Agriculture

Biological Crop Chemistry Primer: Green Shoots Through Green Products

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Related Companies:	Share Price:
AGU	89.47
FMC	66.57
MBII	13.34
MON	97.65

CONCLUSION

Biological crop chemistry is gathering momentum as farmers around the globe struggle with increasing weed and pest resistance to long-standing, and often over-used, crop chemistry and agronomic practices. Additionally, regulatory scrutiny is intensifying around the environmental impact of synthetic crop chemicals. We believe these factors set a positive, multi-year backdrop for the biological crop chemistry and biostimulant products. A wave of industry consolidation and strategic investments from the 'Big 6' crop chemical companies would indicate that these industry giants share our enthusiasm for the category, with lofty valuations paid for early-stage, innovative technology companies. With the category estimated to experienced double-digit growth and gain share from traditional chemistry, we favor shares that offer direct exposure to this theme: MBII offers pure-play exposure, FMC is expanding its footprint in the category, and MON is pursuing its own RNAi-derived platform.

- **Biologicals are beginning to gain broad market adoption – a key growth theme within the Crop Chemistry market.** Biologically derived crop chemistry – products derived from naturally occurring microorganisms, plant extracts, and organic material – are beginning to gain broad market attention as farmers around the globe strive to maximize yield. Several factors stand in the way of this yield goal, including increasing weed and insect resistance issues to traditional crop chemistry and agronomic practices, environmental side-effects and worker safety issues stemming from synthetic chemistries, and plant health deficiencies. Biological crop chemistry, which is experiencing wide product proliferation, has the potential to address each of these issues. These 'green' products also enable organic farming which is gaining increased attention, albeit off a small acreage base. We expect the $2 billion biological crop protection chemistry market – which constitutes less than 5% of total crop chemistry industry sales – will experience double-digit growth through the balance of the decade, bringing total market share to ~10% by 2020. We also see very promising growth potential for the biostimulants and plant health category, which we estimate is a $1 billion industry today. When combined these two product categories represent one of the most attractive growth markets within the Crop Chemistry industry.

- **Exposure to the biological category presents significant upside potential.** Within our Agriculture sector coverage, we believe the secular growth of the biological crop chemistry and biostimulant category represents a key investment theme. For direct, pure-play exposure we recommend shares of Marrone Bio Innovations. Through a robust product pipeline and key distribution partnerships, we forecast that Marrone Bio will experience rapid sales growth over the next three years, reaching $120 million in FY16 revenue. For more tangential exposure, we recommend shares of FMC as we believe the biological crop chemistry category will represent a key driver within the company's Vision 2015 growth targets. With Monsanto, we believe the biological market represents a 'call option' as the company pursues its potentially game-changing RNAi-technology derived BioDirect program.

RISKS

Commodity prices, weather, general economic conditions, regulatory approvals & environmental regulations.

INVESTMENT OVERVIEW

As farmers around the globe grapple with increasing resistance issues to over-used synthetic crop chemistry and ineffective agronomic practices with GMO traits, we believe growers will continue to look for alternatives to preserve and expand crop yields. This issue – when combined with tightening scrutiny around the environmental impact of synthetic crop protection chemistries – presents an attractive opportunity for the biological crop chemistry market. Biological crop chemistry is an umbrella term that encompasses all naturally derived agricultural products that aim to improve crop protection and enhance plant productivity. In many ways the industry is tracking in a similar manner to the seed industry in the 1980s as it is just waiting for one blockbuster product to open up a multi-decade stretch of unrelenting growth. It is a unique segment in agriculture as new developments create value throughout the entire food chain because it enhances growers' ability to produce higher yields, diminishes environmental impact while contributing to sustainable agriculture, and assures end consumers that their food is grown using naturally derived chemicals. Today, biological crop chemistry is approximately a $2.0 billion industry and accounts for ~4% of the total crop protection market; by the end of this decade we believe the category has the potential to reach 10% of the total industry with annual sales surpassing $5 billion. Biostimulants represent another $1 billion market that has the potential to grow 20% per year over the next 5+ years.

Biologicals are typically used as a part of an Integrated Pest Management program, where they are used in combination with other synthetic crop chemistries. Biologicals provide a new mode of action for insects, weeds or plant disease, which protects the plant from a myriad of pests and helps combat resistance issues. This allows growers to realize improved yields by reducing loss from stress and increasing plant productivity. Additionally, these naturally derived products are safer and more environmentally friendly. Biological crop chemicals reduce the amount of time a grower must wait before getting back into the field after spraying as well as the time the crop can be harvested following chemical application.

There has been a significant amount of interest in bio-based crop chemistry over the last year from the major crop chemical manufacturers, including Monsanto's newly launched BioDirect™ platform, Bayer's acquisition of Agraquest, BASF's acquisition of Becker Underwood, and Syngenta's acquisitions of Pastueria and Devgen. Major crop chemical companies have paid healthy premiums for access to the biological chemical market, where acquisition multiples ranged from 4x-15x revenue in a series of strategic purchases in the fall of 2012. Along with specific product benefits, of significant interest for crop chemical producers is that biologicals have a faster time to market and a lower cost of development than synthetic chemicals in the United States. The EPA allows an expedited registration for bio-based chemicals and although other regions in the world do not yet have the same fast-track registration, we believe the safety and environmental benefits of biologicals are gaining traction, which may lead to faster registration in other global regions.

To gain exposure to the biological sector, we recommend shares of MBII and MON. Marrone Bio Innovations is a pure-play in the biological crop chemistry sector, and as the company launches new products to complement existing offerings and expands geographically, we look for revenue to expand to $120 million in 2016. Monsanto intends to enter the category in the latter half of this decade by way of its RNAi technology through BioDirect™.

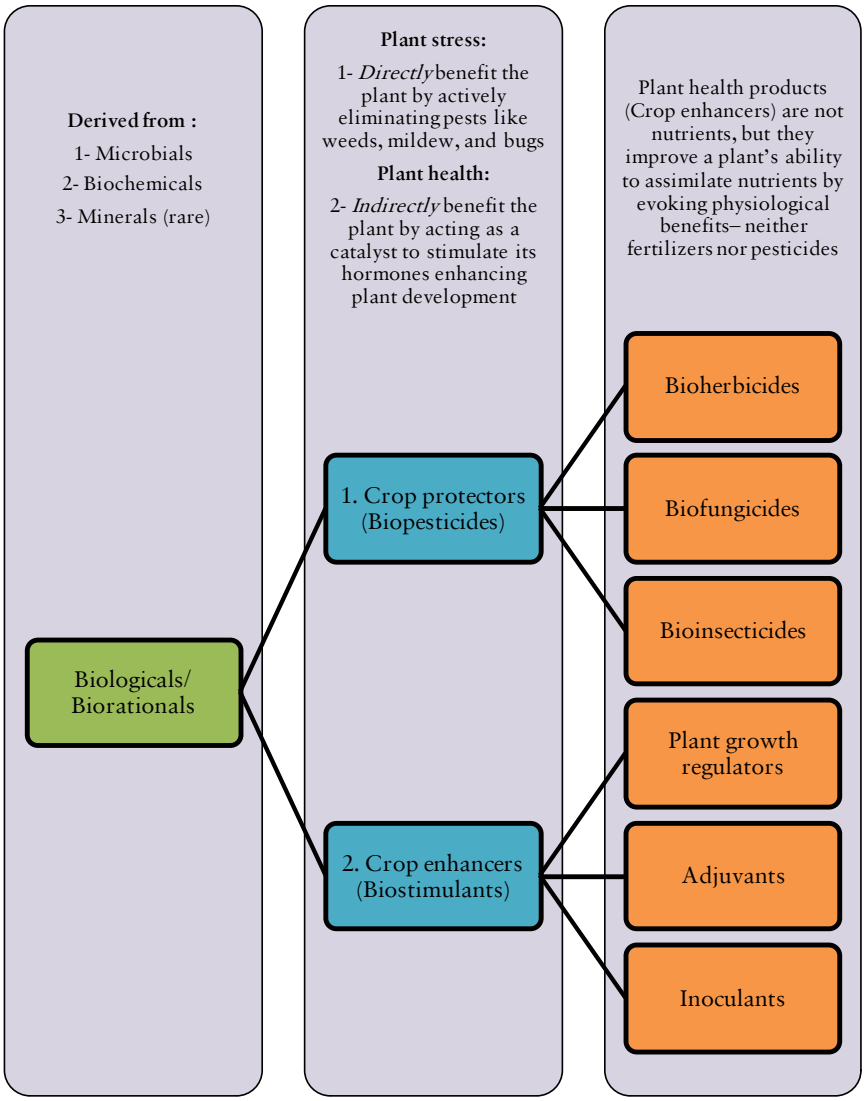
OVERVIEW OF THE TECHNOLOGY

What Are Biologicals?

Biological crop chemistry can be broken down into two categories: products directed at minimizing plant stress and products directed at maximizing plant health. It is important to distinguish that neither of these types of products are synthetics, but rather that they are derived from natural, biological sources such as microbials, biochemicals and sometimes minerals. The entire industry is often lumped under terms including "biologicals," "biorationals" or "biochemicals." Exhibit 1 shows a breakdown of the hierarchy.

Exhibit 1

HIERARCHY OF BIOLOGICAL PRODUCTS



Source: Marrone Bio Innovations, EBIC, EPA, Biostimulant Coalition, Piper Jaffray research

Biopesticides Or Biological Crop Protectors

The first front involves products that ***protect plants from pests*** and are the biological equivalent of chemical pesticides. Companies are creating biological substitutes and complements for synthetic herbicides, insecticides and fungicides that are starting to be incorporated into Integrated Pest Management (IPM) programs on farms across the world. These products are applied in the same fashion as traditional pesticides and can be mixed into holding tanks with chemicals to reduce the toxic load on the environment and the cost of overall crop protection for the grower while increasing efficacy. The **Environmental Protection Agency of the United States** (**EPA**) defines a biological pesticide or biopesticide as *a pesticide derived from such natural materials as animals, plants, bacteria, and certain minerals.* They are used by growers to **directly** control various biotic plant stresses such as weeds, insects and diseases. Biopesticides are generally derived from microbials (bacteria, fungi, viruses, protozoa and yeast) which make up 63% of the market and biochemicals (botanical extracts, semi-chemicals and fatty acids) which make up the majority of the remaining market share – refer to Exhibit 1.

Biopesticides, just like traditional pesticides, carry out their objectives through various Modes of Action (MOA). A MOA is the sequence of events from absorption into a plant until death that a biopesticide uses to eliminate pests or stress. Generally, extremely focused products aimed at a singular foe will have multiple MOA making it harder for the pest to develop a resistance. Broad spectrum biopesticides that cover many sources of stress are more likely to have a singular MOA making it easier for pests to develop a resistance. The majority of biopesticides have a focused coverage spectrum. Some common MOAs are nutrition inhibitors, reproduction suppressors, oxygen intake reducers and ovicides. It is important to note regarding the biopesticide definition above that even naturally derived products are not classified as biological pesticides, but rather chemical pesticides by the EPA if they act on the nervous system of the target.

Biostimulants Or Biological Crop Enhancers

The second front includes biological catalysts, nutrient intake boosters, adjuvants, plant growth regulators and inoculants that all ***enhance plant health***. Another term used to define this segment is "performance chemistry." Biostimulants are often incorporated into regular fertilization practices in a supplementary way that boosts plant health. They are versatile because they can be applied as a pre-plant seed treatment, via seed furrows when planting, or as a foliar spray application. There is no definition for biostimulants at the federal level but the Biostimulant Coalition, a group of companies that is working to address regulatory and legislative issues regarding biostimulants, has proposed a definition that is similar to what the European Biostimulant Industry Consortium (EBIC) has declared. The coalition defines a biostimulant as *a material that, when applied to a plant, seed, soil or growing media – in conjunction with established fertilization plans, enhances the plant's nutrient use efficiency, or provides other direct or indirect benefits to plant development or stress response.*

Their benefits can be measured by two methods: visual growth parameters (root mass/strength and clipping weight) and physiological parameters (photosynthetic and antioxidant capabilities, improved nutrient use and increased hormone activity). The products interact with soil to increase root size and improve root structure to heighten nutrient uptake and augment nutrient retention. They increase fine root hairs in corn which allows the plant to absorb water more efficiently and survive drought periods more effectively. This allows for lower volumes of inputs to be applied as they are being used in a more effective way that increases yields while minimizing soil and water damage from leaching and runoff. In short, biostimulants help plants help themselves **indirectly** by assisting or stimulating their natural physiological processes and are neither a fertilizer (they do not correct nutrient deficiency) nor a pesticide (they do not eliminate pests).

DEVELOPMENTAL HISTORY OF THE INDUSTRY

The Concept Of Biological Crop Chemistry Has Been Around For Over 50 Years

The concept of biological crop chemistry has been around for more than 50 years, but until recently the age-old mentality of planting a crop being a biological event was brushed aside by the productivity gains of the Green Revolution. Synthetic fertilizer, chemical pesticides, and mechanical irrigation over millions of mono-cropped acres turned farming into a technocratic process. As the Green Revolution ceded into an era of breeding and engineered seed (Gene Revolution) beginning in the early 1980s crop yields continued to soar. Productivity gains maintained their impressive clip beyond the turn of the century when Monsanto (MON) introduced Roundup Ready® seeds in the mid-to-late 1990s which created a dominant pest control and yield-lifting combination when paired with Monsanto's blockbuster herbicide Roundup®. In hindsight the benefits of the Green Revolution were not limitless. Intense agricultural practices resulted in tangible, long-lasting impacts on water, soil and air resources. Additionally the dependence on glyphosate, the active ingredient in Roundup® and Roundup Ready® seed, created massive, widespread resistance problems that threaten to derail continued yield growth.

However, the realization of the environmental consequences from the practices of the last 40 years and the understanding that agricultural productivity cannot plateau if the world is to feed its projected 9.5 billion inhabitants by 2050 have reinvigorated many minds into incorporating biology into the farming process again. 90% of the necessary expansion in food production will have to come from increasing yields and cropping intensity as there is little arable land left to expand planting. Historically, growers and industry firms have relied on chemicals, seed trait technology and, more recently, precision agriculture to drive productivity gains, but biological crop chemistry is emerging as a new avenue toward self-sustaining agriculture. It has the potential to transform the crop protection industry for the first time in 50 years and bring to life a new industry offering of biological crop enhancement while creating value that is shared by developers, growers and the entire world in its sustainability effort.

Why Farm With Biologicals?

In the past there were not many reasons for growers to farm with biologicals. The efficacy to cost ratio was much greater in chemicals, resistance was not as devastating or even existent, EPA and other international bodies' regulations were much looser, and neither food retailers nor end consumers had strong demand for residue-free or organically grown product. Today nearly all of these situations have reversed and are reasons for growers to swap chemicals for biologicals or at least integrate biologicals into current farm practices. In general, most biologicals have at least equal efficacy, but their cost does remain at roughly a 10%-20% premium on synthetic counterparts. Resistance issues are most growers' largest concern and affect at least half of all farms in the United States. Finally, regulating bodies are growing concerned with the effects of chemical pesticides on field workers, exported food and the environment. While at the same time food retailers are responding to end consumers' demands for transparency throughout the entire chain and pesticide free offerings. In addition to those turnarounds, the omnipresent challenge of feeding the rapidly growing world population is one more reason to take farming with biologicals mainstream. Biopesticides will combat resistances in the field getting yields everywhere to their current capacity while biostimulant advances will push the productivity ceiling to new levels.

Integrated Pest Management (IPM)

The new practice of Integrated Pest Management (IPM) will help accelerate adoption of biologicals because it allows growers to ease into the new realm rather than make a serious leap of faith. IPM is a system of biological, cultural, physical, and chemical tools combined with best farm practices to protect the environment while minimizing plant stress to optimize yields. It is a methodology of finding the right balance of all strategies in an effort to promote safety, sustainability and profitability. Historically the use of chemical pesticides has allowed more no-till fields, but recent emergences of resistance have forced growers to resort to plowing again – causing the exact soil erosion that conservative till farming tries to prevent. When growers add biopesticides into their crop protection plan they will be able to vary their application enough to break resistance cycles. This allows them to continue limited tilling while not having to plow every year to try and shake resistances. Practitioners of IPM will generally experience lower overall crop protection costs as a targeted application of a biopesticide can mean a cutback in the required amount of synthetic pesticide to be applied. As growers get more comfortable with the efficacy of biopesticides they may start leaning that direction giving them much more flexibility for getting into their fields when they need to. IPM practices can also grant growers access to valuable export markets where the toxic residue requirements are stricter, but the selling price is much higher. A selling point of IPM for skeptical growers is that they still have the ability to spot-treat areas with chemicals if they need to quickly stop an outbreak. There is resounding consensus of both chemical and biological firms in the industry that combining chemicals and biologicals in an IPM system is considerably more effective than only using one method or the other.

Comparison Of Biologicals And Chemicals

Biologicals are nearly always safer and easier on the environment than chemical products. Biopesticides are often formulated to only affect the target pest and closely related organisms (selective) in direct contrast to chemical pesticides which frequently offer broad-sweeping coverage (non-selective) that will negatively impact insects, birds and anything else that comes in contact with them. Another advantage of biopesticides is that they can be extremely effective in small quantities and perform well when huge amounts of pest are present. On the other hand, the potency of chemical pesticides can be diluted when up against large quantities of pests forcing growers to increase application volume and hope for greater effect. Biopesticides also decompose quicker, resulting in a much shorter (<4 hours) Restricted Entry Interval (REI) and often no Pre Harvest Interval (PHI) granting the grower the flexibility to apply protection at the most beneficial times without negative operational consequences. Often times the REI for chemicals is a week or two and the PHI can be a month or more in some cases. Finally, biologicals take more time to develop a resistance to an equivalent MOA chemical pesticide. Even though these advantages have been around for years, growers have not considered biologicals until recently due to reservations surrounding their efficacy compared to traditional chemicals.

While recent developments have put biologicals on growers' radars, there are still certain advantages chemical products have that maintain their practicality in IPM systems. They are still cheaper for the same effect when resistance problems are held aside. Traditional chemical pesticides are quicker acting than biologicals because they attack the nervous system. They are also broad-spectrum, complete coverage so growers can generally apply only one, maybe two chemical products to gain total control over all pests (again holding resistance issues aside) whereas biologicals are generally selective in nature meaning that sometimes multiple products need to be used separately or blended together. Furthermore, biologicals often have zero or minimal residual activity (chemicals have long lasting periods) meaning that timing application during the most vulnerable point in the pest's life cycle is vital. This forces the grower to be much more knowledgeable in pest management because crop protection is not as simple as applying glyphosate to the entire field in the beginning of the year. Most chemical solutions have a minimum shelf life of at least five

years and can handle a broad range of temperatures with equal effectiveness compared to biologicals that lose efficacy quickly under strained conditions and generally do not last much longer than 12 months. Biological developers are still working on trying to get their products to consistently deliver the same results when variables such as humidity and soil structure change. This has historically been an area where traditional chemicals have excelled, causing growers to become extremely comfortable with them because they know exactly what they are going to get when applied (once more, resistance issues are changing this).

GLOBAL REGULATION AND REGULATORY APPROVAL PROCESS

The eventual exemption of biologicals from tightening regulatory restrictions is expected to be a broad, sweeping catalyst for global market development. However, biological developers have been frustrated by the steadfast "chemical mindset" of regulatory bodies. While these regulatory bodies in Europe, South America, Asia and Africa have promised the industry a lot in terms of commitment to biologicals, they have delivered little to date. With the exception of the U.S., regulation setters in China are the only notable ones to have actually produced tangible results. Industry development is being shackled in markets that are naturally receptive to biologicals, namely Europe and Asia for their strict residue tolerances, by nonsensical regulatory structure. As shown in Exhibit 2 much more investment has been poured into research and development in the United States because the approval system is much more sensible than other regions across the world.

