I
Keynote and Plenary Lectures

Pesticide Chemistry. Crop Protection, Public Health, Environmental Safety
Edited by Hideo Ohkawa, Hisashi Miyagawa, and Philip W. Lee

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1
Challenges and Opportunities in Crop Production Over the Next Decade

James C. Collins, Jr.

1.1
Meeting Society's Agricultural Needs

There has never been a more complex and challenging business environment in global agriculture. The world we live and work in is changing every single day, and nowhere is it more evident than in the agrochemical industry.

In agriculture, there are few single solutions that will be capable of addressing the problems that farmers and the growing world population face today and in the future. Instead, combinations of solutions and collaborations across the public and private sectors will be required. Neither biotechnology nor chemistry has all the answers.

The intersection of biology, chemistry, and environmental stewardship/sustainability has created unique opportunities to meet societal needs for food, feed, fiber, and fuel. New products are safer, better, and more effective in meeting these needs. Productivity improvements will remain the most important factor in determining the characteristics of global markets, especially as the population grows and available land for agriculture is reduced.

This industry will always be, I believe, about new technology. New technology is driving change and will win in the marketplace. It is going to be the recipe for us to continue to succeed in the face of the challenges ahead. So as companies at this conference who are actively investing in not only chemistry but also biotechnology, I believe we're investing in the right place.

1.2
Global Trends and Uncertainties

There are a number of trends and uncertainties, over which we have no control, that have a significant impact on the agriculture industry. The global population is increasing. Energy demand is increasing, and we are all aware of the price of oil. In some parts of the world, there are shortages of critical resources, such as

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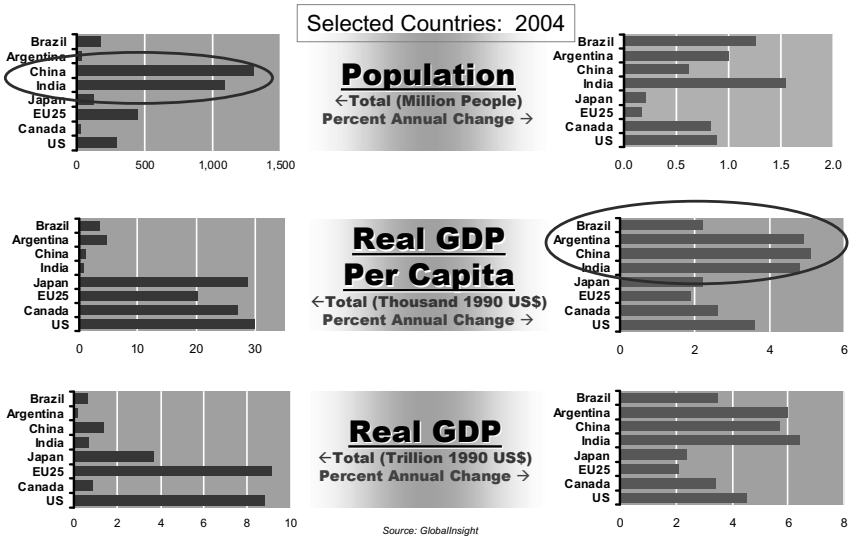
land, water, and capital. There are fantastic emerging agricultural markets in India, Brazil, Argentina, and parts of southeast Asia. But access to these critical resources is a constraining factor. There is tremendous uncertainty about what is going to happen to agricultural subsidies and global trade policies. Exchange rates have a huge impact on our industry, as does global unrest and terrorism, the economic balance of power, natural disasters, the regulatory environment.

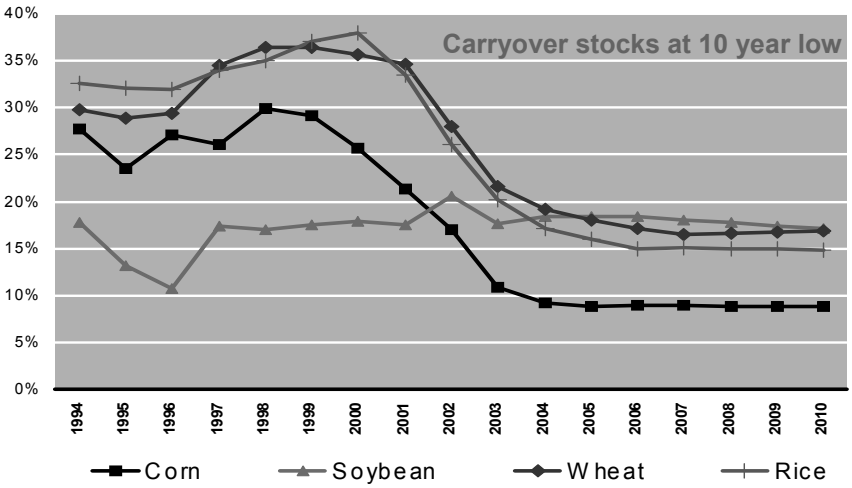
Global population growth is about 1.3% every year and is expected to reach 7 billion by 2015 and 9 billion by 2050. Forecasters have estimated that the number of cities greater than one million people will double to 60 over the next decade. These new cities will be in developing countries, placing significant pressure on the food supply infrastructure. World income is rising annually at 1.3%. More disposable income impacts people's diets as they demand more protein.



