmers deliver on that demand. Vistive® Gold soybeans combine breeding and biotechnology to produce soybean oil with mono-unsaturated fat levels similar to olive oil and the low saturated fat content of canola oil. This would allow the food industry to cost-effectively meet recent dietary guidelines to eliminate trans fats and significantly lower saturated fat content in food products. This oil product would also significantly improve frying stability of the oil while maintaining the flavor and economics of soybean oil. Vistive® Gold would allow farmers to help meet the growing demand for better oils with a domestically produced soybean-based option.

SDA omega-3 soybeans are designed to produce oil with omega-3 fatty acids. Omega-3 fatty acids traditionally found in fatty fish have reported health benefits including heart health. Similar to soybean oil in taste and shelf life, oil from these soybeans, which will be marketed as Soymega™ with our collaboration partner, Solae, LLC, could be used as an ingredient in a wide range of food applications such as yogurt, granola bars and spreads. SDA omega-3 soybeans should provide consumers a new option to obtain desirable omega-3 fatty acids from foods rich in SDA omega-3—a further opportunity for farmers to help deliver health benefits to consumers.
A NEW WEED MANAGEMENT TOOL

In some cotton-growing areas, farmers are challenged with tough, yield-robbing weeds. The more tools they have, the better equipped they will be to manage these weeds. One such weed management tool in our pipeline is Dicamba- and Glufosinate-Tolerant Cotton. For farmers, this new cotton product would represent the first three-way stack of herbicide-tolerant technologies including Genuity® Roundup Ready® Flex, dicamba tolerance and glufosinate tolerance for three unique modes of action for killing weeds. The product would provide cotton growers with the most effective weed management system available.

A DROUGHT-TOLERANT COTTON PLANT

Collaboration with BASF

Drought-tolerant cotton is designed to minimize risk in cotton farming by providing yield stability in environments experiencing occasional or consistent water stress and reducing water needs on irrigated acres. This product would allow farmers to stabilize yields even during times of drought, helping them meet the growing demand for fiber.
We are currently developing Genuity® Bollgard® III, the third-generation of insect control which aims to provide season-long protection from the widest range of caterpillar pests.

PROTECTING COTTON FROM YIELD-ROBBING PESTS

Cotton farmers around the world face costly yield losses due to insect damage. Two generations of Bollgard® insect-controlled cotton are currently helping these farmers. We are currently developing Genuity® Bollgard® III, the third-generation of insect control which aims to provide season-long protection from the widest range of caterpillar pests. In addition to the improved insect control, this product would target significant cotton pests with multiple insecticidal proteins, further enhancing effectiveness and helping to ensure the continued success of beneficial insect-control traits.

Our scientists are also developing Lygus Control Cotton, a product designed to extend the spectrum of cotton insect control to Lygus bugs, piercing and sucking insects that cause damage to the reproductive tissues of cotton, damaging boll development and reducing yield. This product would extend the spectrum of insect control to a pest that has emerged as the next unmet need in cotton pest control.

Nematodes are cotton plant parasites that can cause serious on-farm economic loss. Our scientists are using advanced breeding techniques to accelerate the incorporation of resistance to Root Knot and Reniform Nematodes into elite cotton varieties. Our Reniform Nematode-Resistant Cotton product could potentially increase lint yield by an average of 10 to 15 percent while the Root Knot Nematode-Resistant Cotton product could potentially increase lint yield by an average of 8 to 10 percent.

These products have not been commercialized. Commercialization will be dependent on many factors, including successful conclusion of the regulatory process. For more information on our R&D pipeline, visit www.monsanto.com.

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Monsanto has several specialty crops in our pipeline. These crops include canola, sugarcane, alfalfa and most recently, wheat. Our work with these crops seeks to provide farmers with increased yield potential, better protection from damaging insects and increased weed management options.

**SPECIALTY CROP R&D PRODUCT PIPELINE**

**BOOSTING CANOLA YIELDS**

Collaboration with BASF

Our scientists are concurrently working on first- and second-generation higher-yielding canola products specifically designed to boost canola yield potential. These technologies would represent the first yield traits in canola and would give canola farmers the opportunity to increase production without increasing inputs.