Exhibit 2

REGISTERED BIOPESTICIDE ACTIVE INGREDIENTS BY GEOGRAPHY

Geography	Registered active ingredients	Date
U.S.	~400	*As of early 2013*
China	85	*As of 2011*
EU	79	*As of early 2013*
Brazil	26	*As of August 2011*
India	15	*As of 2008*

Source: U.S. EPA, Agrow Informa UK, Biopesticides: Pest Management and Regulation, Embrapa Environment, African Journal of Biotechnology, Piper Jaffray research

Latin America

Complicated registration systems throughout **Latin America** have anchored biological development. In Brazil it currently takes four to five years on average to register a product, which amounts to a huge expense for developers. There has historically been no specific process for biopesticide registration causing extremely slow market penetration. Biopesticides only make up about 2% of the country's crop protection sales compared to the 4% global average. Industry alliances have been formed in Brazil to collaborate with regulators in addressing this problem, but results have been slow to materialize. If these registration hurdles can be removed soon we have seen some local studies indicating that 10% of Brazil's crop protection sales could be derived from biopesticides by 2020.

Europe

In **Europe** the biological market has been primed for take-off by nearly every possible driver, but registration inefficiencies threaten to stall industry lift-off. On average it takes three to four years to get a biopesticide registered in the EU compared to often less than a year in the U.S. This is a direct result of how biopesticides are classified under EU registration policy. They are not considered low risk by definition and are not granted the accelerated approval process given to applications that meet that definition. Unlike in the U.S., biologicals are also subject to efficacy testing, further hindering the registration process. Additionally, there is a lot of uncertainty for developers in the process because of a lack of transparency and communication between the EU regulatory body and the industry. This and cases like Andermatt Biocontrol where approval took eight years have created a

lot more risk for biological development in the EU than in the U.S. even though overall financial costs are comparable.
The EU uses a two-tiered registration system for biologicals that is extremely process driven. In the first tier the European Commission evaluates registration of the **active ingredient** after Minimum Residue Limits (MRL) are set. The second tier involves national registration of the **product** by each country through a zonal system (based on geographic and climatic similarities) where there is one lead member for each of the three zones across the EU. Each zone either grants or refuses product authorization with the same conditions for all countries unless specific national conditions justify differential treatment. This process means that separate efficacy data is needed for each crop, country and pest. The first tier of the process (active ingredient) generally takes between 2-2.5 years while the second tier (product) usually takes about 1-1.5 years – although there has been talk of proposals that would extend the second tier timeline from two to three years to allow more time to resolve disagreements between countries over mutual recognition.

Despite the historical tendency for EU regulatory to get bogged down in a "goal displacement" mindset by focusing on internal processes rather than outcomes, there are increasing signs that this may be starting to change. The United Kingdom and the Netherlands have introduced their own adjustments to the process in order to better facilitate adoption of biologicals. The United Kingdom has recently reduced application fees for biopesticides and an organization in the Netherlands is providing up to €100,000 to help offset costs of registration. More groups within the EU that are actively supporting biological development are discussed in further detail later on.

India

Biological registration in **India** has historically been favorable to the industry, but changes to its structure in the last year are already starting to affect development that in a way will prove difficult for small and medium size firms to remain in the market. Since 2012, biopesticide active ingredients have been held to the same standards as chemical active ingredients. New registration requests have fallen dramatically as a result. The recent change in policy also revoked authorizations of over 400 registrations. All the knowledge that was constructed over the 1990s and 2000s through biological research is at risk of being unutilized.

MARKET SIZE AND PENETRATION RATES

We believe the biological crop chemical industry is poised for growth globally. Multiple factors are converging to promote a solid foundation for market adoption, including the following: large multinational agriculture firms wanting to maintain market share or generate incremental revenue streams, active government regulatory bodies concerned with sustaining the environment, growers looking for new ways to generate higher yields, and end consumers desiring greener food options and overall wellness. Essentially, the biological industry can deliver investment opportunity by serving every agricultural stakeholder on a global basis.

By Product Type

Biopesticides

The global biopesticide market was roughly a $2 billion industry in 2012 by our estimates. We projected this market to grow ~15% annually over the next five years. While biopesticides currently make up about 4% of the total global pesticide market today, this figure could nearly double by 2017. This increase in share comes from stagnation of the once steady 5%-7% compound annual growth rate (CAGR) of the entire crop protection industry, which was roughly $50 billion in revenue in 2012, over the last decade. Much of the past decade of growth can be attributed to increasing resistance problems which led growers to apply larger volumes of chemical products. However, the expected CAGR of the crop protection market is expected to run at 3%-5% going forward as more growers look for solutions other than increased chemical volumes to combat resistance and biologicals begin to replace or complement (which generally decrease volumes of traditional pesticides purchased) synthetics in crop protection arsenals throughout the world.

Biostimulants

We currently estimate the global biostimulant market to be approximately $1 billion and see it growing at ~20% annually over the next five years. There is still much debate over the exact definition of a biostimulant around the world. The intriguing aspect of biostimulants is that they do not directly replace another product offering as is often the case with agriculture. Tractors replaced horses; biotech seeds replaced traditional seeds; biopesticides will replace (to some extent) traditional chemicals, etc. The emergence of the biostimulant product category may displace some fertilizer sales and possibly even some crop protection sales. While still somewhat of a nascent market, we believe that farmer education around the benefits of biostimulants is increasing. Spreading stories of productivity champions, like Kip Cullers, should help drive adoption. The perpetual demand for higher yields to feed the world's rapidly expanding middle-class population will drive growth in the biostimulant market for the foreseeable future. From a geographic perspective, we believe the U.S., Europe and South America represent compelling growth opportunities within biostimulants.

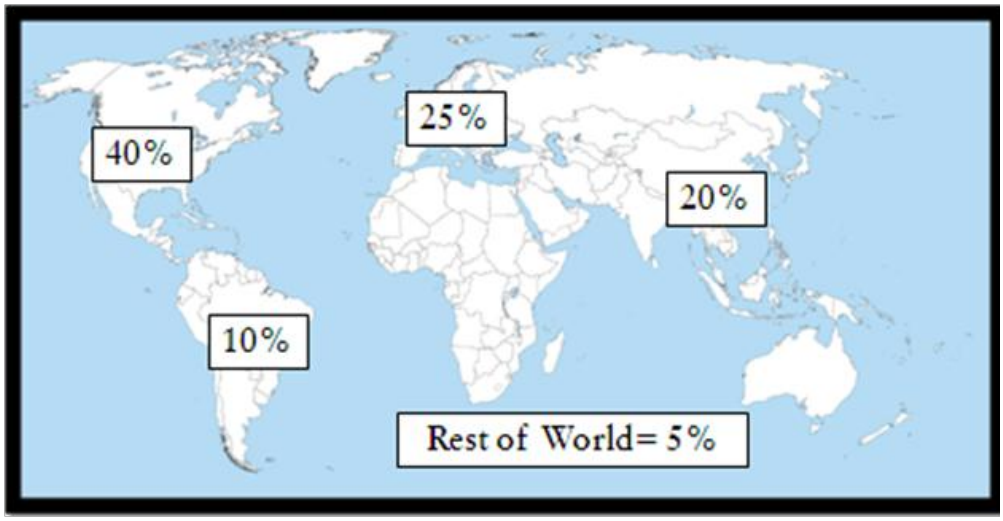
By Geography

Adoption rates of biopesticides and biostimulants are highest in more developed regions with advanced agricultural practices. The approximate geographic breakdown of the biopesticide market in 2012 is shown in Exhibit 3. There are a couple significant explanations for these trends. First, growers in North America and Western Europe are generally about five years ahead of developing country growers in the new product adoption cycle. Second, most biological developers and distribution networks are situated in developed countries. Finally, middle-class demand for organic foods, residue-free produce and overall wellness has been much stronger in developed countries. While developed countries will still continue to be the volume drivers of biologicals in coming

years, with the U.S. leading sales of biopesticides and Europe leading demand growth for both biopesticides and biostimulants, trends in developing agriculture powerhouses such as Brazil, Eastern Europe and China are aligning to allow more industry growth to be tacked on.

Exhibit 3

ESTIMATED GEOGRAPHICAL BREAKDOWN OF THE GLOBAL BIOPESTICIDE MARKET IN 2012



Source: Agrow World Crop Protection News, Piper Jaffray research

United States

Biological crop products (especially biopesticides) have seen the strongest uptake in American growers in large part thanks to the most streamlined product registration process in the world. In 1994, the Biopesticides and Pollution Prevention Division was established in the Office of Pesticide Programs by the U.S. EPA to better facilitate the registration of biopesticides. The division is the one of few worldwide where biopesticide registration is handled separately from traditional pesticides fast-tracking product time-to-market. It allows biopesticides to be registered with significantly less data and testing than traditional pesticides because they present fewer environmental risks. New biopesticides can often be registered within a year in the United States compared to traditional pesticides which average over three years. This has lead to ~70% of new pesticide registrations in the U.S. being biopesticides. This distinctive advantage has incentivized biological developers to remain in the U.S. or move foreign operations there. Strong R&D and distribution in the U.S. has resulted in growers becoming more aware of the benefits of adopting biologicals and IPM practices. The growing number of large agricultural firms making biological plays in the U.S. through acquisition and strategic alliances should continue to advance penetration rates.

Europe

We see Europe continuing to be a leader in adoption of biopesticides and biostimulants as the desire for improved agricultural productivity comes to the forefront. Biologicals represent the only plausible solution in the next few years for continent wide, environmentally friendly crop protection and yield enhancement. The European Union is the most regulated local in the world regarding chemical pesticides and Genetically Modified Organisms (GMOs).

On May 24, 2013, the European Commission adopted a restriction on the use of three pesticides in the neonicotinoid family across the EU27 on the grounds that they are harmful to bee populations. Back in 2006 the EU outlawed the use of the second most used pesticide in the U.S. when it banned the use of atrazine-based products after already banning 320 other pesticides in 2003. Overall the number of approved pesticides in the EU has been reduced from an all-time high of around 1,000 to about 300 today. Furthermore, a global study on the usage of 40 common pesticides found that the EU had the strictest MRLs for 29 of the 40 pesticides and by a significant margin in most cases.

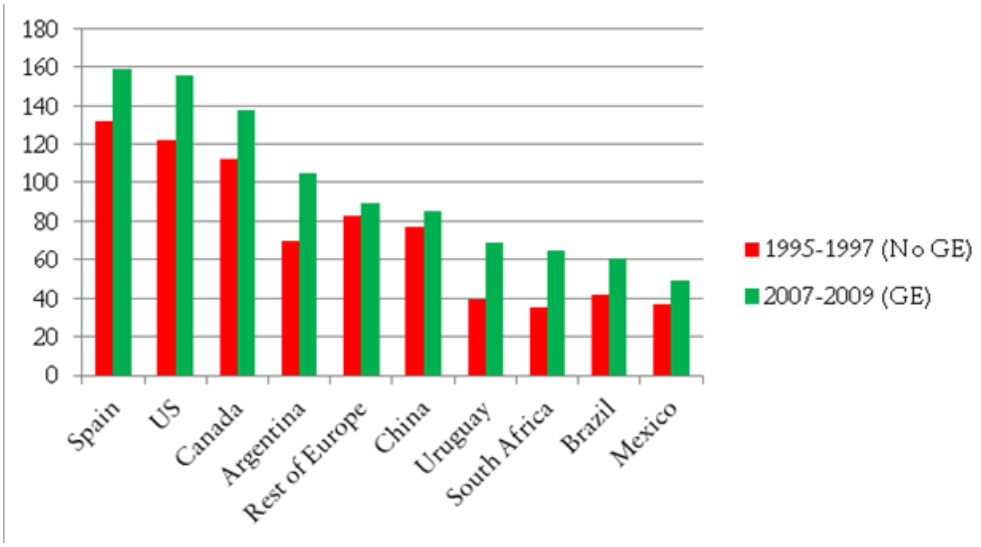
European citizens shore up regulatory opposition to traditional chemical pesticides. The public's broad demand for chemical free produce or limited residue food has been bolstered by corporate level support from agricultural supply chain leaders such as Tesco and Wal-Mart. The support from these key leaders has forced agriculture to make devising ways around chemical pesticides a major priority. The initial demand for wellness and sustainability from end consumers has rippled through the supply chain causing food retailers to ask their suppliers for information regarding water, fertilizer and chemical use. This trend is starting to compel agriculture to look for long-term solutions to address end consumer concerns in a rational, economic way. We believe biologicals are the most promising method for addressing the situation.

The EU has also been in staunch opposition to genetically modified seeds as a regulatory and public body. While there are some signs to the opposition easing (Tesco allowing GMO feed livestock), it is still clear that broad acceptance of GMO seed technology will not occur anytime soon due to overall perception. In fact, public opinion polls show that the majority of EU residents (61%) feel "uneasy" or "skeptical" about GMO seeds. While the EU has dropped many restrictions on planting GMO crop, most individual members still enforce these same restrictions at the individual country level. This is despite the fact that EU scientists have put out evidence showing that GMO seeds are safe and that the continent needs to increase its agricultural production. Additionally, large agricultural firms spent years trying to push GMO seed into the EU market with marketing, lobbying efforts and requests for product approval.

Despite all these efforts to change regulation and public perception, Monsanto and BASF have backed out of the EU within the last two years by discontinuing sale of GMO products in most of the region. The end result of these developments is nearly all of the EU planting conventional seeds. Only eight of the 27 countries in the EU allow commercial growing of GMO seeds and most countries enforce strict regulations on how it can be performed. For example, in Latvia growers must leave four kilometers of space between GMO crop and conventional due to concerns of cross-pollination drift. Policies like this effectively discourage planting of GMO seed in countries where it is legal. The notable exceptions to this are Spain and Portugal. These two countries grow 95% of Europe's GMO crops (still less than 130,000 hectares) and have increased their yield productivity significantly since adopting the technology as seen through Spain in Exhibits 4 and 5.

Exhibit 4

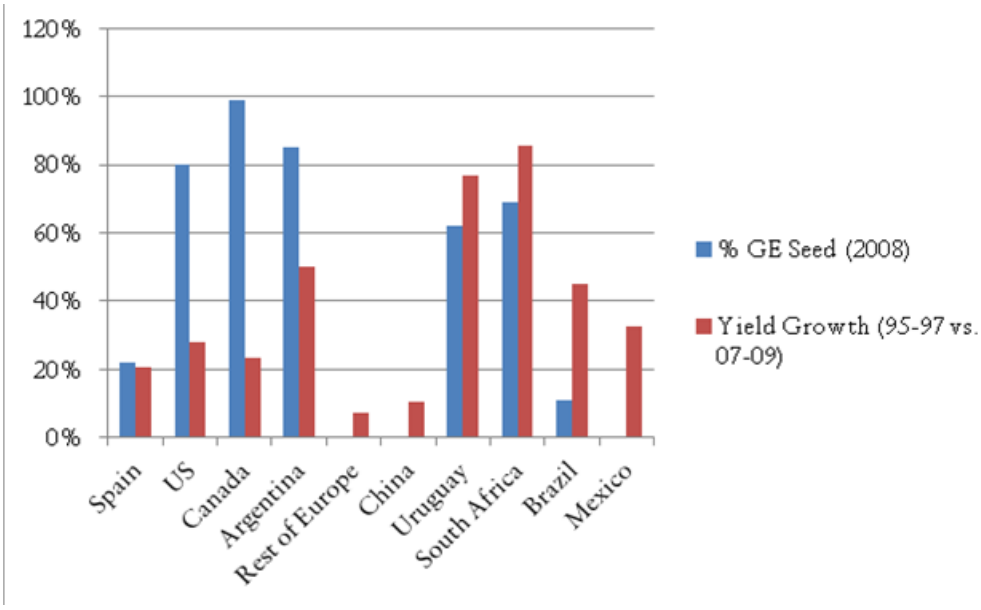
THREE YEAR AVERAGE CHANGE IN CORN YIELD (BU/ACRE) FROM GENETICALLY MODIFIED SEED ADOPTION



Source: Farm Journal Magazine

Exhibit 5

GENETICALLY MODIFIED SEED PLANTED COMPARED TO YIELD GROWTH ATTAINED



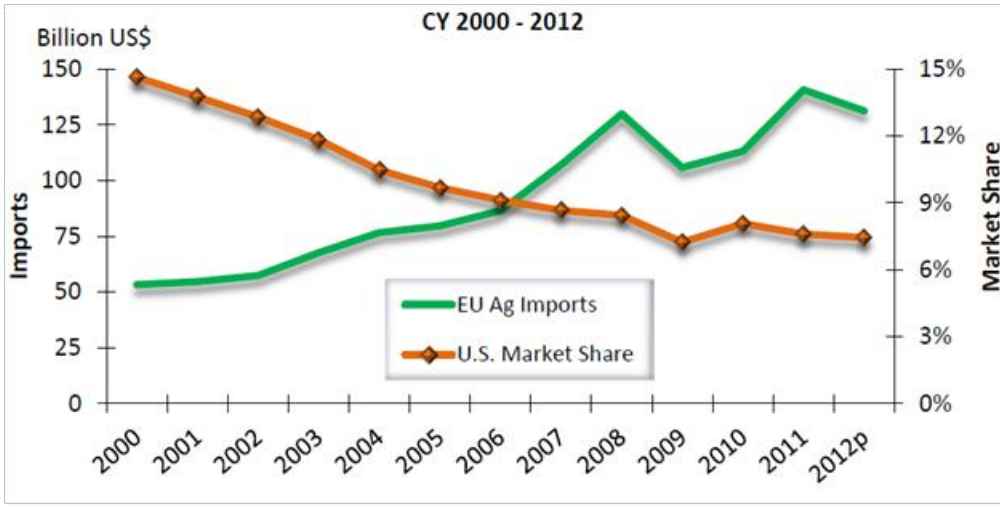
Source: Farm Journal Magazine

The increasingly stringent restrictions on chemical pesticides aimed at decreasing their usage and the utter lack of seeds with GMO traits for pest protection open up a huge market opportunity for biological growth acceleration in Europe. If Europe wants to be able to compete on an agricultural basis with the rest of the world it needs to be able to

protect crops and promote plant health in some fashion. The sweeping, global trend of using GMO seed to boost crop protection techniques is facing public resentment in Europe due to the perception that it is not "green" enough. Huge gains in productivity are needed in the region as many food retailers (even entire countries) are no longer purchasing food derived from GMO crops which will lead to higher import prices paid as the world's supply of non-GMO food contracts. While some of the needed productivity can be attained through precision agriculture adoption, the majority of Europe is already fairly advanced in this regard (Eastern Europe – especially Ukraine is the notable exception). The majority of EU productivity gains over the coming years will be unlocked with biologicals as uptake rapidly accelerates in order to facilitate a self-sustaining environment. See Exhibit 6 to observe how reliant the EU is on agricultural imports and the dwindling amount of U.S. imports because of GMO crops. Exhibit 7 supplements this by showing how fast GMO crop is taking over the world agricultural output.