Looking at the above chart, everyone knows that China and India have big populations, but it is interesting to note that countries with large percentage changes in population also include Brazil and Argentina.

A similar situation exists with per capita Gross Domestic Product. The United States, Canada, Japan, and Europe are the leaders as expected. But the percent change in GDP is highest in places like Argentina, China, and India where we are seeing a wealth buildup. Likewise, the percentage change in total GDP in the developing world is astounding. That money is being spent on food and infrastructure and is placing unique demands on our industry. So, in thinking about where to target business growth, it will not be the traditional countries. Similarly, we can probably expect the same scenario over the next ten years in Africa as the political environment begins to settle down.

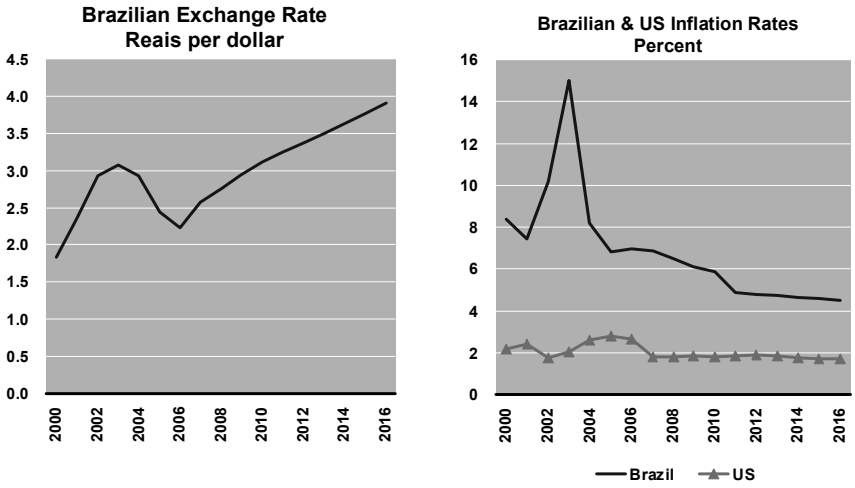
1.3
Grain Stocks



Another leading metric that we look at very closely is carryover stocks of grain. In 1999–2000, the industry had high stocks for traditional crops, like rice, wheat, corn, and soybeans. By 2005, productivity had gone up. A good example is Brazil. Brazil is producing five times the amount of soybeans they were producing just a few years ago. During that time frame, the amount of grain that was left over at the end of consumption went down every single year. We can expect these carryover stocks to continue to decline, which complicates the logistics of moving limited supplies to the place where they are needed most to feed the world's growing population. Companies and countries will upgrade the efficiency of their distribution systems to address this issue.

As Brazil's soybean production grew, U.S. production remained flat. You might expect that Brazil flooded the market with all these new soybeans and that the prices fell dramatically because of the supply glut. The fact is, however, that the additional supply was directed to China. China made a fundamental decision that it is better at other activities than producing soybeans and partnered with Brazil to set up a bilateral trade agreement. It has become a fantastic agricultural partnership, and similar agreements between other countries can be expected.

1.4
Exchange Rates

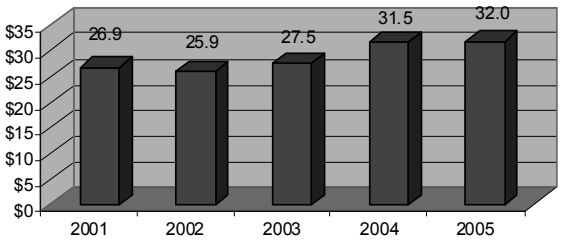


Exchange rates certainly affect our view of the world. Consider what is going on with the reais in Brazil compared to the dollar. It has created tremendous fluctuations in profitability because Brazilian farmers sell very little of their soybeans in Brazil so when that exchange rate fluctuated, growers in Brazil were only able to recover about 70% of what they invested in the crop. Next year, Brazilian farmers might decide to give up on production or plow a crop under because they will make more from government subsidies than by selling on the open market. If we adjust the price of soybeans to take inflation into account, there isn't a great deal of difference between the profitability of a U.S. and a Brazilian farmer. The government has stepped in and proposed some major financing proposals to help the farmers with these liquidity issues.