**WEED MANAGEMENT SOLUTIONS FOR CANOLA**

We have two products in our canola pipeline that are designed to provide farmers with improved weed control and greater flexibility to manage weeds. *Genuity® Roundup Ready® 2 Canola* is a second-generation herbicide-tolerant trait that would allow farmers to apply Roundup® herbicide at higher rates with a wider window of application, enabling them to control tough-to-kill perennial weeds without damaging their crop. Greater flexibility would help farmers ensure yield-robbing weeds are removed at the optimal time. With *Dicamba-Tolerant Canola*, the addition of dicamba tolerance to the Genuity® Roundup Ready® 2 Canola platform would provide farmers with another important tool for a flexible, high-yielding weed management system.
Insect-protected + Roundup Ready® Sugarcane is designed to use the Bt technology widely adopted in corn and cotton to control economically damaging pests in Brazil, including sugarcane borer.

INSECT-PROTECTED + ROUNDUP READY® SUGARCANE

Sugarcane producers are facing increasing global demand for sugar and ethanol, but at the same time are challenged with yield-robbing insects and weeds. Insect-protected + Roundup Ready Sugarcane is designed to use the Bt technology widely adopted in corn and cotton to control economically damaging pests in Brazil, including sugarcane borer. The Bt trait is combined with the Roundup Ready® gene for more flexible weed control. This product would not only provide sugarcane producers with the opportunity to meet the growing demand by increasing yield but also improve the quality of the sugarcane.

THE FUTURE OF WHEAT

Yield and Stress Wheat is a Collaboration with BASF

Wheat is an important large-acre, global crop, but it has suffered from the lack of industry investment in technology. As a result, the productivity of wheat acres continues to fall behind other major row crops like corn and soybeans. Now through breeding and biotechnology, Monsanto scientists are working to provide wheat farmers high-yielding varieties that can better withstand yield-robbing factors such as insects, disease and moisture stress. They are also developing herbicide-tolerant wheat to bring new weed management solutions to wheat farmers.

IMPROVING ALFALFA

Collaboration with Forage Genetics International

Alfalfa hay is an important source of fiber and carbohydrate energy in most dairy cattle feed. One challenge alfalfa farmers face is the high level of lignin, a component of alfalfa that affects an animal’s ability to digest it. In an effort to provide alfalfa farmers with higher quality and higher-yielding alfalfa, Monsanto is collaborating with Forage Genetics International. Together, our scientists are identifying genes that would enable alfalfa farmers to increase yield and reduce lignin, ultimately providing alfalfa producers with higher quality and higher forage yield potential.

Our alfalfa yield program is identifying promising genes for increasing forage yield and altering alfalfa agronomics.
VEGETABLE R&D PRODUCT PIPELINE

Farmers around the world plant a wide-array of fruits and vegetables that have already been improved using traditional techniques of plant breeders. However, Monsanto breeders increasingly are using advanced breeding techniques, such as marker-assisted breeding and compositional analysis, to bring benefits to producers and consumers of fruits and vegetables. These benefits include better disease resistance, higher yields, greater nutrition, better flavor, convenience and other desirable consumer characteristics, such as color and texture.

IMPROVING RESISTANCE TO DAMAGING DISEASES

Downy Mildew-Resistant Cucumber

Downy mildew is a globally significant disease problem affecting yield and quality for many crops, including cucumbers. Growers’ only available defense against this damaging disease is costly fungicides. New downy mildew-resistant cucumber lines, developed through conventional and marker-assisted breeding, have shown potential for a distinct advantage in harvestable yield while greatly reducing both the number and cost associated with the fungicidal sprays growers currently use to control the disease.

Gemini Virus-Resistant Tomato

Gemini viruses are the most significant threat to tomato farmers in many world regions and can result in a total yield loss in severely affected fields. There are many Gemini viruses that infect tomatoes, with the Tomato Yellow Leaf Curl virus being the most significant and prevalent. Our scientists are currently developing new tomato hybrids, bringing together multiple sources of resistance to these devastating diseases.

Resistance to Phytophthora Blight in Pepper

Phytophthora Blight is one of the most destructive diseases facing pepper producers as it can attack the roots, stems, leaves and fruit. Marker-assisted breeding approaches are being used to introduce resistance into commercial products. Initial products will be launched in sweet peppers for the eastern United States, and hot and sweet peppers for Mexico. Subsequent market introductions are targeted for India, China and South Korea.

Improving resistance to Phytophthora Blight, one of the most destructive pepper diseases.

Diseased | Healthy
In tests, Beneforté™ Broccoli boosted antioxidant enzyme levels at least two times over current commercial varieties.
PRODUCING MORE | CONSERVING MORE | IMPROVING LIVES