Exhibit 6

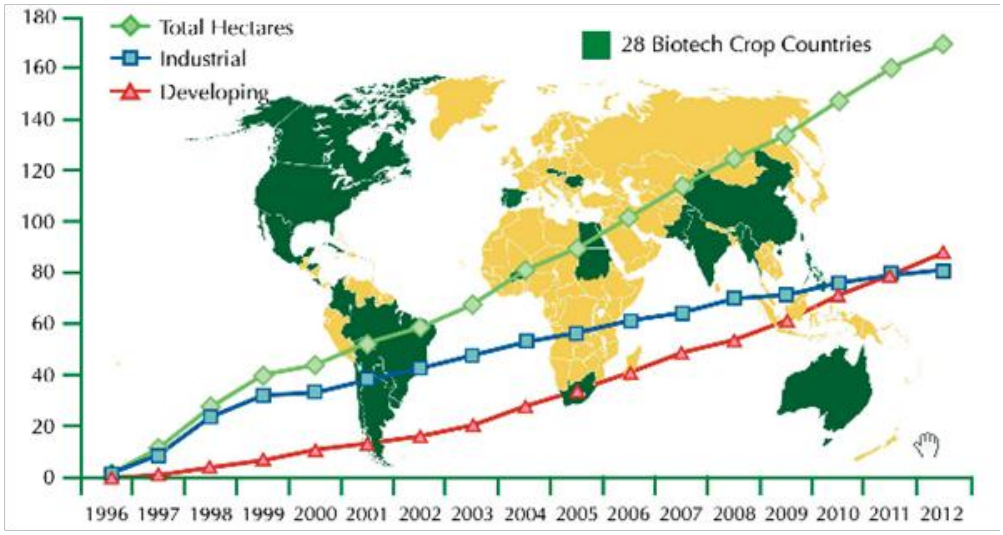
EU AGRICULTURAL IMPORTS GROW AS U.S. MARKET SHARE FALLS



Source: USDA

Exhibit 7

GLOBAL GROWTH OF GENETICALLY MODIFIED SEEDS (MILLIONS OF HECTARES)



Source: Clive James/ISAAA

The EU is the largest importer of agricultural produce in the world. Their annual imports would cover a virtual land area larger than Germany (35-40 million hectares). Much of the EU's increasing reliance on imports can be attributed to their failure to improve yields with the rest of the world. As the export market to the EU has boomed, the United States has fallen from the largest exporter to the fifth largest. The decline of American exports to the EU began as GMO seed was introduced to U.S. growers and continued to accelerate as they went mainstream beyond the year 2000. While some of this decline can also be pinned on increased global competition it is clear that GMO food is definitely playing a role, especially as Ukraine (no GMO corn planted) has become the largest exporter of corn to the EU.

The amount of farmland in the world that is used for GMO crops has expanded from essentially zero 15 years ago to over 10% today and this trend shows no sign of slowing down as Brazil continues to increase GMO corn plantings at roughly 20% a year. Over the last decade Brazil overtook the U.S. as the largest agricultural supplier for the EU. The rapid adoption of GMO crops in Brazil means the EU will again have to look for a new supplier to feed its human population at a minimum (they do feed animals both transgenic and conventional grain). That supplier may have to be the EU itself and the only way to meet its own demands in a way that reduces the need for toxic pesticides and maintains their non-GMO production is to generate heavy investment, development and penetration in/of biopesticides and biostimulants. Biologicals are the only products that can fill the role of synthetic pesticides in crop protection and generate "green" productivity increases.

South America

The exciting phenomenon in biological development in South America is that it is driven primarily by grower demand. Sales volume of biologicals are higher in the U.S.; however this is likely due to situational factors, not massive, widespread grower interest. The fast-track EPA registration system, many large agricultural firms with large research, development, and distribution platforms, and end consumer demand for non-residue food sources have essentially forced product penetration across the United States.

In addition to naturally receptive growers, situational factors are starting to align which will prime South America for sustained growth of biologicals. The extraordinary uptake of transgenic crop (GMO seed) starting with Argentina in 1996 followed by Brazil in 2005 (time of permanent introduction) with its accelerated, science-based approval system has created a couple of significant trends that will act as tailwinds to biological development. First, glyphosate resistance problems are progressing in a similar pattern to the U.S., just lagging a few years behind. Agricultural suppliers offering biopesticides will be able to garner support from local growers easily as they will likely be extremely receptive to IPM practices. Second, large agricultural firms will look to expand on their successful introduction of GMO seed in Argentina and Brazil by partnering with or acquiring both local and foreign biological developers in order to leverage their new relationships with South American growers to create additional revenue streams that supplement their other product offerings. There has already been plenty of small and medium sized developer merger and acquisition activity across South America recently. Within the last couple of years two major European developers, Koppert Biological Systems and Novozymes BioAg, have made strong biological acquisitions within Brazil.

The other situational factor that is a strong, but a niche driver for biological demand in South America is the fast growing organic food market. According to the Brazilian Ministry of Agriculture the country's organic food market is growing between 15-20% annually. While it is only a small market, at roughly $550 million in 2011, it is expected to continue to swell due to the rapidly ascending middle class population who become more demanding in their food choices as their income rises. There is a lot of room for penetration in Latin America as Brazil and Argentina combine to produce ~18% of the world's organic food. Brazil is just one particularly robust segment of a far-reaching global trend that adds additional support for the continued advancement of biologicals.

China

China houses a lot of potential for the biological industry. The country has 30 biopesticide research institutions that are continuously screening possible active ingredients. This and world class research and development resulted in the registration of 85 biopesticides by 2011, including 55 since 2000. Currently, biopesticides are used to treat around 80-100 million acres or about 8% of the total area treated with pesticides. This figure is expected to leap to 15% by 2015. Overall crop protection trends look encouraging as chemical pesticide usage is declining at 2% a year and biopesticide usage is growing at 20%.

Despite all of this potential the biological industry has yet to truly blossom, but the Chinese Ministry of Agriculture's Institute for the Control of Agrochemicals (ICAMA) has been taking strong steps to speed the development of biologicals. From 2005-2007 they phased out five highly toxic pesticides nationally which created more than $550 million in new market opportunities. In 2011, they issued the Program for the Elimination and Prohibition of Highly Toxic Pesticides which deemed 22 pesticides unsafe for humans. Production of 10 of these was stopped in 2011 and the remainder are being phased out as less toxic alternatives emerge. The eliminated revenue has to be picked up in some way and biologicals are well situated to do so in the future. Furthermore, the ICAMA has reduced much of the documentation that is required for registration of biologicals so that it is considerably less than traditional pesticides.

To unlock the enormous amount of value for biologicals in China, major agricultural companies need to push into the country and create large development, production and distribution networks to capitalize on all the biological knowledge present. Industry fragmentation is currently handicapping the awareness and availability of biologicals in addition to underutilizing the biological resources already in place. There are about 240 biopesticide manufacturers in China, but only five to ten of them are considered large-scale

enterprises. Since most of the pieces are already in place in China, a great opportunity is present for a multinational company to commercialize the industry there.

India

The development of biologicals in India began in the middle of the 1980s with government and national institution research as resistance issues became apparent. This decade of research created a pool of technical expertise which was tapped into by small private companies as they started to create offerings. However, imitation products soon started arriving on the market and the Ministry of Agriculture acted by adding biopesticides to the Insecticides Act of 1968 and charging a small fee for product registration. The registration system was created by gathering inputs and having active discussions with academics, scientists, industry associations, and regulators. It allowed firms to take their products deep into the development process before registering them. Biopesticides were also fast-tracked through the process in order to facilitate quicker throughput. The combination of these regulatory policies generated a strong biological knowledge and research base in India.

Even though there is a large knowledge vault in place, penetration of biologicals has been slower than expected. Additionally, as mentioned earlier, changes to the registration system within the last year threaten to erase much of the gains made in years past. Only about 4% of the country's total pesticide market comes from biological varieties (about equal to global average). There may still be grower skepticism related to the fraudulent products on the market a decade ago. Also, education is needed to help growers understand the benefits of using biologicals and give them knowledge to correctly deploy them in their fields. There is a large divide in culture, knowledge and understanding of best agricultural practices between research institutions and growers in India that is contributing to the slow uptake in biologicals. The industry is also fragmented like China and would benefit from arrival of a large agricultural firm.

Despite those minor drawbacks, India is a promising market for biologicals in the coming years. The explosion of the middle-class in India has created higher incomes and a conscious awareness of health and wellness. The size and scope of this socioeconomic movement has produced the world's fastest growing organic food market at 20-22% CAGR. The biopesticide market growth in the region should outpace the global average if large agricultural firms push into India and monetize the vault of biological knowledge, research and product development created by small firms over the years that is currently being underutilized.

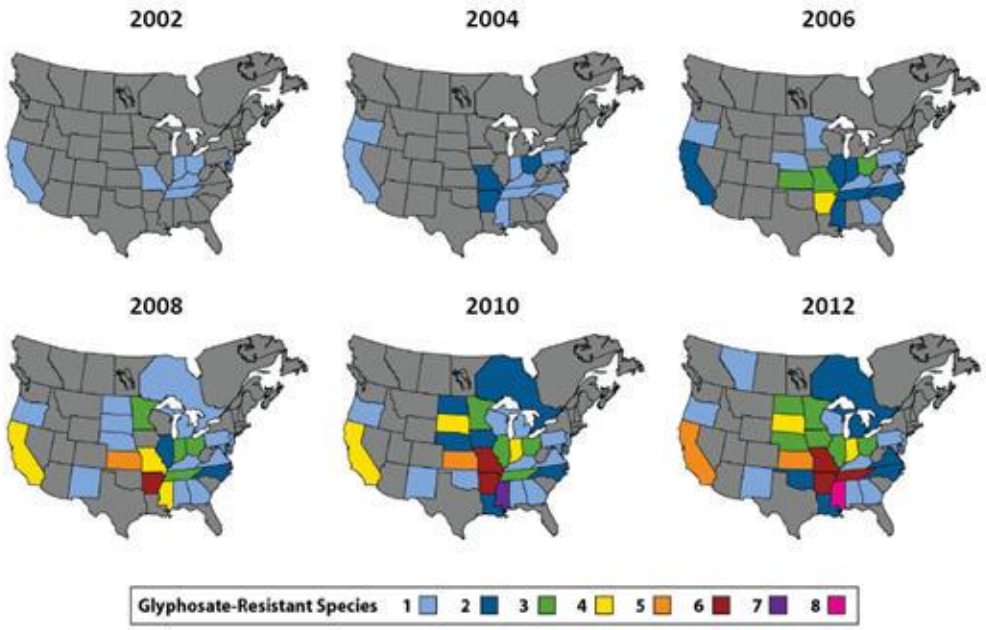
KEY BENEFITS TO GROWERS

Stave Off Resistance

The simplification of crop protection over the last 15 years stemming from glyphosate immune GMO seed and lower cost herbicides has led to increased incidence of weed resistance. Growers became overly comfortable with the cheap, perennial crop protection practice and neglected to rotate crops, mix herbicides and perform basic tillage. The steadfast reliance on a singular MOA resulted in massive acceleration of resistant weed types to a herbicide that had no documented resistant species in its first 20+ years of service. The phenomenon is no different than the development of bacterial resistance to antibiotics such as penicillin. Exhibit 8 shows how quickly resistance has developed across North America in the "glyphosate era" of farming where the application volumes approximately doubled over 2001 to 2007 from 85-90 million pounds to 180-185 million pounds.

Exhibit 8

GROWTH OF GLYPHOSATE RESISTANCE IN THE U.S. BY SPECIES



Source: Pioneer

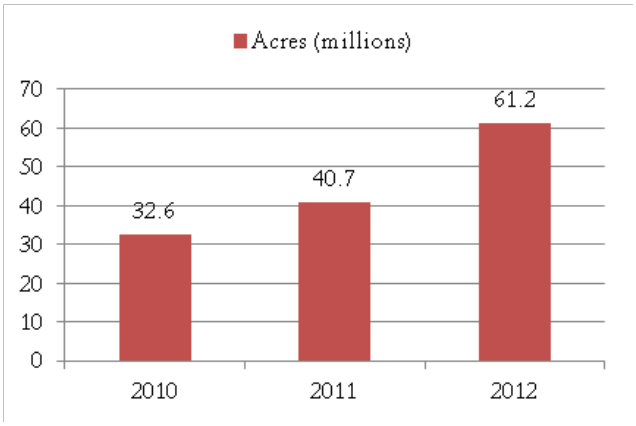
Resistant weeds species strike fear into growers for a variety of reasons, but the primary concern is yield loss. Weeds compete for the limited nutrients and resources in the field, lessening the share for the crops. Late in the season large weeds can clog machinery inhibiting harvesting flexibility for the grower which results in not harvesting at the optimal time. Early season weed control is the most vital as crops, especially corn, are most vulnerable to pests. South Dakota State University research indicates that early season weed competition can result in a 20-40 bushel per acre yield loss even after glyphosate is applied

early in the season. To combat continued resistance problems over the last few years growers have often just increased their glyphosate application rates.

However, that response has done nothing but create further problems for growers. Glyphosate resistance issues have been intensifying, growing more complicated and spreading further geographically. As mentioned the same problems have been developing in other regions such as Brazil, Argentina, Canada and Australia and will continue to track the progress of the United States. Stratus Agri-Marketing Inc. tracks glyphosate resistance problems through continuous surveys of U.S. growers and notes that resistance in 2012 on land in Iowa, Indiana and Nebraska nearly doubled compared to 2011. They also point out that the problem is becoming more challenging to combat as 27% of farms across the country report having at least two resistant weed species in 2012 compared to 12% in 2010. More details of their surveys can be seen in Exhibits 9 and 10. Growers are looking for any new weapon to deploy in their crop protection arsenal that fends off the largest, sustained threat agriculture has seen in recent times.

Exhibit 9

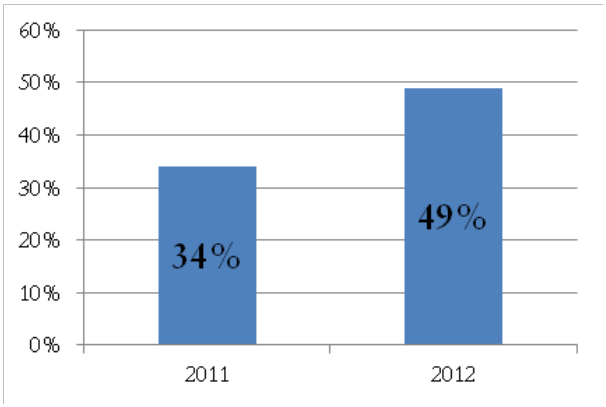
AREA INFESTED WITH GLYPHOSATE RESISTANT WEEDS IN THE U.S.



Source: Stratus Agri-Marketing Inc.

Exhibit 10

PERCENTAGE OF GROWERS IN THE U.S. WITH GLYPHOSATE RESISTANT WEEDS

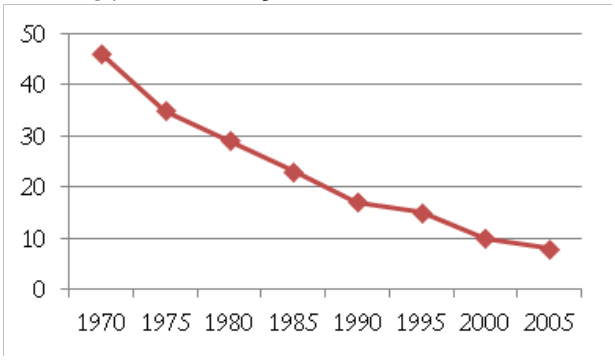


Source: Stratus Agri-Marketing Inc.

Biopesticides offer something not seen in the traditional realm of crop protection for over 20 years: a new MOA. As seen in Exhibit 11, the number of firms working to discover new synthetic breakthroughs has dwindled as large agricultural companies acquired them and scaled up production of just a few platform products (glyphosate, atrazine, etc.) resulting in the number of herbicide MOA available falling from about 70 in 2000 to roughly 35 in 2010. Part of this decrease comes from the increased regulation of chemical products, but part of it can also be explained by major companies scaling back pesticide research to invest in GMO seed as the market was fairly solidified. On the other hand, biopesticide developers are numerous, as seen in Appendix A, and consistently producing new active ingredients and products with multiple MOA that add a lot of capability to crop protection arsenals because they are much harder to develop immunity to. Some biopesticides are now proven to be at least equivalent in efficacy to traditional pesticides. A specialized bioherbicide aimed at problem weeds combined with a broad spectrum glyphosate product creates a formidable IPM assault for mitigating resistance problems in a more sustainable manner.

Exhibit 11

APPROXIMATE NUMBER OF COMPANIES CONDUCTING HERBICIDE DISCOVERY FROM 1970 TO 2005



Source: Arnold Appleby: *A history of weed control in the United States and Canada – a sequel*

Rootworm resistance has become more prevalent due to the growth of corn-on-corn planting and the reduced ability for biotech traits to handle corn rootworm and secondary insects. Nearly 30 million U.S. corn acres face heavy to moderate rootworm pressure and an additional 10 million acres face light pressure. Corn rootworm is one of the most destructive insects in U.S. corn with estimations that rootworm damage results in a $1 billion loss per year. Bt traits, first released by Monsanto in 2003 to combat corn rootworm and corn borer, have been effective but we are starting to see increased cases of rootworm resistance to multiple Bt traits (Monsanto, DuPont and Syngenta). Utilizing a bio-insecticide together with genetics has proven to be an effective means to combat resistance and protect growers from yield loss.

Biostimulants Offer Attractive Yield Increases

While biopesticides will slightly boost yields by combating resistance issues in IPM systems, resistant pests will develop over time. This means that new formulations will need to be continually developed and adopted to break resistance cycles. Biostimulants are the subset of biologicals that offer growers yield lift potential because nearly all crop loss is due to weather. By acting as a catalyst for natural metabolic processes they enhance how the crop will perform in its environment by increasing its tolerance to abiotic factors such as drought or extreme heat and to biotic factors such as insects and weeds. There are many

documented uses in Europe that support a minimum yield lift of 5% all the way up to a maximum of 25% lift for a variety of biostimulants.

Most biostimulants come in liquid or dissolvable granular form and are easy to apply to row crops. The products improve plant respiration, photosynthesis, nucleic acid synthesis and ion uptake. By improving root size and structure better germination will result leading to a full stand. Additionally, nutrient uptake/retention and water holding capacity will be enhanced allowing the plant to better survive periods of harsh weather. We see growers quickly adopting biostimulants more once mainstream awareness emerges as they do not involve a radical change in grower practices, offer improved yields and allow for significant reductions in application of expensive fertilizer.

Entry Into Lucrative, Organic Export Markets

Organic food often commands a 100% price premium over its conventional counterparts. It is a nice market to get into if growing costs can be controlled because demand is growing much faster than global supply can keep pace with. Growers that move into some organic production early on will be able to generate strong returns before supply finally catches up to demand in the future. Moving heavily into organic production is an appealing strategy for developing countries lacking the massive fields and sophisticated machinery present throughout the dominating agriculture countries. Countries like India and Argentina have benefited greatly from the global organic trend. In fact, India's exports of organic products nearly tripled last year. In February of last year the U.S. and the EU announced they would soon begin treating each other's organic standards as equivalent. This action doubles the potential market for producers in both countries. The U.S. Department of Agriculture (USDA) estimates that U.S. organic exports to Europe will triple within three years. As countries start defining organic farming in concrete terms rather than leave it as a mindset the global network of markets will expand and provide new opportunities to growers all over the world.

Long time organic producers and new growers looking to enter into the market will both drive growth and development of the biopesticide industry. Zero residues on crops, virtually zero REI and guaranteed worker safety are all significant benefits of biopesticides for the organic producer. They increase production efficiency and decrease growing cost by reducing the need for handwork in the field. Additionally, they also make it possible for organic growing of traditional row crops which will be instrumental as demand for organic food potentially shifts slowly to include staple foods rather than just fringe products and produce.