Exchange rates can also mask revenue ups and downs. In 2002, many were predicting the collapse of the crop protection business because a number of new active ingredients and products had come along and extracted most of the value. Investing in new technology needed to be re-thought as a priority. If we look at the change from 1997 through 2002, the market was down 14% – a very significant drop. But when you analyze the situation more carefully, it is clear that the real reason the market was down was the exchange rate. It just depends on whether we counted dollars, euros, or yen. During that time frame, product hectares were up 3%.

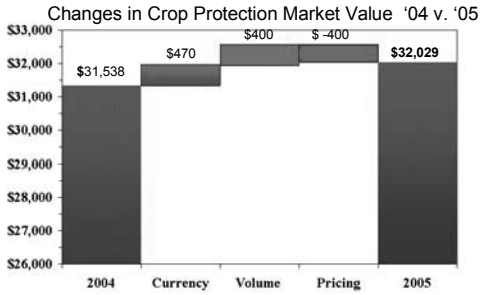
The same scenario occurred between 2002 and 2003, it had a 6% growth. It was a return to profitability, we thought, but the reason for the improvement was how we define the dollar's exchange rate. In reality, we treated absolutely no new acres during that time frame.

The crop protection market is essentially flat at about 32 billion USD. It has grown somewhat over the last few years so some companies have benefited from



Phillips McDougall	**$31,190**
Cropnosis	**$32,867**
Average	**$32,029**

Average of Cropnosis and Phillips McDougall data



market share increases. The conventional seed market is in the 15 billion USD range. The genetically modified seed business is about 5 billion USD.

If we consult with Cropnosis or Phillips McDougal and ask them about the future, we get two completely different answers. Phillips McDougal says the market is going up by 1.3% and Cropnosis says that there is going to be a 1.5% decline. So you draw those two curves and you realize they are estimating our future is somewhere between 28 and 36 billion USD. We all need to determine how to navigate through those estimates because the answer is not clear cut.

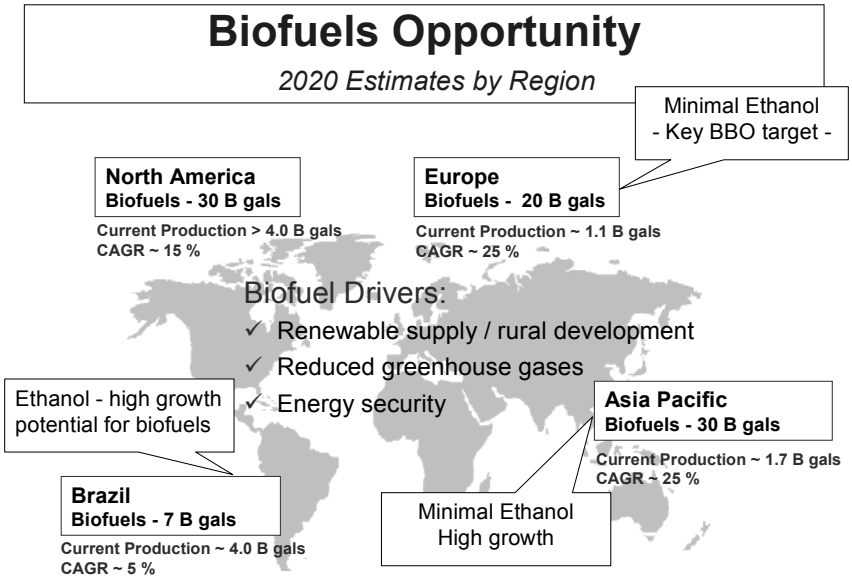
We belong to a classic cyclical industry. What goes up one year will go down the next and vice versa. The problem is the magnitude of the cycle is getting much larger every year. So, in past years, we would have been up or down 1–2%; now we are seeing 4–7% swings. The other problem is the cyclical swings are occurring virtually annually, instead of in two- or three-year cycles. Principal factors impacting these cycles are changes in exchange rates, carryover grain stocks, and protein consumption.