Improved Operational Flexibility

One of the most difficult challenges in farming is performing the processes at the optimal time. Weather is uncontrollable, but restrictions on field access stemming from chemical pesticide application complicate timing actions further. The REI is critical for organic and fringe products that rely on hand work such as pruning. Some chemical pesticides have a REI of two weeks or more before hand work may be performed while current phosphates for organic production have a 10 day REI. For field crops the PHI is the bigger obstacle. Depending on the pesticide harvesting cannot generally occur anywhere between 15-60 days after application as residues on the crop will exceed the MRL. This can be problematic when late season pests need to be controlled – especially as late season fungicide application has increased. In situations like this biopesticides would be excellent yield protectors. Many biopesticides have only a couple hours REI and a zero day PHI offering invaluable flexibility to the producer, whether it is organic niche crops or common field crops, throughout the year.

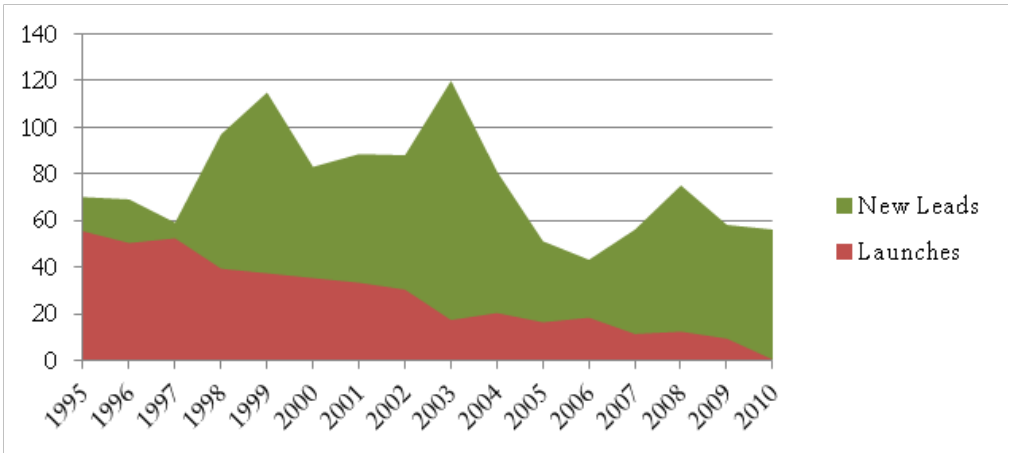
KEY BENEFITS TO SUPPLIERS

Quicker And Cheaper To Develop And Market

One of the most powerful tailwinds for biologicals right now is the environmental forces causing traditional pesticides to become more difficult to develop, produce and market than biologicals. Traditional pesticide development has been hindered by increased scrutiny of toxic chemicals, lengthy registration processes and industry consolidation. Today companies must spend long periods of time on exhaustive screenings in order to have the chance of developing an extremely expensive product to bring to market in an industry facing dim growth prospects. See Exhibit 12 for more detail on the increased difficulty of generating value from a chemical pesticide. This trend has increased interest in biologicals over the last few years. The detailed breakdown cost and time investment for four major agricultural products are displayed in Exhibit 14.

Exhibit 12

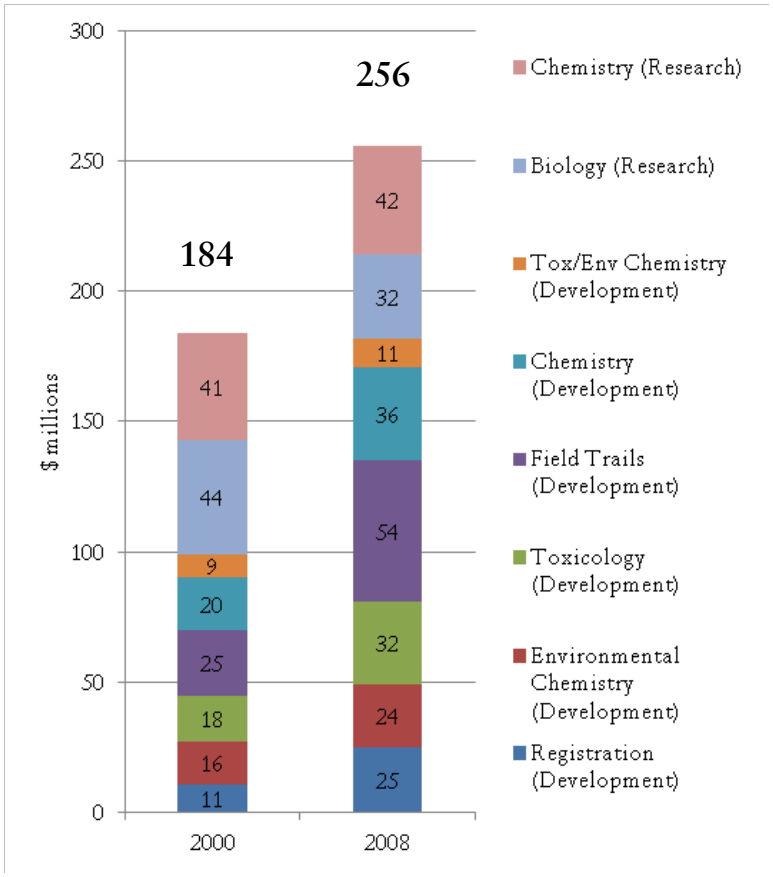
DECREASING NUMBER OF NEW CHEMICAL PESTICIDE LAUNCHES



Source: Ag Chem New Compound Review

Exhibit 13

INCREASED COSTS OF LAUNCHING A CHEMICAL PESTICIDE PRODUCT FROM 2000 TO 2008



Source: Phillips McDougall Research and Development Study for CropLife America, Piper Jaffray research

Exhibit 14

TIME AND COST INVESTMENT FOR FOUR AGRICULTURAL PRODCTS

Type	Time to Market	Cost of Development
Traditional chemical pesticide	10 years	$260 million
Genetically engineered trait	8-13 years	$140 million
Biopesticide	3 years	$8-15 million*
Biostimulant	1-2 years	$1.5-3 million

Source: CropLife America / ECPA study, CropLife International study 2011, BPIA, Marrone Bio Innovations

As seen in Exhibit 12 the number of new product launches has steadily decreased over the years. Roughly 140 chemicals need to be screened in order to find one product today compared to only about 20 in 1990. Exhibit 13 lays out how much development costs have climbed relative to a noticeable reduction in research costs. This is a direct result of the increased environmental data and efficacy testing needed to register a chemical pesticide

and regulators pushing the crop protection industry toward products that are "softer" on the environment. Exhibit 14 shows just how appealing it is for a crop protection company to delve into creating a biological research platform to start building up a product pipeline. The total cost to develop a biological product is much less than the increase in cost of chemical product registration from 2000 to 2008. There is often truth to the argument that the ratio of sales to development costs has favored chemical pesticides, but that trend is likely reversing. Large firms can think of the cost of constructing a biological platform as a small insurance policy that will protect the firm for when biologicals become a larger percentage of overall crop protection sales and possibly cannibalize sales of their existing synthetic products. The time and dollar investment for a large firm is barely material, but the payoff of patenting the first big, breakthrough product in the biologicals could be huge considering growth on the horizon for the industry.

Additional Revenue Stream That Extends Traditional Pesticide Lifespan

By venturing into biologicals, firms can create an incremental revenue stream, expand their share of the crop protection market or extend the life of a current chemical pesticide. As shown previously the cost of competing in this market is relatively low for the possible payoff. Additionally, there is a lot of revenue share to be gained in the new crop protection market as biologicals grow at an estimated 15% CAGR, while chemical pesticide growth will likely run with inflation at best. Companies that have strong crop chemical exposure, such as Syngenta, Bayer and Monsanto, are fortunate for running into a great opportunity to maintain key revenue driving products by helping facilitate mainstream grower adoption of IPM practices. If biopesticides fail to develop quickly, standby products such as Roundup® may no longer be purchased due to ineffectiveness. Monsanto is just one example of a large agricultural firm that has a key stake in the development of this industry as Roundup® (their Agricultural Productivity segment) makes up roughly 30% of their total annual sales. If Roundup® is no longer a viable herbicide option because of resistance concerns, growers will have no incentive to pay a premium for Roundup Ready® GMO seed causing Monsanto to lose out on sales of a high-margin profit driver. There are other agricultural firms with cash cow products that are in the fray too. One other way these companies can help extend the life of their current revenue generating products is to combine their soon to come off patent chemicals with new biological strains to re-patent their cash cows. Large agricultural firms will create significant momentum for the biological industry because a fair amount of their success hinges on how these new products develop within the market.

Viable Exit Strategy For Small-Scale Developers

While large agricultural firms will ultimately get the credit for taking biological products mainstream, it would not be possible without the knowledge harnessed over years of research by small-scale developers. The recent interest in biologicals by large agricultural firms is the catalyst needed for both the industry as a whole and for small developers' research to be commercialized. The new interest by agricultural firms will bring all the final pieces together including mainstream grower awareness by accelerating research institutions' involvement in the field. The interest by the big players also serves as a viable endgame for the small developers because they finally have an exit strategy.

Over the last 20 years there has been an immense amount of biological research done by start-ups, but was often all for nothing because they could not do much with it. Even though the cost to develop and register a biological product was not a barrier for those firms, few of them had the financial means to scale up production on a broad level, the distribution network and sales channels needed to dispense the product, or even the grower recognition and trust necessary to generate mass interest in their offering. 10 years later the industry is starting to develop and behave more like the pharmaceutical arena. Large firms with the infrastructure and capital selectively acquire the companies that have the best

biological platforms and product portfolios they want to pursue. Today successful developers will no longer sputter out and dissolve when funding runs dry as there are plenty of large strategic firms waiting to integrate their capabilities into deep product pipelines whether by acquisition or product licensing. Startups can now go the distance when aligned with a large agricultural firm because of access to a widespread customer base, larger research and development platform, and global production capabilities. This will be a huge spur to development as start-ups have a method for monetizing their technological developments.

INDUSTRY SUPPLY CHAIN

Crop Protection Industry Landscape

The crop protection industry has historically been slow-moving and heavily reliant on old stand-by products because of the high cost of researching and developing new chemical pesticides. It has also been dominated by six major companies that currently control nearly 75% of global crop chemical revenue. The industry structure remained dormant until a few years ago when external factors in the environment began forcing the leaders to put emphasis on innovation, specifically biological, in order to remain competitive. The continued blurring between crop protection products and seed manufacturing has been a driving force for agrochemical companies to make strategic moves. Within the last two years five of the "big six" have made some type of play into the biological realm. A holistic breakdown of this history is in Exhibit 15. The crop protection landscape can be broken down into three tiers: 1) the "big six" agrochemical companies focusing on row crops and global business development, 2) the generic suppliers focusing on leveraging their sales force to sell others' chemicals and biologicals, and 3) the biological developers that focus on discovery and screening to bring new products to life via acquisition by a large firm or a licensing agreement.

Key Crop Protection Players

Bayer Cropscience AG

Bayer is headquartered in Monheim am Rhein, Germany and is the second largest player in the crop protection market with about 17% of the market. Bayer, the 150-year-old company known for commercializing Aspirin, created Bayer CropScience in the middle of 2002 when they purchased Aventis CropScience. They have primarily been focused on traditional pesticides. They are the world leader in insecticide sales and second in the world in fungicide sales. However, the company has moved into the biological arena by acquiring AgraQuest and Prophyta within the last 12 months. Their strong position in the fruit and vegetables market should be strengthened by their new biological capabilities. They are now focusing on leveraging their acquired resources to create a new biological portfolio and push into biological seed treatment. We believe their innovative partnership with Mendel Biotechnology, who has an immense knowledge base in plant genetic regulatory networks and possesses proprietary genetic tools, to develop synergistic formulations to improve crop yields by enhancing biotic and abiotic stress resistance offers great possibilities for agriculture and provides further validation for expanded biological potential.

BASFAgricultural Solutions

BASF is the world's largest chemical company. Their Agricultural Solutions division houses their crop protection business segment, which is the third largest player in the crop protection market and headquartered in Ludwigshafen, Germany. They have a strong distribution network and customer base in Europe which positions them well for the biological boom in agricultural. BASF has been involved in distributing and supplying biological products since their 2009 alliance with AgraQuest; however, they recently decided to become directly involved in the emerging market by creating their own research platform. On September 20, 2012 BASF made the largest acquisition of a biological developer to date when they purchased Becker Underwood at ~4 x 2012 sales, or just over $1 billion, in continuation of its strategy of buying secular growth companies that are less dependent on global business cycles. The move instantly vaulted them to among the leaders in biological agriculture and allows them to expand on their sustainability initiatives such as their research platform AgBalance™ and their crop enhancement portfolio AgCelence®. BASF sees chemical and biological products as complementary and believes that Becker

Underwood's BioStacked® technology will give them an advantage in the market because of the ability to combine stimulants, enhancers, inoculants and biopesticides on crop seeds.

Dow AgroSciences

Dow AgroSciences is headquartered in Indianapolis, Indiana and is part of the Dow Chemical Company that was established as a joint venture between Dow Chemical and Eli Lilly in 1989. Their percentage of global crop protection revenue is modestly below 10% and ranks them as the fifth largest player. Most of their focus over the past few years has been on GMO seed traits in order to catch up to other competitors in the segment. Between 2007 and 2011 Dow AgroSciences acquired 12 companies that were all seed or trait based. They have not been as focused on biologicals as the rest of the "big six" agribusinesses and currently do not offer any biological products. Interestingly enough, Dow AgroSciences won the Green Chemistry Award from the U.S. EPA in 1999 for its development of spinosad, the active ingredient in its natural based Entrust® insecticide. However, spinosad products are not biological products even though they are certified for organic growing as their MOA targets the nervous system. While Dow may be gaining on competition in seeds and traits, they are quickly falling behind in the biological arena.

Dupont Crop Protection

DuPont Crop Protection is a subsidiary unit of E.I. du Pont de Nemours and Company's Agriculture segment that is headquartered in Wilmington, Delaware. We estimated their percentage of global crop protection revenue to be 5%, ranking them as the sixth largest player in the industry. While historically known as a chemical company, their $6.3 billion acquisition of Denmark biotech and nutrition firm Danisco in May 2011 clearly shows their interest in aligning their business units around the theme of industrial biosciences and enzymes going forward. While DuPont has not yet acquired a biological developer it has experience in working with them. In June 2007, Marrone Bio Innovations created an alliance that allowed them to screen DuPont's complex discoveries for biological development. DuPont also partnered with AgraQuest in October 2011 to exclusively develop and distribute a biopesticide created for oilseed rape producers. Six months ago DuPont also began a collaboration effort with Mendel Biotechnology to commercialize new gene leads for increased water use efficiency and photosynthesis in corn to promote physiological-based yield increases. A biological specific acquisition may be near on the horizon for DuPont to build on the intangible resources gained through the Danisco acquisition and other partnerships as industry growth is imminent.

Monsanto

Monsanto, headquartered in St. Louis Missouri, is the global leader in the seeds and traits market, but also has a strong presence in the crop protection market (forth largest player). Their 10% market share stems completely from herbicides and is driven from Roundup®. Its crop protection segment, Agricultural Productivity, only contributes 27% of total revenue in 2012, compared to 66% in 2002. It would me easy to write it off as a dying player in the crop protection market, but these figures are a testament to how much growth the company has generated from its innovative Seeds and Genomics segment, which includes an enormous amount of crop protection built into seeds. This means that Monsanto plays a role in crop protection before chemical pesticides are even applied. While Roundup® sales initially fell as a result of increased global competition and channel oversupply after Monsanto's patent expired in 2000, its sales have come back at 13% growth in FY10-11 and 15% in FY11-12 due to strong global demand and rising selling prices. In an interesting turn of events, the products that continue to be responsible for Monsanto's robust earnings growth are primary tailwinds for the adoption of IPM practices and thus biologicals.

While Monsanto has not made massive acquisitions like many other agribusinesses they have quietly moved into biologicals. In the last two years Monsanto has acquired assets of two small biological start-ups and formed a 10-year strategic alliance with Alnylam Pharmaceuticals to develop RNAi (post transcriptional gene silencing) biological controls.

These resources fit nicely into Monsanto's newest research platform, BioDirect ™ which aims to develop biological control agents in order better protect crops in a way the supports environmental sustainability. Additionally, Monsanto is using it to develop biological technologies that could make glyphosate resistant weeds susceptible to Roundup® again. We see BioDirect™ as a potential incremental booster to Monsanto's product pipeline value.

Syngenta

Syngenta is headquartered in Basel, Switzerland and was formed in November 2000 after the merger of Novartis Agribusiness and AstraZeneca Agrochemicals. They are the largest player in the crop protection market with roughly 19% of total revenue. About 80% of their annual sales come from crop protection while the remainder comes from seeds. They have a strong focus on emerging markets and generate half of their crop protection sales from those regions. In the last 12 months Syngenta has made two major acquisitions in the biological tier of the market. In 2011, Pasteuria Bioscience and Syngenta entered a partnership to develop a bionematicide portfolio to help control soybean cyst nematodes that cause an estimated $1 billion in crop losses a year in the U.S. alone. This product will be ready to solve one of the largest unresolved problems for soybean growers by U.S. planting season in 2014. In September 2012, Syngenta purchased Pasteuria and followed that by acquiring Devgen less than a week later at ~14x estimated 2013 sales. Syngenta has also been working with Novozymes since April 2012 to commercialize the biostimulant JumpStart® which lowers the amount of phosphate fertilizer required, improves crop performance by enhancing root development, and is registered for use on more than 12 crops. Syngenta also has a unit, Bioline, which is a platform for non-field crop biologicals which has five production sites in the U.K., U.S., the Netherlands, Spain and Portugal.

Exhibit 15

LARGE AGROCHEMICAL COMPANIES MOVE INTO THE BIOLOGICAL INDUSTRY

Date	Company 1/Acquirer	Company 2	Type of alignment	Acquisition price in USD
9/20/2012	BASF	Becker Underwood	Acquisition	1.02 billion
4/2/2009	BASF	AgraQuest	Strategic partnership	
1/21/2013	Bayer	Prophyta	Acquisition	N/A
8/16/2012	Bayer	AgraQuest	Acquisition	500 million*
3/31/2009	Bayer	AgroGreen	Acquisition	N/A
10/21/2011	DuPont	AgraQuest	Strategic partnership	
6/18/2007	DuPont	Marrone Bio	Strategic partnership	
1/30/2013	Monsanto	Agradis	Acquisition	N/A
8/28/2012	Monsanto	Alnylam	Strategic partnership	
9/28/2011	Monsanto	Beelogics	Acquisition	N/A
6/28/2011	Syngenta	Pasteuria Bioscience	Strategic partnership	N/A
2/19/2013	Syngenta	Isagro	Strategic partnership	
9/19/2012	Syngenta	Pasteuria Bioscience	Acquisition	123 million*
9/21/2012	Syngenta	Devgen	Acquisition	523 million
4/25/2012	Syngenta	Novozymes	Strategic partnership	N/A

**Includes milestone payments*

Source: Company news releases, Piper Jaffray research

Changing Industry Dynamics

From around 2008-2011 strategic alliances and licensing deals were formed as startup developers looked to gain access to broader reaching distribution channels so they actively sought the attention of large agrochemical companies. Since 2011 agrochemical firms have been the party actively seeking ownership of small biological developers to gain a quick foothold in the emerging market before they are locked out. We expect to see major product innovation and commercialization as the infrastructure to support the industry solidifies. This will allow for widespread grower awareness leading to escalation in product penetration as other external environmental drivers continue to bolster industry development.

Despite the number of recent acquisitions in the biological industry there are still plenty of big-potential firms flying under the radar that present opportunities for agrochemical companies such as Dow or DuPont that have not launched a biological platform or even venture capital firms looking to move into this space. Whether it is coveted product patent, advanced formulation knowledge or experience handling the registration process there are still value-creating investments yet to be monetized.

Innovative Biological Developers

The numerous number of companies actively developing and marketing excellent products is proof that the industry consolidation period still has a lot of room to run. A few particularly promising innovators are as follows. For a complete listing of active firms in this space please reference Appendix A.

Marrone Bio Innovations

Marrone Bio Innovations (MBII) was founded in April 2006 in Davis, California by Pam Marrone. The firm possesses a remarkable amount of human capital with a leadership team carrying a wealth of experience from former industry standouts such as AgraQuest. MBII has two extremely successful commercial products that were both voted Best New Biopesticide by Agrow in 2010 and 2012 and a deep pipeline that includes nearly ten products in development. Their broad screening process and rapid product development has allowed them to assemble a portfolio of over 180 global patents pending. Cultivation of distribution partnerships with global chemical companies Syngenta (Europe) and FMC (Latin America) early in their lifespan has allowed for quick, clean transitions from product registration to widespread distribution.

Regalia®, Agrow 2010 winner, is biofungicide that controls diseases but also enhances physiological factors. It has been proven to deliver strong yield lift for high value crops like strawberries and yield increases for row crops, such as soybeans. These figures improve yields even more once mixed with traditional chemicals in IPM practices.

Grandevo®, Agrow 2012 winner, is a bioinsecticide that functions as a reproduction repellent. MBII believes this product will generate strong interest among row crop growers because it is the first broad spectrum microbial insecticide since Bt (used in most multi-stacked seeds) emerged over 50 years ago.

MBII's product pipeline includes the first new broad-spectrum bioherbicides that control glyphosate resistant weeds and possess synergistic activity with several chemical herbicides, two bionematicides, and even a couple biostimulants for enhancing plant abiotic stress tolerance.

The proactive steps taken by MBII such as expanding in-house production capacity through capital investment, gaining access to global distribution channels, and developing a broad, deep product pipeline have positioned the company well for sustainable growth. They will

be able to fully take advantage of the shift in biological focus from specialty/niche crops to row crops and the eventual development of mainstream grower awareness.

Advanced Biological Marketing

Advanced Biological Marketing (ABM) is a company that develops and markets products that fall under the biostimulant segment of biologicals and focus on enhancing crop yields in an environmentally safe method. ABM's soybean inoculant products (Excalibre™, Graph-Ex™, and Marauder™) coat extra Bradyrhizobium Japonicum bacteria on the seed before planting to ensure the plant has all the necessary bacteria need for optimal nitrogen fixation. Its corn inoculant (SabrEx™) features ABM's patent pending iGET™ technology. This technology is a formulation of two biological fungi strains called Trichoderma that colonize with the root system of the plant and feed of its sugars and starches as they are produced. These proprietary strains then give off enzymes and proteins for the host plant to absorb which result in larger more resilient root systems. Data over the last four years shows that SabrEx™ gives an average yield increase of 8.5 bushels an acre. At a cost of ~$6/acre depending on planting population a grower can earn anywhere between $40-50/acre more profit assuming corn prices fluctuate around $6/bu. Samples indicate that SabrEx™ generated up to 20 extra bushels an acre in the Midwestern drought of 2012 than untreated fields. Exhibit 16 shows the difference between corn treated with SabrEx™ and without.

Exhibit 16

SABREX™ TREATED CORN PERFORMANCE OVER CONTROL CORN

Source: Advanced Biological Marketing

Valent Biosciences Corporation

Valent BioSciences (VBS) is a subsidiary of Sumitomo Chemical that has a wide range of biopesticides and other biological products including plant growth regulators. They have an innovative development platform that focuses on beginning to end agricultural solutions. This allows VBS to participate in activities throughout the production cycle from seed coatings, to crop protection, and pre and post harvest application. Their $65 million dollar acquisition of post-harvest specialist Pace International in December 2012 supports the continued broadening of their product line. Their full-spectrum development strategy has yielded vast amounts of intellectual property consisting of over 240 issued patents and approximately 800 product registrations across 95 countries. They have sophisticated manufacturing processes that produce consistent products with superior stability and shelf life. VBS is currently constructing a $150 million biological production facility in Osage, Iowa that is expected to be complete by June 2014 and will significantly expand the firm's capabilities. The entire complex is being funded by internal cash flow indicating the firm's sustained history of success.

Bug Agentes Biológicos

Bug Agentes Biológicos (BUG), founded in 2001, is a start-up developer of unique, biological crop protection agents headquartered in Piracicaba, Brazil. The company was highlighted by the magazine Fast Company in 2012 for being one of the world's 50 most innovative companies (ranked 33) for their pest decimating wasps. BUG's wasps attack the eggs of the sugarcane borer by injecting their own eggs into them preventing them from proliferating. BUG has learned how to mass produce their crop protectors despite the complex breeding process. They sell them to growers in patented, biodegradable packages (as seen in Exhibit 17) that are placed in the field 20 meters apart. Once the wasps hatch they leave the holes in the package and target only the sugarcane borer. The company is also developing a promising pipeline of products for corn and soybeans. Their merger with Promip in 2011 gives them the ability to scale their production capacity quicker as demand begins to mount.

Exhibit 17

BUG AGENTES BIOLÓGICO'S BIODEGRADABLE PACKETS

Source: Bug Agentes Biológicos

Novozymes Bioag

Novozymes BioAg is a developer of both biopesticides and biostimulant style products that is headquartered in Saskatoon, Saskatchewan. They have over 700 products used in 130 countries that are focused on three fronts: biofertility, bio control and bioyield enhancers. Their JumpStart® inoculant improves the usage of phosphate fertilizer by releasing organic

acids that break down bound-up phosphate so crops can utilize it quickly when it is needed most. Exhibit 18 shows how crops without strong root systems or the benefit of an inoculant will not be able to use much of the applied phosphate because of its minimal movement within the soil. Novozymes has products available for all types of crops that have been proven to increase yields in excess of 5%. In November 2012, Novozymes acquired Natural Industries to expand their research platform and product reach. Within the last two weeks Novozymes also acquired TJ Technologies to continue its development in bioyield enhancers. They are recognized as a leading innovator in the field of biologicals and along with Marrone Bio Innovations were awarded up to $2.5 million by the U.S. Department of Energy to develop new enzyme-based technologies for converting corn stover into sugars which can then be used in the production of biofuels.

NewLeaf Symbiotics

NewLeaf Symbiotics, formerly known as TrophoMax LLC, is a developmental-stage company focused on natural crop enhancement technologies and headquartered in St. Louis, Missouri. NewLeaf is focusing on commercializing products based on their discoveries surrounding the advantages of the beneficial bacteria Pink Pigmented Facultative Methylotrophs (PPFMs) on plants. While plants naturally make use of PPFMs on their own, NewLeaf has found that manually enhancing the concentration on seeds in a prescribed manner promotes physiological benefits such as faster growth, increased plant vigor, greater biomass and better seed germination. They expect their technologies will be applicable to all fruits, vegetables and row crops. NewLeaf rose $7 million in a round of Series A financing earlier this year to further support formulation efforts, expand field testing capabilities across critical market segments and develop intellectual property.

Actagro

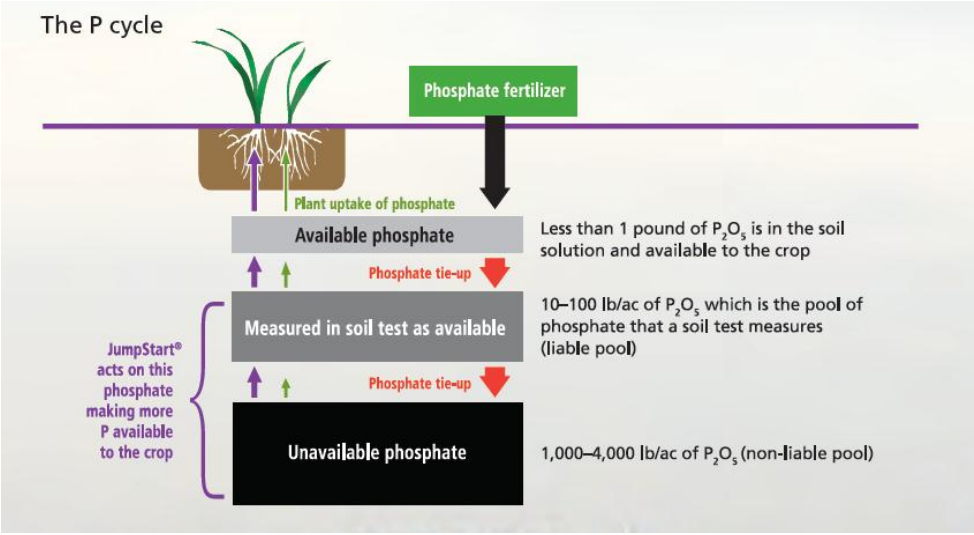
Actagro is a plant nutrient company that offers growers access to biologicals through plant stimulants and fungicide. They are headquartered in Biola, California and has a manufacturing facility in Osceola, Arkansas. In aggregate the firm can produce over 150,000 gallons of N-P-K, micronutrients and stimulant products daily. Their biological products have demonstrated the ability to improve grower yields by promoting healthier crops through stimulation of natural metabolic processes and strengthening of soil profiles. Actagro's extension from nutrients into biologicals shows management's foresight and potentially signals the dawn of new industry interest in biologicals.

Kip Cullers Do Brasil

Kip Cullers do Brasil, headquartered in Ribeirão Preto, Brazil, is focused on developing biostimulant products that work in a harmonized system to promote agricultural productivity gains. Benefits of the Kip Cullers system include: enhanced genetic potential, improved nutrient use, better energy capture during photosynthesis and accelerated penetration speed of foliar applications. The concept of the firm is based on Kip Cullers, their figurehead and lead product developer. Cullers and his team have harnessed their proprietary formulations and know-how developed on over 15,000 corn and soybean acres in Missouri to offer yield lifts to growers in Brazil. The potential of the firm's products is validated by the historical production averages recorded on Kip's farm – 291 bu/acre and 103 bu/acre for corn and soybeans respectively. Product adoption is beginning to ramp in Brazil, and we see acreage growth in country as an additional tailwind.

Exhibit 18

TIE-UP IN THE PHOSPHATE CYCLE



Source: Novozymes

Stoller USA

Stoller USA, headquartered in Houston, Texas, is a world leader in biological plant performance products aimed at enhancing crop health by stimulating natural processes in all stages of life, from germination to maturity. Their Bio-Forge® crop enhancer aims at optimizing plant hormone use within plants to maximize yields. It works by inducing plant hormones to maximize their genetic expression (defined by GMO trait) to better overcome climate related stress. Most growers only receive about 30%-35% of the genetic potential of their expensive seeds, because after planting climate changes cause crops to lose genetic expression capability. Stoller research indicates yields can be increased by 30% on today's averages by efficiently regulating a plant's response to climatic conditions via locking in genetic expression early on. Stoller's research is supported by numerous universities, agricultural institutes, and growers across the country. Fives years and dozens of trials show that Bio-Forge® can increase a grower's yield anywhere from to ten to fifty bushels or more an acre. The number of growers that perennially place high in the National Corn Growers Association Yield Contest using Stoller products is a testament to their success.

Agricen

Loveland Products is a subsidiary of fertilizer-maker and farm center retail chain operator Agrium (AGU) and based in Loveland, Colorado, that offers a complete line of traditional chemical pesticides. However, they have recently expanded their product offerings to include some biostimulants. On August 1, 2012 they announced that they acquired an ownership position in Advanced Microbial Solutions which changed their name to Agricen in 2013. Agricen's biologicals have expanded rapidly in acreage – from 50k in 2008 to over three million in 2012. The strategic move by Loveland has given them accessibility to Agricen's strong platform of sustainable products (Accomplish® LM and Titan® PBA) that facilitate uptake of fertilizer that is tied-up in soil or crop residue by stimulating the crop's root structure. The grower can significantly reduce the cost of their most expensive input on the farm, fertilizer, as one it only costs ~$4-5 to cover one acre with their biostimulants, but they gain anywhere from 6-10 bushels of extra yield. The acquisition highlights a strategic decision by Agrium to get involved in biologicals before they pull revenue out from the fertilizer giant's grip. Agrium has nearly half of their Crop Production Services sales representatives selling the products.

Agrinos AS	Agrinos is a biological crop input provider headquartered in Lysaker, Norway that was founded in 2009. They offer growers a complete three component system called High Yield Technology (HYT™) that is an integrated approach to crop nutrition fixation and preservation. Additionally benefits include increased water retention and crop resistance to pests, disease and stress. They produce their biostimulants from a combination of naturally occurring amino acids, micronized chitin and shrimp industry waste. Their system increases yield dramatically for growers as seen in Exhibit 19 and helps reduce the billions of dollars spent a year on fertilizer that ends up being wasted and causing environmental degradation. Key growth catalysts for the company include the recent partnership with Syngenta and the resulting $10 million cash infusion, a deal with MasAgro, the Mexican government's 10 year program to improve agricultural performance, to supply HYT™, and recent approval of a nationwide product license by the Chinese Ministry of Agriculture for HYT™ A.

Exhibit 19

YIELD INCREASES FROM HYT™ BIOSTIMULANT SYSTEM ACROSS MULTIPLE CROPS

Source: Agrinos AS

Certis USA

Certis USA is a subsidiary of the Japanese conglomerate Mitsui & Co. They were one of the early players in the biological crop chemistry industry and are currently headquartered in Columbia, Maryland. Certis is a holistic biological crop protection developer that focuses on everything from screening to field development to global registration. They have multiple products with varied MOAs for nearly every crop protection category. Within their wide portfolio of biological offerings Certis has a leading lineup of Bt bioinsecticides that helps growers support GMO trait crop protection abilities. Their Gemstar® bioinsecticide offers growers control over *Helicoverpa zea* (AKA corn earworm, cotton bollworm, soybean podworm) through a unique viral-infection MOA and mixes effectively

with chemical pesticides. Certis has a fermentation facility in Wasco, California and a neem extraction plant in India. They are an example of a company that has begun to capitalize on their strong position in fruit, vegetable and organic niche-markets by successfully creating offerings geared toward more sizeable agricultural markets (row crops).

Eden Research

Eden Research, headquartered in Witney, United Kingdom, stakes its claim in biologicals through intellectual property and expertise in encapsulation and terpenes. Their proprietary technology has the potential to improve biological shelf life and UV light stability, while reducing the volatility of active ingredients. The encapsulated technology offers slow, 14-day residual release that lessens the need for precise application timing of many biologicals – enhancing their efficacy four-fold. We look for Eden Research to work in conjunction with larger biological or agrochemical developers to commercialize products that aim to increase the stability and ease-of-application of biologicals.

Industry Alliances Emerge Globally

In addition to continued innovation and product development biological firms have formed industry collaborations to support the development of biopesticides and biostimulants. These industry collaborations or alliances use outreach activities such as global forums, agricultural summits and industry panels to ensure the voices of their members are heard. They also act as a communication link between growers, developers, and regulatory bodies to find industry solutions that benefit all parties. Currently, these organizations are trying to move the biological industry from a narrow focus on primarily niche and organic markets to a broad focus on all crops, including rapid expansion into row crops.

Major organizations in the United States include the Biopesticide Industry Alliance (BPIA), formed in 2000, and the Biostimulant Coalition, formed in 2011. The main organizations in Europe are the International Biocontrol Manufacturers Association (IBMA), formed in 1995, and the European Biostimulants Industry Council (EBIC), formed in 2011. In the exploding agricultural region of South America one of the better known alliances is the Brazilian Biocontrol Manufacturer Association (ABCbio), which was formed in 2008. All of these organizations are made up of 10 to 100 or more firms with a stake in biologicals including developers, consulting agencies, university researchers, organic food producers, etc.

Industry collaborations will play a vital role in the future development of biologicals because of their unique ability to be a voice for all stakeholders across the globe. While nearly all other factors around the world are aligned for broad biological development, fractured regulatory procedures and lack of cohesive product definitions continue to stand in the way. These alliances will be the key to removing those final worldwide hurdles impeding development. Whether it be through political outreach, controlled negotiations or intense lobbying efforts these organizations will put enough pressure on regulatory bodies to take uniform action on the behalf of biologicals to create global definitions and streamlined registration processes. There are simply too many other demand factors around the globe driving biological growth for regulation to stand in the way much longer.

INDUSTRY CHALLENGES

Manufacturing And Product Formulation

One of the greatest advantages traditional chemical pesticides have against biological products is ease of manufacturing. From production scalability to consistency in product formulation chemicals still hold the edge. However, over the last few years there is plenty of evidence that biological developers are closing that gap quickly. Yet, there are still a few specific production challenges in the biological realm that must be addressed before the industry can truly take off on a global basis.

Since biologicals are derived from natural sources their shelf life is limited. It also means that product stability is much harder to maintain than it is with traditional chemicals. Moisture content is critical in maximizing the shelf life of biopesticide products and it must be individually optimized for each formulation. Biologicals are also extremely sensitive to ultraviolet (UV) light and degrade quickly in its presence. Temperature ranges for storage of biologicals need to be much more regulated compared to chemicals. For example Monsanto's Roundup® herbicide can be stored anywhere from 5-122 degrees Fahrenheit for a minimum of five years without efficacy loss where as Novozyme's biostimulants must be stored under 68 degrees Fahrenheit. Additionally, biologicals like Novozymes cannot be exposed to huge and/or frequent temperature changes or freezing conditions. While a few biological products can last for more than 12 months (Marrone Bio Innovations), most lose efficacy after that time period.

In addition to the stability of biological products another challenge is generating consistency in product effect over various farm situations. This is a concern developers will need to prove they have addressed if they want a truly global product. Products must be designed to generate the same results across soils with different pH, nutrient and moisture levels. They must also perform with consistency both when applied on different crops or genetic traits and when used in varied climates. Finally, developers will benefit by producing formulations that can be applied with equipment that growers currently use for chemical application. Growers will be much more inclined to adopt biologicals and start an IPM program if they do not have to purchase new equipment applicators or even new attachments for them.

Product stability and consistency concerns could weigh on widespread biological growth. Until some of these problems are fixed broadly, supply chains will need to be incredibly efficient and flexible. With limited shelf life and strict storage restrictions distributors will not want to carry large inventories. This means that even if end consumer demand is strong and manufacturer production is capable the distribution networks will constrain the entire supply chain. With inventory that perishes so quickly they will want to minimize the working capital they have invested in it even if they lag current demand. The best way to correct this problem until biological shelf life improves to consistently greater than 12-18 months is to allow distributors to carry lean inventory. By running quick and scalable production with a flexible distribution network product build-up in the supply chain can be minimized while still matching consumer demand. Flexible production will require some innovation for biopesticide manufacturers due to the fermentation in the process. Effective sales forecasting, logistics management and cost control are vital for the industry until shelf life improves. If this happens soon the industry could stimulate product penetration by switching to a push style delivery rather than the current pull style as it works better with the slow adoption habits of growers.

While it is likely that all of these production challenges will be conquered in the near future – a few companies have done so already in some ways – the real question is at what cost? If too much cost is added it will limit the marketability of biological products compared to traditional synthetics because the increase has to be absorbed somewhere in the chain. If the manufacturers absorb it they will be hard-pressed to continue innovating. If distributors are forced to pick it up their focus on selling biologicals will be lessened because of lower margins. If the growers are stuck with the difference they will likely continue using chemicals or at least never fully adopt biologicals. That said costs do not have to be as low as traditional chemicals for strong market growth to occur with all the other factors driving demand, but they do have to provide value to the grower at a reasonable cost. We feel that this will not be a challenge as large agrochemical firms getting involved will significantly reduce costs and even stand-alone developers, such as Marrone Bio Innovations, have shown they have the ability to develop stable products with repeatable efficacy at a reasonable price. There is plenty of evidence behind the efficacy claims of these recent products. These new products are also being released with increased shelf life, longer residual activity and wider pest coverage.