We have products that were invented and launched in the 1950's that are still being sold today. Any product developed before the mid-1970's is a commodity. Then there is a group of products that we call generic. They have come off patent but are still available. Finally, there are products still under patent protection that were launched in the late 1980's or afterwards. Market share for each product category is about one-third.

If we analyze product use on global high-performance acres, the percent of proprietary herbicides, fungicides, and insecticides being applied to those acres has increased over the last few years. While the perception is that the market is becoming increasingly generic and more commodity-based, the reality is it

is becoming more proprietary on the high-production acres. The percent of value represented by proprietary products has increased most dramatically in fungicides.

1.5 Biofuels



Biofuels are a huge opportunity, we believe. The concepts of renewable supply, reduced greenhouse gases, and energy security are driving biofuels opportunities globally.

Today, about 1.6 billion bushels of corn are being used in ethanol production. We expect that to approach 4 billion bushels over the next decade. Most counties in the midwestern U.S. have one to two ethanol plants that have received building permits, and this is not even counting the facilities already in existence. It will be interesting to watch the price of corn as it moves into new markets.

We think that there are about 30 billion gallons of potential in North America, with only about 4 billion gallons being produced today. In Brazil, we are probably only looking at a potential of about 7 billion gallons and we are already producing four of that. So we have already seen the explosion in Brazil using sugarcane. Other areas with significant market expansion potential are Europe and Asia-Pacific.

1.6
Counterfeit Products

An issue that is significantly damaging the industry is the prevalence of counterfeit products. There is an estimated 500 billion USD impact to global GDP based on counterfeit goods, including an economic impact of 35–40 million USD annually to DuPont's sulfonylurea product line. So, counterfeiting has become an area we are going to address aggressively over the next few years. We hope to collaborate with CropLife and the rest of the industry to undertake a joint and concerted effort. Counterfeit products can be found in any region of the world so it impacts all of us.

It can be very hard to distinguish counterfeit from actual products. I saw two product containers where the registered trademark on the real product was about 2-mm wide. The counterfeit one was about 1-mm wide. There were some wording changes on the label itself. However, the only way you could really tell that one was counterfeit was to take this product home and apply it to your corn. In fact, the product had the wrong active ingredient in it and did substantial damage to crops of some farmers in Europe.

A number of our regulatory partners, especially in China, the U.S., and India have been very proactive at policing this practice, but they just do not have the manpower or product knowledge to identify where it is occurring. This is an emerging area, and we have a lot of work to do to help educate not only consumers and regulators, but also ourselves on how to better police some of these issues. It is critical we take on this responsibility.

List	No. of Products	Products of Commercial Significance*	Accepted into Annex 1	Re-registration admissible/ pending	Not accepted/ Not supported
Existing Products					
1	90	90	53	8	29
2	148	114	12	38	64
3	389	263		135	128
4	204	11		9	2
Total	**831**	**478**	**65**	**190**	**223**
New Active Ingredients			55	47	7
Total Existing + New a.i.s.			**120**	**237**	

* as active ingredients for crop protection

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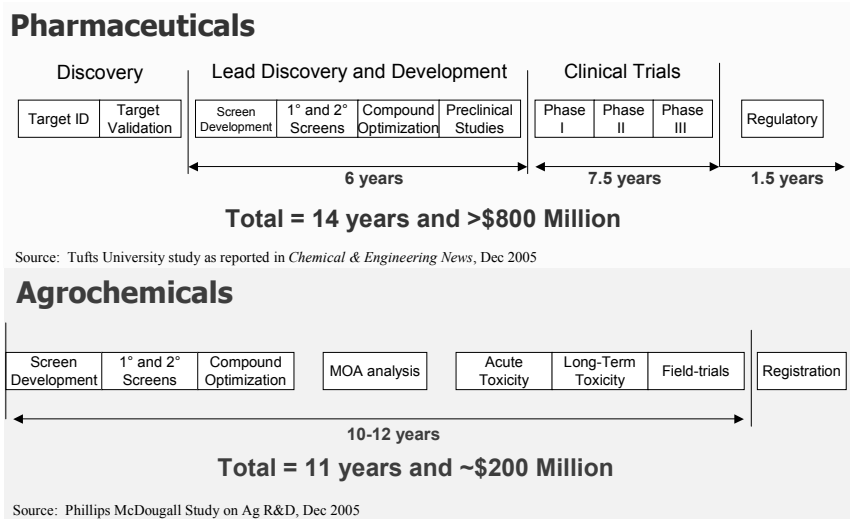
The re-registration procedure that is going on in the EU is difficult. The industry has about 470 products right now in that system. These are commercial products that have useful roles to play for farmers. Today, there are only about 350 of those that we can say are either going to be accepted or have a pending admissible label. So, there are some 200 products that will not be available to customers.