Companies that garner a robust understanding of interactions between multiple biologicals and traditional chemicals in addition to all other variables in the field will be well-prepared to potentially create the blockbuster product the industry is seeking. Not until product stability and broader applicability are achieved can a company have true global product that can be sold in multiple markets. From there companies will be able to leverage their research platforms and expand their knowledge bases through acquisition to get genetic seed traits, traditional pesticides, biopesticides and biostimulants working in harmony positioning them to dramatically advance agricultural practices.

Unpredictable Regulatory Action

As touched on earlier, global regulatory processes or even definitions are in no way standardized around the world and always changing. While registration of biologicals was initially introduced to be less onerous than biopesticides, firms within the industry complain that regulatory requirements are increasing as more scrutiny is placed on chemical pesticides. These trends have added more unpredictability to the equation for small biological developers. Extra regulatory requirements and evaluation time are more costs that a firm's platform must engulf. Predictability in the registration process would allow a firm to stop development of a product that did not make commercial sense much earlier in the process before it becomes too late and costly. In addition to the sometimes unpredictable regulatory processes the fragmented nature of global biological standards complicates the development process. Varying MRLs, different organic food requirements and lack of standard definitions for both chemical and biological pesticide products force developers to make choices of which countries to market the product in during the design phase. The resulting effect is companies focusing on markets they know and have experience in rather than new, high growth regions because different standards and unfamiliarity complicate development add cost. If the world was able to start converging standards with open discussion global adoption would be facilitated as all biologicals could be developed to be global products from the beginning.

Fortunately, we are seeing mounting indicators in the biological industry that foreshadow a renewed regulatory focus on favorable treatment of biological products in addition to more transparency and greater convergence of standards across the globe. Multinational agricultural firms jumping into the industry bodes well for increased university research which will result in support for industry development by a trusted third-party source. Additional pressure will be felt by regulatory bodies from global biological alliances. By getting companies, researchers, alliances, growers and regulators collaborating, the

complex registration processes will finally be clear, streamlined and predictable for firms on a global basis.

Creating A Paradigm Shift In The Mindset Of Growers

Another challenge to the biological industry that will (and has already started to) benefit from increased focus from large agricultural firms and university researchers is lingering negative grower perception. Growers, notorious for being steadfast in their ways, have been sold poor biological products tethered to unrealistic claims in the past and thus maligned them to old, western "snake oil" products. Small developers have been fighting that misnomer and embedded grower skepticism over the last decade, but industry restructuring activity in the last two years will do a lot to turn around grower perception. First, it adds credibility to biological claims of equal or better efficacy for a similar price in addition to bringing university research bodies and agricultural extensions, which are historically the most influential body to growers, into the fray. Second, it allows developers to get their products in front of growers to educate them in field demos, at trade shows, etc. by means of acquisition or a licensing partnership. Positive responses at these in-person events will spread quickly via word-of-mouth throughout farming communities generating a positive end-consumer buzz surrounding biopesticides, biostimulants and IPM practices and the benefits gained from them.

Managing Growth Effectively As A Small Developer

It is extremely difficult to bring a biological product from a screened strain, to an active ingredient, to a plausible formulation, and finally to a full-fledged commercial product. Even though the hit rate per screening is tremendously higher for biologicals than traditional chemical pesticides, it requires a lot of foresight to reach commercialization of a product – let alone a successful one. Many brilliant formulations have never reached commercialization because of mismanagement.

Start-up companies need to carefully manage their resources early and often throughout the growth process. Cash flow needs to be allocated with diligence to ensure no crucial portion of the process fall apart. Research and development, field testing, marketing services, registration, and legal management must all be properly funded or the entire development process will falter. Small firms do not have the time or financial resources to cover up mistakes and misallocations.

Once again, the invasion of large agricultural firms is creating a solution to current industry challenges. The infusion of cash, a sales force and a distribution network to a small-medium size developer will significantly improve their chances of successfully commercializing their product(s). In addition to the tangibles a large company will provide both financial and developmental oversight, more clout with registration bodies and growers, and broader research and development capabilities. Acquisitions in this space are much like the pharmaceutical arena in that they simply give the developer the platform to focus on what they do best and not have to be preoccupied with what they do not do well. While small developers focused on a specific biopesticide or biostimulant may still be selectively targeted and acquired like in pharmaceuticals, it is easier to become a realistic acquisition target by developing an expansive umbrella of biologicals rather than just focusing on one area. A single product can be easily reverse-engineered and does not show a complete body of developmental prowess and intangible research knowledge that a large repertoire of prospects, ideas and products does. In addition, a full line-up of products will also allow a firm to participate in the entire food cycle process from seed treatment, to crop protection, to pre- and post-harvest applications. This allows a firm to have a viable chance of being successful without the aid of a large multinational once the industry fully solidifies causing acquisitions to taper off.

KEY INDUSTRY TRENDS

Global Environmental Concerns

Concern for the environment is one of the broadest, long-term growth drivers for the adoption of biologicals because it is so multi-faceted and far reaching. Environmental sustainability is a large concern nearly everywhere and agriculture is under more pressure everyday because its practices are such a strong determinant of it. Traditional chemical pesticides are increasingly seen as detrimental to crop soil, water sources, hired workers and end consumers. The crusade for "greener" food and agricultural products that are "softer" on the environment is being joined by all segments around the world. Agricultural sustainability resonates with regulatory bodies, large corporations, research extensions, end consumers, and even growers are getting involved. Even though most of this may be reactionary from the effects of decades of aggressive agricultural practices, it is important that these segments are proactively trying to incorporate biologicals into practices going forward.

In addition to reducing the number of legal toxic pesticides, regulatory bodies have created grant programs and external funding for non-toxic biopesticide development in sustainability efforts. In 2003 the U.S. EPA created the Biopesticide Demonstration Program (BDP) in a collaborative effort with the USDA. The BDP can award about $400,000 in competitive grants annually to university researchers and biopesticide developers that collaborate to focus on various annual priorities (i.e., certain MOAs or species of pests). The Interregional Research Project #4 (IR-4) in conjunction with the BDP puts heavy emphasis on field demonstrations to improve grower education and awareness. The IR-4 also maintains a searchable online database of all formulations and screenings performed with BDP funding. Moreover, the U.S. EPA is providing resources for broader adoption of promising biological technologies into the market via the Biopesticide Technology Transfer Initiative by partnering with key stakeholders such as product developers, university research/extension personnel, crop consultants and grower organizations.

Other regulatory bodies are also throwing their support behind the development of sustainable crop protection initiatives. India's state governments have over 200 labs producing biopesticides and often allocate half of their government funding for crop protection toward biopesticides. The Netherlands government supported program GENOEG aims at identifying effective products, assisting in funding for registration and increasing grower knowledge of sustainable crop protection products. France recently launched "Ecophyto 2018." They aim to cut pesticide use in half by 2018 through a combination of supporting biological developers, promoting safe growing techniques and providing educational outreach with about a €50 million budget. Programs such as Denmark's "Green Growth" have been instrumental in continuing to reduce Scandinavian pesticide use to ~50% of previous application output by providing financial support to environmentally friendly developers. Much of this global regulatory action results from political pressure by environmental activists and climatologists and is likely to increase in coming years.

Large corporations are beginning to release annual sustainability or corporate responsibility reports informing stakeholders how they are taking steps to minimize their negative environmental impact. Shareholder groups have become increasingly active in this regard recently. In March 2009, McDonalds agreed to begin surveying their potato growers on their pesticide usage and then encourage all of their suppliers to adopt the current best practices. They are the largest purchaser of potatoes in the U.S. and have a lot of influence within the supply chain. Multiple large, multinational grocery chains in the EU are

undercutting the government's mandated MRL by going beyond the law to meet customer demand. Resistance to adoption of IPM practices will begin to fold as large players in the food supply chain begin to impose their own restrictions on chemicals in order to better serve their customers and expand their market share. Such cases are already appearing as some grocery chains are asking growers to document their sustainability practices. The emergence of Big Data in agriculture will make tracing foodstuffs all the way back to the grower easy. Software systems will be quickly implemented across food supply chains to appease consumer demand for more transparency throughout the entire process. This trend will leave operations that do not comply with environmentally sustainable practices behind. Compliance with these new practices of biological crop protection will become an unwritten rule for growers if they want to remain competitive – even if governments do not make it written law.

One final environmental trend worth highlighting is the crop protection and management methodology beginning to focus on soil health and sustainability across the entire ecosystem rather than simple threshold analysis with pests. This new, pragmatic approach is vital to preventing growers from turning back to more toxic chemicals to control glyphosate resistant weeds. By educating growers on how practicing environmental stewardship will preserve the long-term productivity of their farms the biological industry can enhance agricultural sustainability and their own profitability. Under this new environmental approach biopesticides will reduce chemical dependency in a safer, complementary manner, while biostimulants will enhance plant and soil health in the world's challenge to engage in sustainable agriculture.

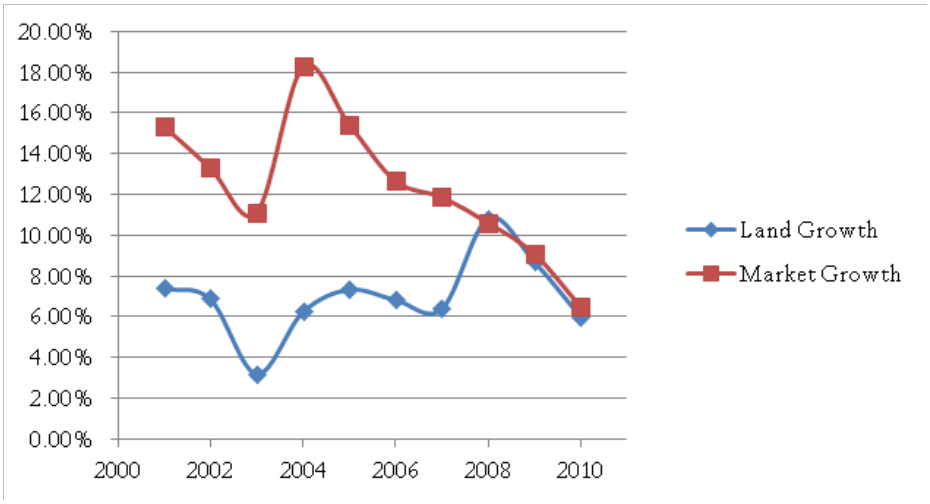
Growing Organic Food Market

Although the organic food market alone will never grant biological products widespread mainstream adoption among growers, it has been the catalyst that generated both the awareness and the innovation base biologicals need to do so. Only about 1% of farmland in the world is certified as organic, but the niche industry has given the biological industry the foothold it needs in order to expand its research and development platforms for the movement into row crops. While biologicals have dabbled into these agricultural mainstays, the full assault will come soon as global factors in the environment are quickly aligning to warrant it. That said, the expected worldwide growth of organic demand makes this niche market a material contributor to the long-term biological growth track.

In the past organic food was grown on tiny fields with much of the work being done by hand. These practices worked quite well for global market until recently when consumer incomes in developing countries started to soar. As purchasing power rose around the world, demand for organic food followed. The global organic food market is expected to swell to $104.7 billion in 2015 from $57.5 billion in 2010. The rampant CAGR of ~12.5% over this period will cause supply to lag demand presenting a wonderful opportunity for the biological industry. Exhibit 20 shows how global market growth has outpaced organic land development recently. In order to meet demand land must be converted to organic or productivity on current organic fields must be increased. Both of these scenarios bode well for biologicals. Most land conversion will be in regions with large, undeveloped, and arable fields. This scenario lends itself well to biopesticides because they can replace a lot of hand labor that is impractical on large fields. They also allow for late-season spraying just before harvest because of their lack of residue. Biostimulants, the other segment of biologicals, will benefit from organic growers trying to get more productivity out of their current fields. Biostimulants offer the same benefits to organic growers as they do to row crops (e.g., increased root mass, improved hormone activity), but they can also improve the shelf life of produce offering the grower more flexibility around harvest time. Regardless of how, the continued growth in the organic market will be meaningful to the biological industry.

Exhibit 20

ANNUAL ORGANIC MARKET GROWTH OUTPACES LAND USAGE GROWTH FOR ORGANICS



Source: FiBL-AMI-IFOAM Survey 2013, based on data from government bodies, the private sector, and market research companies, Organic Monitor, Piper Jaffray research

The organic trend is geographically broad and shows no signs of easing. The three countries with the most certified organic producers are India, Uganda and Mexico. Oceania, Europe and Latin America contain 80% of the world's organic farmland. The U.S. and Europe will continue to reign supreme as consumers of organic food for the foreseeable future as seen in Exhibit 21. These two regions make up more than 90% of current organic sales, but their growth is starting to settle in at about 9% annually. However, the world's fastest growing major markets for organic food, India and Brazil, will both expand in excess of 15% CAGR. Again the rapid growth of the organic food market will not fully support biologicals, but it will buoy the industry until widespread incorporation of biopesticides and biostimulants into row crop practices begins in the next few years.

Exhibit 21

LEADING MARKETS FOR ORGANIC PRODUCTS AS A PERCENTAGE OF GLOBAL SALES

Source: FiBL-AMI-IFOAM Survey 2013, based on data from government bodies, the private sector, and market research companies

Increasing Worldwide Consumption Of Protein And Dairy Based Products

If the 70% increase in agricultural production needed by 2050 to feed the 9.5 billion people predicted by the FAO does not frighten growers, the rising need for feed grain in BRIC countries (Brazil, Russia, India and China) certainly should. In addition to demand for organic foods, strong economic growth in the BRIC countries has resulted in intensifying desires for protein and dairy heavy diets. Effects of the global financial crisis and economic growth rates coming back to reality for these countries will not significantly alter the intake of meat and milk. People who had little to no disposable income a decade ago found themselves as consumers with purchasing power. Global crop production will need to catch up to this newfound grain demand as a widespread conversion of millions back to past lifestyles without the consumption of protein and dairy would be unprecedented in modern times.

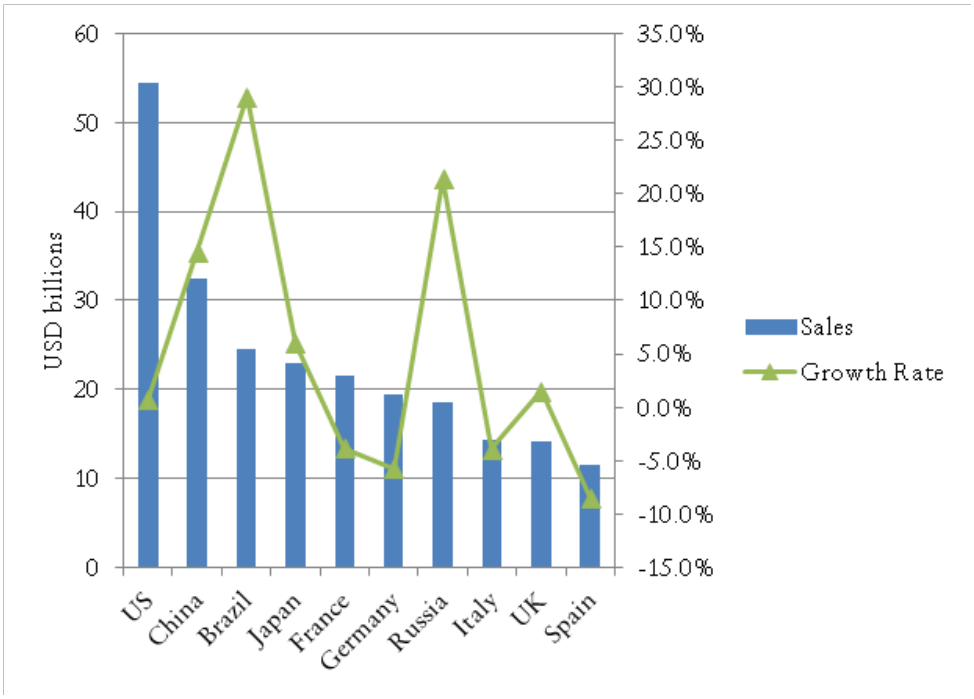
BRIC countries have all experienced robust consumption growth of grain dependent agricultural products within the last decade leading developing countries. Chinese pork consumption per capita has increased 23% since 2002 making it one of the five strongest countries in that metric. Brazil's total meat consumption per capita has increased 17.5% since 2002, primarily due to a 44% increase in poultry consumption per capita. Russian meat consumption per capita increased at 9.8% year-on-year in 2012 after growing at 8.4% annually since 2007. Much of this has been a result of a ~70%-75% increase in both poultry and pork consumption per capita since 2002. Western cultural influences and middle class income growth have started to awaken India's appetite for meat. This trend is surprising and speaks to the strength of the correlation of consumer income and protein rich diets because India is known for being one of the most steadfast vegetarian countries as a result of 80% of its population being Hindu (generally consider the slaughter of the cow taboo). Overall meat consumption in India has increased 14% since 2010 and is again being bolstered by poultry which is growing at 20% annually.

BRIC countries are just the primary engines of the long-term trend toward adoption of protein-based diets across the developing world that has doubled its meat consumption per capita since the late 1980s. Expansion efforts by U.S. quick service powerhouses McDonalds and Yum! Brand Foods in BRIC countries, especially China and India, support the long-term thesis that expanding middle-class purchasing power will drive domestic consumption of meat in developing countries. These strong regions of growth will continue to be the catalysts that are expected to propel global meat consumption to double by 2050 even as protein demand in the developed world stagnates.

The correlation of increased dairy product consumption and expanding middle class purchasing power is staggering. BRIC nations exemplify this trend well and are starting to make up a larger part of the world dairy market as seen in Exhibit 22. China, Brazil, and Russia combine for roughly 20% of the global liquid dairy consumption already. China's overall dairy product consumption per capita has more than tripled since 2000 – by growing at ~25% annually since 1997. The country's aggregate consumption, which is displayed in Exhibit 23, is expected to reach 70 billion liters by 2020 – nearly doubling their current consumption. India's liquid milk consumption is projected to grow at ~10% a year until 2020.

Exhibit 22

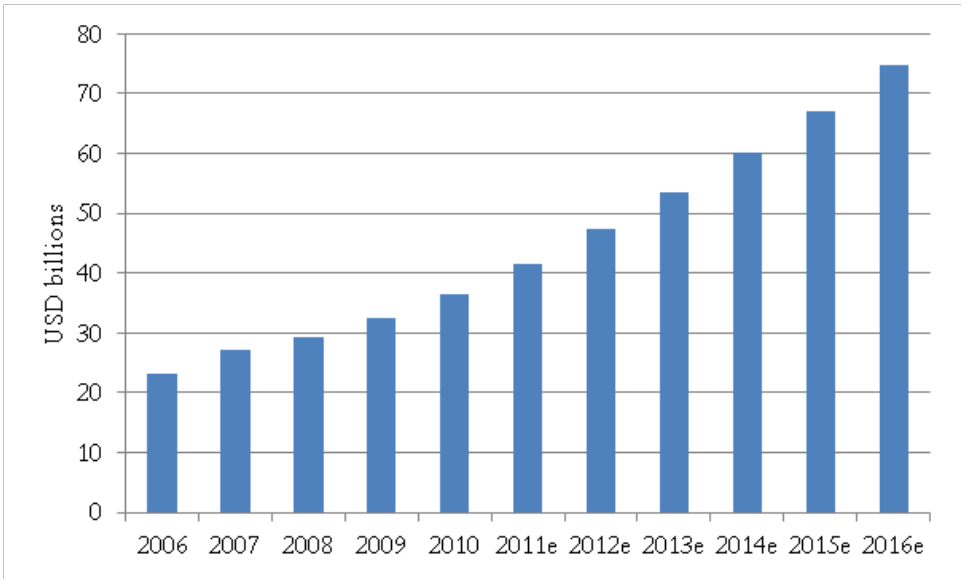
LARGEST LIQUID DAIRY MARKETS IN 2010 AND THEIR ANNUAL GROWTH RATES



Source: Rabobank 2012, Piper Jaffray research

Exhibit 23

TOTAL CHINESE DAIRY MARKET



Source: Euromonitor 2011

There are plenty of demand drivers that will ensure these consumption trends are sustainable in developing regions going forward. First, even though dairy intake has increased tremendously since the turn of the century in these regions there is still room to grow. Chinese milk consumption per capita is still only a fourth of the global average and average Brazilians are still about 25% short of the recommended annual milk intake. Second, advancement of infrastructure and domestic production capabilities will make dairy products cheaper and more readily available for local consumption. The deadly melamine tainted-milk scandal in China back in 2008 has resulted in larger state-supported producers that have increased efficiency with more cow imports and modern milking equipment. Indian producers are also adopting better milking and cattle management practices. Improving dairy production and safety in these regions will restore and create consumer trust in local production which will boost domestic consumption with the help of improved infrastructure for transportation and storage from economic expansion. Third, the swift flight of rural inhabitants to large urban cities in China, India and Brazil will boost dairy (and meat) consumption because of the increased availability of refrigerators that significantly enhance consumption of these products. For example, refrigerator ownership in urban China is essentially 100% while it is only about half of that in rural areas. China's urbanization rate is expected to increase from ~52% today to ~65% by 2025. Even rural areas will drive demand for milk-based products in the long-term for China as purchasing power will trickle out to the countryside allowing for more refrigeration units. Less than 20% of households in India own a refrigerator currently, but historical third-party research in the region shows that this one of the first items to be purchased as discretionary income expands. McKinsey and Company reports that the number of urban households in India with true discretionary-spending power could increase seven-fold to 89 million by 2025.

While the growth rate of protein and dairy consumption in developing countries is incredible, the extraordinary aspect to this story is that they do not even need to meet global expectations in order to spur demand for biologicals. Even if consumption decelerates significantly in the coming decade, the massive population explosion in these regions will mask the slowdown. In summary, increased purchasing power and diet changes in developing countries are exacerbated by the overarching trend of large, growing populations globally. This trend is one of the most solidified, sustainable and long-term drivers of the development of biologicals.

The reason that consumption of protein and dairy-based products increases the demand for biologicals is derived from the need to feed the livestock which produces those products. Producers have resorted to primarily feeding their livestock on grain heavy diets in order to generate a faster return on their investment than possible with traditional grazing (grain puts more weight on quicker). Additionally, pork and poultry producing animals do not perform well on high-fiber diets that result from grazing. However, feeding the world with livestock derivatives is terribly inefficient compared to straight grains. This is because there is a much higher volume of grain fed into the animal than they produce in meat or milk. This input to output system is modeled by a Feed Conversion Ratio (FCR), which is the amount of feed in pounds needed to produce one pound of meat (butterfat and protein for dairy cows). Exhibit 24 is a table showing the FCRs for meat and dairy producing animals. Even though much of the global meat demand is coming from lower FCR producers (poultry is not as quite good as it looks on paper due to the amount of inedible portions), it will still be difficult to feed the world sustainably over the next couple of decades without agricultural production improvement. There are arguments that Dried Distillers Grains and Soluble (DDGS), which is a by-product of ethanol production, will significantly help livestock and dairy producers feed their animals, but as shown in Exhibit 24 it is really only effective with beef cattle. DDGS is hard on the digestive systems of hogs and broilers and does not offer a one-to-one replacement for traditional animal feed. Grain producers are

thus presented with a market opportunity that will allow them to sell more corn and soybeans at higher prices and in larger quantities if they can raise yields to meet demand for consumption. The global trend toward higher costs to supply (FCR) protein and dairy rich palates presents a perfect scenario for biological developers to display why they will be instrumental to agriculture in the coming decades.

Exhibit 24

FEED CONVERSION RATIOS AND DRIED DISTILLERS GRAINS AND SOLUBLES EFFECTIVINESS FOR PRIMARY AGRICULTURAL PRODUCERS

Species	Provides	FCR	Maximum DDGS share of ration	One pound of DDGS replaces Corn	Soymeal
Dairy cows	Milk	8-10	up to 40%	0.6 lbs.	0.6 lbs.
Cattle	Beef	6-8	over 50%	1.1 lbs.	N/A*
Hogs	Pork	3-4	10% to 15%	0.8 lbs.	0.2 lbs.
Broilers (Poultry)	Chicken	2-3	4% to 7%	0.6 lbs.	0.6 lbs.

**Little soymeal is used in most cattle feeding programs*

Source: Congressional Research Service, OECD/FAO Agricultural Outlook, Lallemand Animal Nutrition North America, Piper Jaffray research

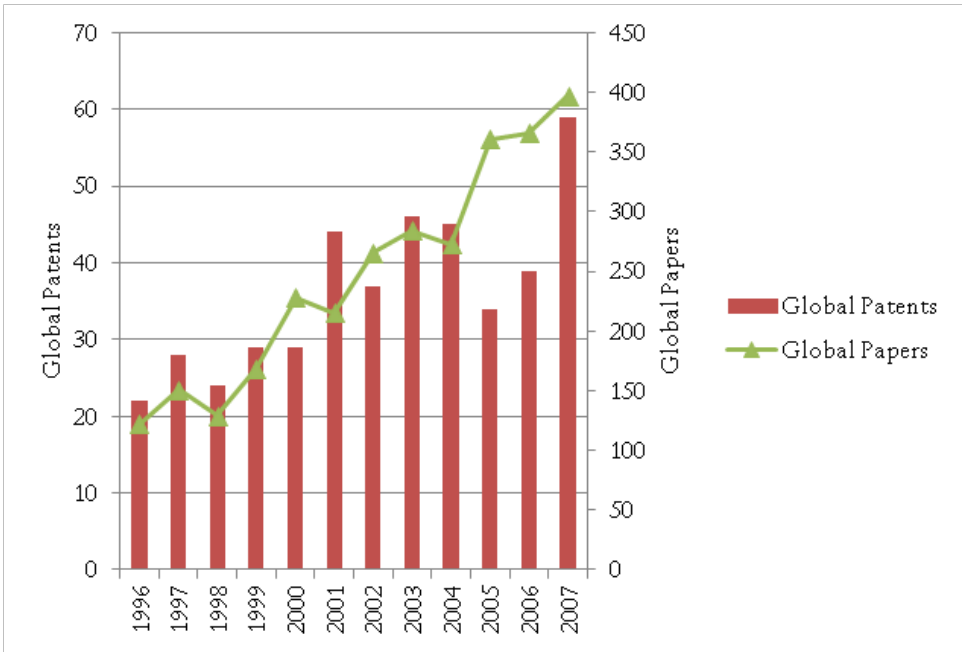
Merger And Acquisition Activity

Environmental factors in the chemical pesticide industry have generally limited growth opportunities causing agrochemical companies to make plays in biologicals. Merger and acquisition activity has quickly heated up in the last two years as previously discussed and shown in Exhibit 15, and we expect it to continue as laggards try to ensure they do not get locked out of the high-potential market. This trend is important because it gives the biological industry newfound capability and visibility.

Large crop protection companies instantly give small developers a logistical and infrastructural advantage in the market place. It gives developers access to the scale and resources needed to quickly source and screen large quantities of potential active ingredients in a short amount of time. This is the exact trend that allowed GMO seed developers to have extraordinary success in the 1990s and continues to allow pharmaceutical developers to focus their efforts on creating innovative products and bringing them to market quickly. Consolidation also allows agrochemical companies to pool their synthetic platforms with biological advances to create potent, hybrid products that combine the best features of both offerings. Additionally, it allows big firms access to valuable local regulatory knowledge – something that is extremely geographic relative – in a much more cost effective method than developing internally. We see a lot of companies participating in this area going forward as biopesticides do not have the advantage over chemical pesticides in every facet and because it is clear traditional synthetics are struggling to control pests on their own or spare the environment. Industry leaders calling both offerings complementary gives us increased confidence that companies will develop integrated pest control solutions for growers while still offering biologicals where independent use is sensible. Essentially, large agrochemical companies will consolidate all the fragmented efforts by small developers and research bodies over the last decade via acquisition. These efforts, which can be observed in Exhibit 25, will be pooled into an already present crop protection research base. Knowledge of traits and chemical pesticides will be harnessed into a broad, global pipeline of biological products that will work in sync with the rest of the growing system.

Exhibit 25

HISTORICAL BIOPESTICIDE RESEARCH AND DEVELOPMENT BUILDUP



Source: NISTADS/CSIR, Piper Jaffray research

The biological industry is also gaining wider visibility across the globe as a result of merger and acquisition activity that will help increase grower awareness of its products and understanding of new crop protection approaches. Furthermore the industry will gain credibility with growers now that they are backed by trusted multinationals. The huge multiples on revenue (4x-15x) being paid to acquire biological developers shows just how much potential agricultural firms see in this industry. Widespread visibility, increased credibility and more accessibility to global company's sales representatives should remove any lingering grower skepticism of "snake oil." Furthermore, the haste with which large agricultural firms jumped into this space has generated a lot of buzz around biologicals that is getting university researchers, environmentalists and venture capitalists excited. Visibility and excitement of this broad in agriculture is not common, but is a sign that biologicals are not a fad and have strong prospects on the farm.

Biostimulant Growth And Development

Biopesticides will continue to improve in efficacy, decrease in cost and expand in share of the global crop protection market while drastically enhancing the possibility of perpetual sustainability in agriculture. However, we believe the biostimulant market is positioned to be another area of growth over the long term. We base this on two unique factors that prime the segment for sustained, innovative development and poise biostimulants to be the next major breakthrough in agricultural products.

First, biostimulants are their own, definitive category of agricultural products. They are neither fertilizers nor pesticides and do not directly encroach on the sale of either of these products. They focus on naturally occurring, interconnected processes inside the plant and on how crops behave within their abiotic environment. In short, they focus on enhancing plant health in ways that have never been targeted by traditional crop products. This is in stark contradiction to biopesticides which can be viewed as an extension or evolution of

conventional pesticides that also encroach on the sale of chemical crop protection products. Biopesticides are simply an environmentally friendly version of the traditional input-output plant health model (e.g. fertilizer and pesticides) that has been used for more than 50 years.

The structural dynamic within the industry is a tremendous boon for biostimulant developers because they do not have to fight off any competitive innovation or siphon sales away from competing products. Even though there has been little to no major innovation to compete within the crop protection industry over the last 30+ years biological developers have to change the steadfast mindset of growers that have been buying the same chemical products for years. This has been a challenge for biopesticide manufacturers as growers are generally set in their ways and hard-pressed to buy new products that are seen as an up-sell of an existing product – even when resistant pests are present. While this skepticism will likely decrease significantly as large, trusted agricultural firms roll out biopesticides and a younger generation of growers emerges in the U.S., the biostimulant segment has an unscathed platform to build on. Biopesticides may never overtake chemical pesticide sales and may just simply be sold as complementary products in an IPM program at best. So while biopesticides will gain more share in a ~$50 billion market, they will probably never be their own definitive category without growth limitations like biostimulants.

Another challenge that biopesticides must overcome that has a limited effect on biostimulants is the continued innovation of GMO seed. Their introduction to the market in the 1990s foreshadowed the change in market dynamics that would occur over time. Today, crop protection is increasingly performed by the traits inlaid in GMO seed. Initially that worked in the favor of some crop protection products such as Roundup®, but continued investment has created double and even triple stacked traits that allow for more diversified pest protection. It is not a stretch to imagine further innovation producing GMO traits that can handle the majority of pest control on their own without the aid of supplementary crop protection products. GMO seed taking business away from traditional pesticides may be a positive for the environment and a convenience for growers, but it is a headwind for biopesticides because it has the ability to shrink the entire crop protection market.

The wide-open and relatively undiscovered nature of the biostimulant industry means that most biological growth and prominence in the coming years will be from the biopesticide segment, but this presents investors with an uncommon opportunity. While large agricultural firms focus on developing biopesticide programs investors have the chance to stake a claim in the biostimulant arena before large acquisitions with premium multiples drive up the entrance fee. Private investment firms have a lot of room to run in this area because this is still a fringe segment that lacks structure and is not quite defined. In fact, most regulatory bodies, including the U.S. EPA, do not even have definitions for biostimulants yet and the first global conference regarding them was not until November 26, 2012. The rapid growth in biostimulant alliances signals that the industry understands its own potential. For example, the EBIC expanded from 10 members in June 2011 to over 35 today. Furthermore, the fact that biostimulant alliances have primarily been formed in the last few years while biopesticide alliances were often founded well over a decade ago gives us conviction that the industry is beginning to come into its own.

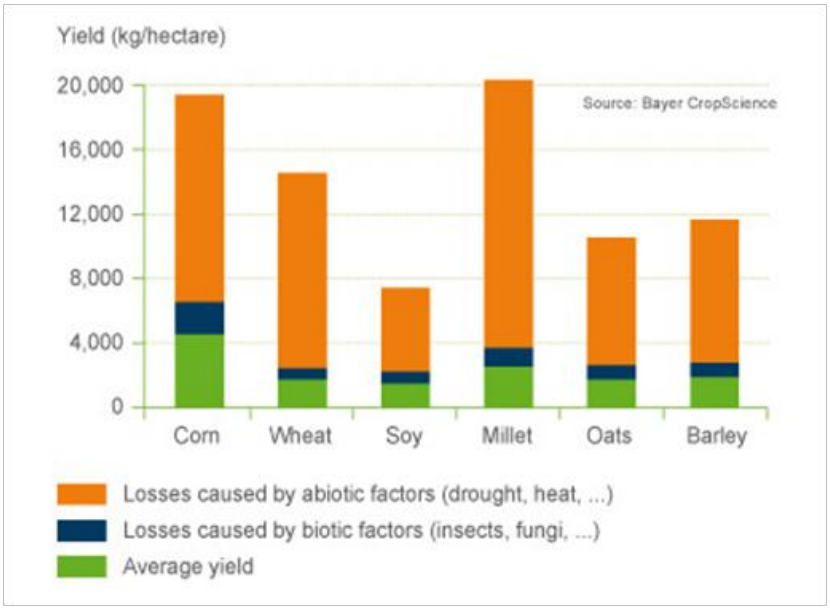
The second unique factor priming the biostimulant market is the emerging global emphasis on crop production over crop protection. It can almost be described as a change in historical agricultural mentality. For years the mindset of growers was to simply preserve and shelter the ceiling potential of yield after seed and fertilizer were in the ground – albeit while sometimes using mechanical irrigation to aide crop development. Now agriculture is beginning to harness the potential of biology trying to raise that yield ceiling by making plants better at performing their natural processes with the help of stimulants and

enhancers. This productivity chase is primarily driven by the underlying need to crop increase yields to feed a growing global population that is eating more agriculturally intense foods, but there are other factors bolstering the trend of productivity emphasis in agriculture. One of these, as mentioned earlier, is the movement toward crop protection being incrementally absorbed by GMO seed that will sap the need for grower applied crop protection over time. Additionally, the growing demand for biofuels is putting even more pressure on growers as they now have to provide a sizeable portion of the world's energy in addition to feeding it.

Biopesticides offer tremendous benefits to society as a whole – especially in environmental sustainability, but biostimulants offer much more direct and explicit benefits to growers. Biopesticides will be great complementary products in IPM practices that will improve the efficacy of crop protection while accelerating the ramp down in toxic chemical use, but these products are used to reduce yield loss. Hence, we believe growers will respond with strong uptake of biostimulants over the long haul. Biostimulants focus on improving plant tolerance to abiotic conditions as opposed to biopesticides or traditional crop protection products that focus on controlling biotic stress. As seen in Exhibit 26 the losses caused by biotic factors barely register in regards to the potential yield gains from overcoming abiotic stress. USDA data supports this conclusion as they find that abiotic stress causes 90% of all crop losses. We feel that biopesticide products will do well at helping growers reach the current growth ceiling, but biostimulants will be the products that dramatically raise benchmarks to unprecedented levels for growers. This augments the previously mentioned drivers of growth including a perpetual need to increase food production to feed the sheer population explosion throughout the world, a likely continued incremental booster of biofuel demand, and an emerging market segment without any convergence from competing products. For these reasons it is possible that the next blockbuster product in agriculture will come from the biostimulant side of biologicals.

Exhibit 26

AFFECT OF ABIOTIC AND BIOTIC STRESS ON CROP PRODUCTION POTENTIAL



Source: Bayer CropScience

COMPANIES UNDER COVERAGE

Ratings, Price Targets And Risks

We have a Neutral rating on Agrium Inc. (AGU) with a 12-month price target of $89 based on 10x FY14E EPS. Risks to our price target include grain price and fertilizer margin volatility, acquisition integration, competition.

We have an Overweight rating on FMC Corp. (FMC) with a 12-month price target of $78 based on 14x our FY15E EPS. Risks to our price target include grain price volatility, weather conditions particularly in South America, commodity prices in FMC's mineral segment (soda ash / lithium), acquisition integration.

We have an Overweight rating on Marrone Bio Innovations, Inc. (MBII) with a 12-month price target of $17 based on an enterprise value to sales multiple of 3x our FY16E revenue, discounted by 1 year at 15%. Risks to our price target include grain price volatility, regulatory approval cost and timeline, new product acceptance in the crop chemical industry, and manufacturing scale-up.

We have an Overweight rating on Monsanto Co. (MON) with a 12-month price target of $135 based on 22x FY14E EPS of $5.40 + $16/share R&D pipeline value. Risks to our price target include competition or poor yield results forcing lower average seed pricing, weather conditions, and commodity prices.