1.7 Product Commercialization



Commercialization is a major issue for our industry. We're going to be developing a lot of new products, which is very good news. The bad news is that we estimate it costs about 200 million USD to bring a new product to market. The time frame is ten to 12 years. So, there is a lot of investment to be made up front to bring in new products. At DuPont, we decided that unless a product had 150 million USD sales potential, we would not pursue it.

Once a company receives a product registration and starts to sell, it takes at least six years to break even and get to the point that we are actually making money for the shareholders. This is certainly an interesting business proposition when you consider the initial investment and lengthy time required to recover investment cost and to generate profile. How many companies have that financial ability? If we lose time in the regulatory submission cycle due to adding a field trial or researching additional data, we run into an even greater delay.

If you take a snap shot of the major industry players that are above the 500 million USD range that existed back in 1990, you can tell that of the 13, there are less than half still here today due to industry consolidation. So, while that can be daunting, it can also be a great opportunity, because these companies have come

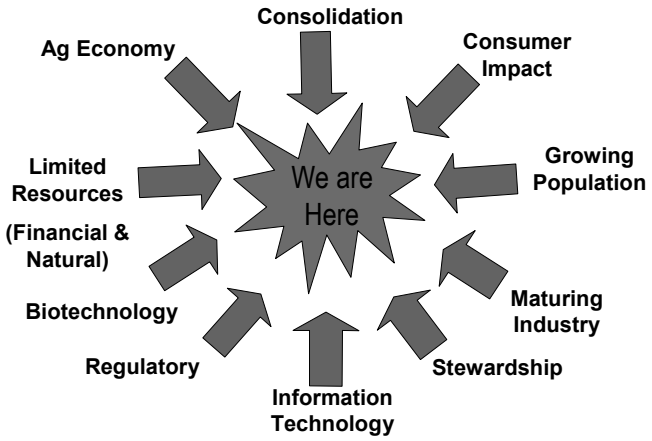
together to really improve the efficiency and effectiveness of their research and development programs.

As an industry, we have gone through fundamental changes in how we approach product discovery and development. From the 1950's to the 1990's, we did work the old-fashioned way – screening 10,000–50,000 compounds a year, mostly in-house. We knew that we needed to decrease cycle time because of the magnitude of the investment and a declining success rate. We are now looking at 250,000 products a year from multiple chemistry sources including brokers, vendors, and universities. Samples are only 2.5 mg and cost 10–40 USD apiece. The screening system for new active ingredients handles a greater volume, is more efficient, and has been targeted around areas of chemistry we know have activity.

One area that has been very interesting for us is the composition of the final product. In 2001, DuPont received about 25 registrations globally, primarily single actives. In 2005, we had 135 registrations and did not include a single active. These are all mixtures, which are combinations of products that come together to make unique leads. We generated five times the number of new registrations but moved away from a single molecule focus.

A good example of the value of mixtures is glyphosate. The amount of straight glyphosate that has been used in the North America corn and soybean market has actually been declining over the last few years. The reason is farmers and our retail partners are looking for ways to add other products into the mix. So, rather than have tank mixes, companies are trying to create these mixtures ahead of time, which is what is driving this regulatory explosion for unique products. Customers do not want to become chemists. They do not want to have to mix five products together in a tank in order to get the control they need. They want to be able to put a single product into the tank and know it will do the job.

1.8
Convergence of Factors



To summarize, our industry is facing an amazing convergence of factors that up until now have been relatively independent of each other. This complicated environment where we work has made it virtually impossible to find a single technology solution and highlights the critical intersection of biology, chemistry, and sustainability.

There has never been a more complex and challenging time in our industry. But, I also believe there has never been a more exciting time for chemistry. I am very encouraged by the fact that there are so many industry members at this conference. I know that you will continue to invest your time, energy, talent, and creativity into meeting the constantly emerging customer needs. I am convinced it is going to be a very collaborative process because, otherwise, the work will not get done.

I will end my presentation with a quote by Paul Anderson, a prolific science fiction writer, who said: "The only thing certain about the future is that we are going to be surprised." I would add to that a comment of my own: "I believe that we are also going to have a lot of fun as the future unfolds."