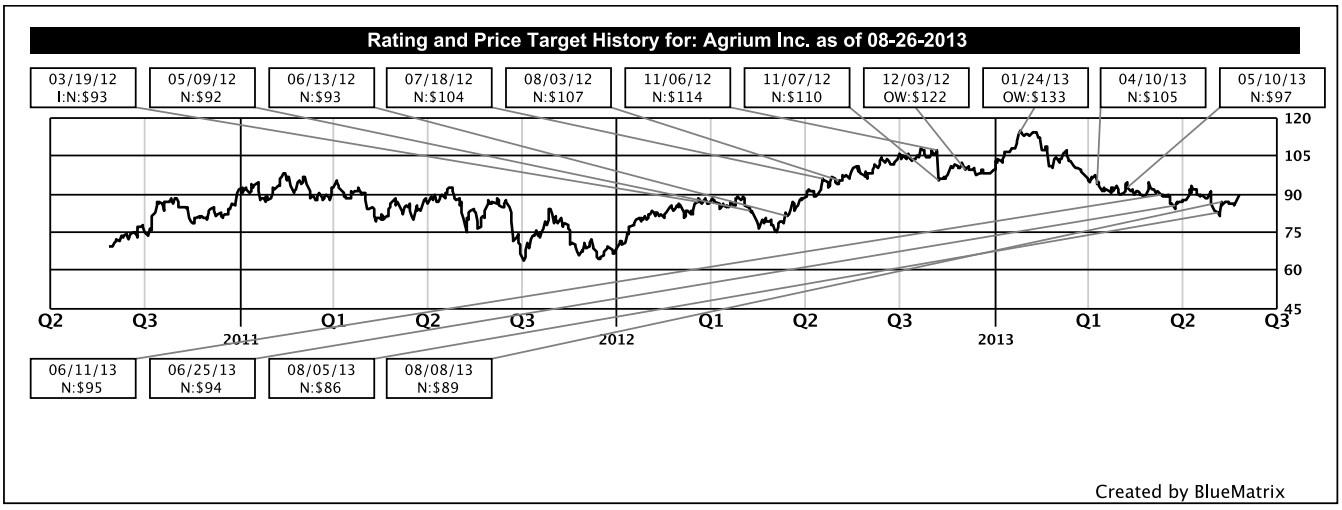
APPENDIX A: SELECTED CROP PROTECTION COMPANIES- SORTED ALPHABETICALLY

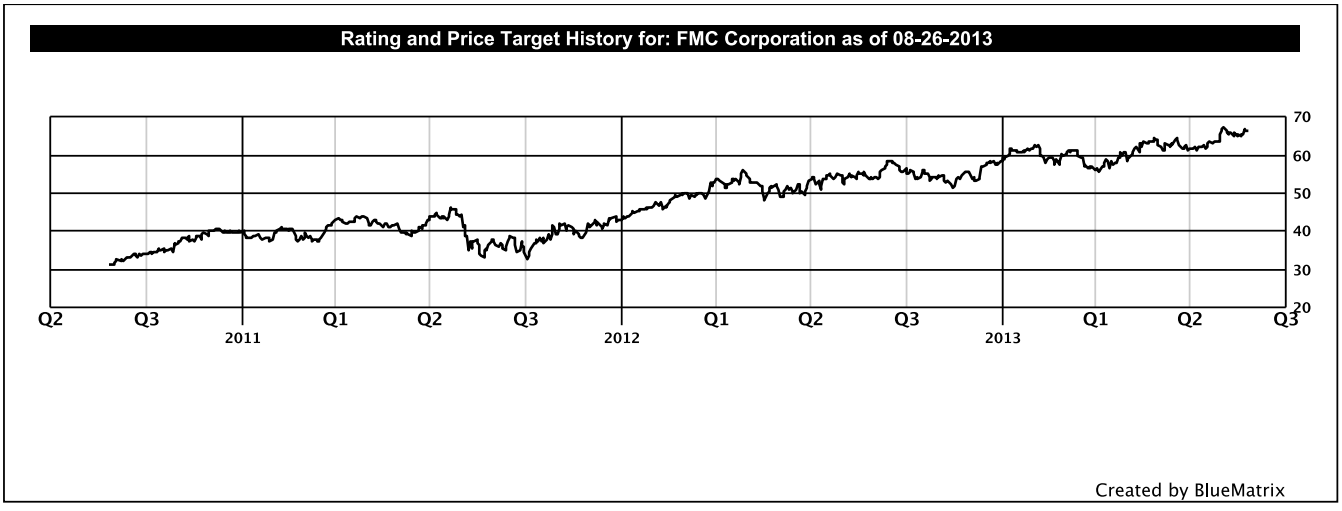
Company Name	Crop Protection	Crop Enhancement	Location	Website
ABiTEP GmbH	X	X	Berlin, Germany	http://www.abitep.de/
Actagro, LLC.	X	X	Biola, California	http://www.actagro.com/
Adjuvants Plus, Inc.		X	Kingsville, Ontario	http://www.adjuvantsplus.com/
Advanced Biological Marketing		X	Van Wert, Ohio	http://www.abm1st.com/
AgBiTech Pty, Ltd.	X		Richmond, New South Wales (AUS)	http://www.agbitech.com/
Agri Life	X	X	Hyderabad, India	http://www.agrilife.in/
Agri-Neo	X		Toronto, Ontario	http://agri-neo.com/
Agrinos AS		X	Lysaker, Norway	http://int.agrinos.com/
Agro-K		X	Minneapolis, Minnesota	http://www.agro-k.com/
AgSciTech, Inc.	X		Logan, Utah	http://agscitech.net/
Ajay Bio-tech, Ltd.	X	X	Pune, India	http://ajaybio.in/
Alpha BioPesticides, Ltd.	X		Suffolk, United Kingdom	http://www.alphabiopesticides.com/
A-Mark Procon	X	X	Hyderabad, India	http://www.biofertilizersandpesticides.com/
American Vanguard Corporation	X		Newport Beach, California	http://www.american-vanguard.com/
Amit Biotech Pvt, Ltd.	X		West Bengal, India	http://www.amitbiotech.com/
Andermatt Biocontrol AG	X	X	Grossdietwil, Switzerland	http://www.export.biocontrol.ch/
Arysta LifeScience Corporation	X	X	Tokyo, Japan	http://www.arystalifescience.com/
BASF Corporation	X	X	Ludwigshafen, Germany	http://www.agro.basf.us/
Bayer CropScience AG	X		Monheim am Rhein, Germany	http://www.cropscience.bayer.com/
Becker Microbial Products, Inc.	X		Parkland, Florida	http://www.beckermicrobialproductsinc.com/
Beta Biologics, Ltd.	X	X	Toronto, Ontario	http://beta-biologics.com/
Bharat Group	X		New Delhi, India	http://www.bharatgroup.co.in/
BioAgri AB	X	X	Uppsala, Sweden	http://www.bioagri.se/
BioAtlantis, Ltd.		X	Tralee, Ireland	http://www.bioatlantis.com/
Biobest Belgium N.V.	X		Westerlo, Belgium	http://www.biobest.be/
Biocare India Pvt, Ltd.		X	Maharashtra, India	http://www.indiamart.com/
Biocontrole	X		Indaiatuba, Brazil	http://www.biocontrole.com.br/
Biolchim S.p.A.		X	Bologna, Italy	http://www.biolchim.it/
Bion Tech, Inc.	X		Jhunan, Taiwan	http://www.biontech.com.tw
BIOPREPARÁTY, s.r.o.	X	X	Horomerice, Czech Republic	http://www.biopreparaty.eu/
BioSafe Systems, LLC.	X		East Hartford, Connecticut	http://www.biosafesystems.com/
BioWorks, Inc.	X	X	Victor, New York	http://www.bioworksinc.com/
Brandt Consolidated, Inc.	X		Springfield, Illinois	http://brandt.co/
Bug Agentes Biológicos	X		Piracicaba, Brazil	http://www.bugbrasil.com.br/
Camson Bio Technologies, Ltd.	X	X	Bangalore, India	http://www.camsonbiotechnologies.com/
CBC Corporation Japan	X	X	Tokyo, Japan	http://www.cbcamerica.com/
Certis USA, LLC.	X		Columbia, Maryland	http://certisusa.com/
Chengdu Newsun Crop Science Company, Ltd.	X	X	Chengdu, China	http://www.cdxzy.com/
De Sangosse	X	X	Pont Du Casse, France	http://www.desangosse.com/
Dow Agrosciences, LLC.	X		Indianapolis, Indiana	http://www.dowagro.com/
DuPont Company	X		Wilmington, Delaware	http://www.dupont.com/
E.I.D.- Parry, Ltd.	X	X	Chennai, India	http://www.parrysbio.com/
Ecowin Company, Ltd.	X	X	Daegu, South Korea	http://www.eco-win.kr
Eden Research plc.	X		Witney United Kingdom	http://www.edenresearch.com/
Embrapa Milho e Sorgo	X	X	Sete Lagoas, Brazil	http://www.cnpms.embrapa.br/

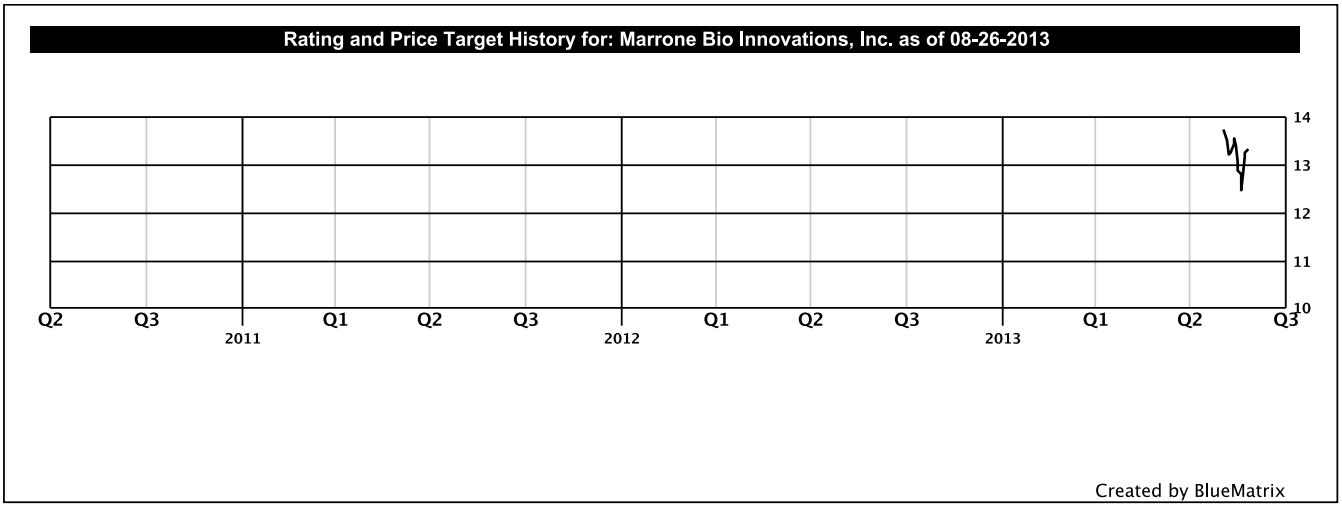
Company Name	Crop Protection	Crop Enhancement	Location	Website
Envera, LLC.	X		West Chester, Pennsylvania	http://www.envera.com/
Enviroquest, Ltd.		X	Cambridge, Ontario	http://www.enviroquestltd.com/
Exosect, Ltd.	X		Winchester, United Kingdom	http://www.exosect.com/
Fargro, Ltd.	X	X	Littlehampton, United Kingdom	http://www.fargro.co.uk/
Fast2Grow, Inc.		X	Houston, Texas	http://www.fast2grow.com/
FBSciences, Inc.		X	Collierville, Tennessee	http://www.fbsciences.com/
Futureco Bioscience S.L.	X	X	Barcelona, Spain	http://www.futurecobioscience.com/
Germains Seed Technology, Inc.		X	Kings Lyn, United Kingdom	http://germains.com/
GreeNeem Agri Pvt, Ltd.	X		Tamilnadu, India	http://www.greeneem.com/
Growth Products, Ltd.	X	X	White Plains, New York	http://www.growthproducts.com/
Gujarat Bio Organics, Ltd.	X	X	Bhavnagar, India	http://www.gujaratbio.com/
Horizon Ag-Products, LP		X	Modesto, California	http://horizonag.com/
ILSA SpA		X	Arzignano, Italy	http://www.ilsagroup.com/en/
INCOTEC Group BV	X	X	Enkhuizen, The Netherlands	http://www.incotec.com/
Isagro S.p.A.	X	X	Milan, Italy	http://www.isagro.com/en/
Italpollina S.p.A.		X	Verona, Italy	http://www.italpollina.com/
JET Harvest Solutions	X		Longwood, Florida	http://www.jetharvest.com/index.html
JH Biotech, Inc.	X	X	Ventura, California	http://jhbiotech.com/
Jiangsu Luye Agrochemicals Company, Ltd.	X		Yancheng Jiangsu, China	http://www.luyeagrochem.com/
Jiangxi Tianren Ecology Company Ltd.	X		Ji An, China	http://www.jxtianren.com/
Kernel Bio-Tech Company, Ltd.	X		Wuhan, China	http://kenuo.en.gongchang.com/
Kip Cullers do Brasil		X	Ribeirão Preto, Brazil	http://www.kipcullers.com/
Koppert B.V.	X		Berkel en Rodenrijs, The Netherlands	http://www.koppert.com/
Labiofam Entrepreneurial Group	X		Havana, Cuba	http://www.labiofam.cu/
Laboratoires Goëmar	X	X	Saint-Malo, France	http://www.goemar.com/
Lallemand, Inc.	X	X	Montreal, Quebec	http://www.lallemand.com/
Laverlam International Corporation	X		Butte, Montana	http://www.laverlamintl.com/
Loveland Products, Inc.		X	Loveland, Colorado	http://www.lovelandproducts.com/
Marrone Bio Innovations, Inc.	X	X	Davis, California	http://www.marronebioinnovations.com/
Mendel Biotechnology, Inc.		X	Hayward, California	http://www.mendelbio.com/
MGK	X		Minneapolis, Minnesota	http://www.mgk.com/
Monsanto Company	X		St. Louis, Missouri	http://www.monsanto.com/
Nemgenix Pty, Ltd.	X		Salisbury, United Kingdom	http://www.nemgenix.com/
Neudorff North America	X		Brentwood Bay, British Columbia	http://www.neudorffpro.com/
NewLeaf Symbiotics, Inc.		X	St. Louis, Missouri	http://www.newleafsym.com/
Nippon Soda Company, Ltd.	X	X	Tokyo, Japan	http://www.nippon-soda.co.jp/
Norace Concepts, Inc.	X		Guelph, Ontario	http://www.noracconcepts.com/index.html
Novozymes BioAg	X	X	Saskatoon, Saskatchewan	http://www.novozymes.com/
Ocean Organics		X	Waldoboro, Maine	http://www.oceanorganics.com/
Oxitec, Ltd.	X		Abingdon, United Kingdom	http://www.oxitec.com/
Parry America, Inc.	X		Irving, Texas	http://www.parryamerica.com/
Plant Health Care	X		London, United Kingdom	http://www.planthealthcare.co.uk/
Qianjiang Biochemical Company, Ltd.	X		Haining, China	http://www.qianjiangbiochemical.htm/
Química Agronómica de México, S. de R.L. M.I	X		Chihuahua, Mexico	http://www.qam.com.mx/
Russel IPM	X		Deeside, United Kingdom	http://www.russellipm-agriculture.com/

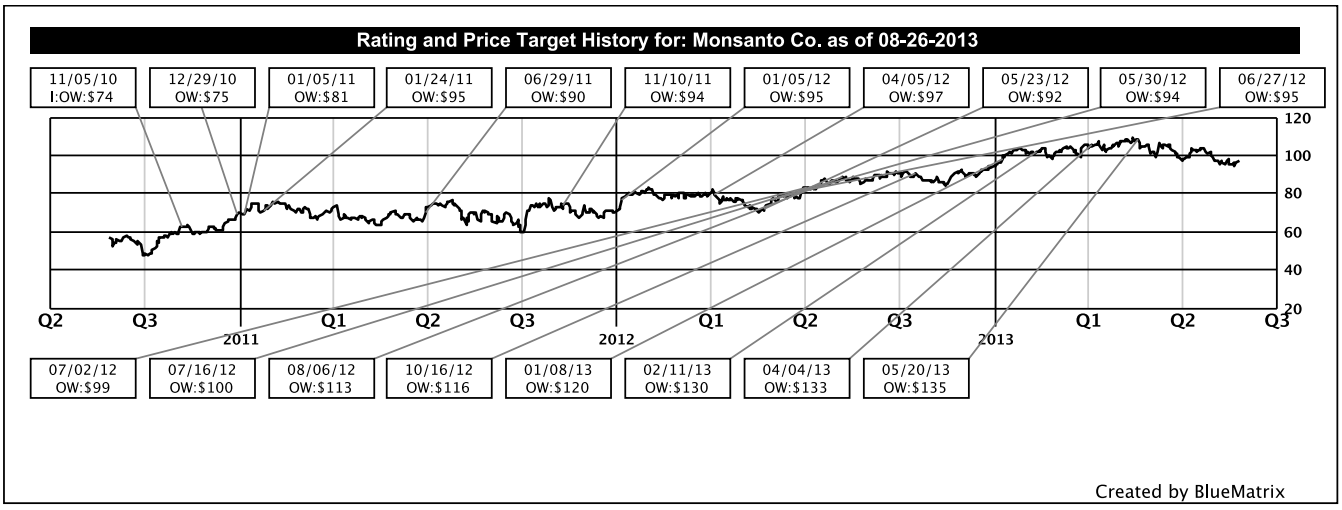
Company Name	Crop Protection	Crop Enhancement	Location	Website
San Jacinto Environmental Supplies		X	Houston, Texas	http://www.sanjacsupply.com/
SemiosBIO Technologies, Inc.	X		Vancouver, British Columbia	http://www.semiosbio.com/
Shanxi Jialunduo CropScience	X		Shanxi, China	http://news.agropages.com/News/
Shenghua Biok Biology Company, Ltd.	X		Deqing, China	http://www.biok.com/
Sicit 2000 S.p.A.		X	Vicenza, Italy	http://www.sicit2000.it/
Sipcam Agro USA, Inc.	X		Durham, North Carolina	http://www.sipcamadvan.com/
SKS Bioproducts	X		Gudivada, India	http://www.sksbio.com/
SRI Biotech Laboratories India, Ltd.	X	X	Hyderabad, India	http://www.sribio.com/
Stockton, Ltd.	X		Petah Tikva, Israel	http://www.stockton-ag.com/
Stoller USA	X	X	Houston, Texas	http://www.stollerusa.com/
Suterra, LLC.	X		Bend, Oregon	http://suterra.com/
Sylvan Bio USA, Inc.	X	X	Kittanning, Pennsylvania	http://www.sylvaninc.com/
Syngenta AG	X		Basel, Switzerland	http://www.syngenta.com/
T. Stanes and Company, Ltd.	X		Tamil Nadu, India	http://www.tstanes.com/
Troy Biosciences, Inc.	X	X	Phoenix, Arizona	http://www.troybiosciences.com/
TyraTech, Inc.	X		Morrisville, North Carolina	http://www.tyratech.com/
União Química S/A	X		São Paulo, Brazil	http://www.uniaoquimica.com.br/
Valagro S.p.A.		X	Chieti, Italy	http://www.valagro.com/
Valent BioSciences Corporation	X	X	Libertyville, Illinois	http://www.valentbiosciences.com/
Vestaron Corporation	X		Kalamazoo, Michigan	http://www.vestaron.com/
Veyong Bio-Chemical Company, Ltd.	X		Shijiazhuang, China	http://www.veyong.com/
Wayne Agro	X		Buenos Aires, Argentina	http://www.wayneagro.com/
Zagro Asia, Ltd.	X	X	Singapore, Republic of Singapore	http://www.zagro.com/

IMPORTANT RESEARCH DISCLOSURES









Notes: The boxes on the Rating and Price Target History chart above indicate the date of the Research Note, the rating, and the price target. Each box represents a date on which an analyst made a change to a rating or price target, except for the first box, which may only represent the first Note written during the past three years.

Legend:
I: Initiating Coverage
R: Resuming Coverage
T: Transferring Coverage
D: Discontinuing Coverage
S: Suspending Coverage
OW: Overweight
N: Neutral
UW: Underweight
NA: Not Available
UR: Under Review

Distribution of Ratings/IB Services
Piper Jaffray

			IB Serv./Past 12 Mos.	
Rating	Count	Percent	Count	Percent
BUY [OW]	341	56.93	69	20.23
HOLD [N]	229	38.23	16	6.99
SELL [UW]	29	4.84	0	0.00

Note: Distribution of Ratings/IB Services shows the number of companies currently in each rating category from which Piper Jaffray and its affiliates received compensation for investment banking services within the past 12 months. FINRA rules require disclosure of which ratings most closely correspond with "buy," "hold," and "sell" recommendations. Piper Jaffray ratings are not the equivalent of buy, hold or sell, but instead represent recommended relative weightings. Nevertheless, Overweight corresponds most closely with buy, Neutral with hold and Underweight with sell. See Stock Rating definitions below.

Analyst Certification — Michael E. Cox, CFA, Sr Research Analyst
— Brett Wong, Research Analyst

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