Virtually all industries are affected in at least some small way by the specter of climate change, but few are feeling its effects as acutely as agrochemicals. Based in the outdoors and rooted in the earth, the agriculture business can never afford to ignore the weather or fail to react to changes in the environment, and it is the agrochemicals industry that plays the biggest role in ensuring that crops can thrive in less-than-ideal conditions. While “plagues” ranging from pestilence to drought have always been a danger for crops, climate change is intensifying existing challenges and posing brand new ones.
A 2007 study by Lobell and Field asserts that climate trends over the last three decades have shown “a discernible negative impact on global production of several major crops”. Global warming is one of the most pronounced of these changes, and the increased global temperatures brought on by climate change can have a number of effects potentially hazardous to agriculture. For some crops, the added heat could mean the growing season isn’t as long as preferred, while for other crops the higher temperatures could inhibit pollination.

The warming temperatures are also making it possible for some invasive species to make their way into areas where they did not used to be a problem. Management and technology executive Dr. Ronald Purdum, a former scientist and R&D manager at Monsanto, cites kudzu as a particularly notable and worrisome example of this problem. Known as the ‘plant that ate the South,’ kudzu is moving northward and now being found in states like Ohio and Illinois. It’s bad enough that kudzu can suffocate trees and ruin manmade structures, but it is also a host for a disease that could devastate soybean crops.

And of course the extremes in weather are increasingly problematic for farmers trying to grow healthy crops amidst harsh droughts and catastrophic floods. Randall Madden, a 60-year-old, self-described “farm boy” who spent years working on breeding and biotechnology in the agrochemical space, has seen these extremes on the Iowa family farm that he owns and operates. “We’ve had two to three 100-year floods in the past few years,” he says, noting that if these patterns become the norm instead of the extreme, it will put much more pressure on management to maintain and improve crop protection measures.

Food shortage fears

Frustratingly, climate change threatens to damage and lessen the planet’s food supply at a time when we need more food than ever. The worldwide population continues to explode, meaning that it’s not just about protecting the current supply, but also being prepared to grow it substantially to meet an ever-greater global demand. The United Nations has declared that food production must double by 2050 in order to feed the burgeoning population, one billion of whom are already suffering from hunger. This is a concern that is raised again and again among those working in agrochemicals, who feel a great responsibility to see their industry meet this vital need.
Researchers are working on biotechnology that could solve any number of problems related to climate change, but it can be a long and arduous process of trial and error, as they attempt to find effective solutions.

“...I’m a big believer in biotech and the doors that it can open,” says Madden, who was working at Asgrow (a seed company owned by Monsanto) when the first biotechnology products were introduced in the 1990s. “Humanity is dependent on crop breeding in combination with biotechnology to keep up with climate change.”

Advances in biotechnology have made it possible to genetically modify crops with traits that make them resistant to pests and diseases. This not only helps farmers fight off problems that may result from climate change, but it also means that they contribute less to it themselves. Why? When farmers get better yields, they need less land to grow on – therefore slowing deforestation and the greenhouse gas emissions that come with it.

And there is so much more that biotech could do to actively fight climate change. In a piece in The Berkeley Blog, author David Zilberman suggests that one such innovation could be to make GM soybean crops with improved digestibility, so that the cattle eating them release fewer greenhouse gases.

Researchers are working on biotechnology that could solve any number of problems related to climate change, but it can be a long and arduous process of trial and error, as they attempt to find effective solutions. GM crops that are resistant to drought, for example, would be a godsend for farmers, but Madden explains that though “drought tolerance has been worked on for quite a while, early gene products have been somewhat disappointing to companies based on what is offered and achieved. “He points out that regional differences in rainfall and soil type, as well as climate shifts, can complicate matters.

GMO WOES

Of course, while biotechnology has at times seemed like a miracle solution, it has not been without controversy. The debate has been heated, with some detractors worrying about the possible long-term consequences that these crops could have on the environment, and others wondering if there are any potential health risks to consuming them. Some people are also raising concerns over issues like agricultural sovereignty, where farmers fear becoming too dependent on the GM seeds being sold to them by large multinational companies. GMOs are also sometimes fallible when it comes to doing what they are designed to do: protect crops. “In some species,” Madden explains, “insects can adapt and develop resistance.” As a result, agrochemical R&D departments must constantly be working to keep ahead of the pests with newer, better GMOs.
Scientists can easily boost the mutation rates using either chemicals or radiation and, given the knowledge of the genome sequence and an idea of which genes they want to change, they can select mutated seeds without having to go through the entire life cycle of the plant to identify the most promising variants.”

Breeding hybrid plants has long been a way of cultivating the best traits in crops, such as disease resistance, and the possibilities for climate change resistance are significant. For instance, Lewis Ziska, a Research Plant Physiologist for the USDA, has been spearheading promising work with weeds. Weeds, of course, are known for their persistence, often thriving in the worst conditions and threatening the lives of food crops. Ziska’s goal is to capture the traits that allow weeds to survive high temperatures and CO2 levels and transfer them to popular crops like rice and wheat. Success with these hybrids could mean we’ll have stronger crops better able to survive our warming climate and feed our growing population.

In India, which has a population topping one billion, the government itself has challenged the agrochemicals industry to invest more in R&D in order to pave the way for the agricultural innovations needed to ensure a good food supply for the nation’s people. Indrajit Pal of the Ministry of Chemicals and Fertilizers has put particular emphasis on pursuing “the development of eco-friendly green agrochemicals,” as this is an important emerging area in R&D.

Agrochemical products like fertilizers and pesticides are nearly indispensable in farming today, but they are not necessarily known for being eco-friendly. However, biosurfactants, which offer protection for plants from problems such as fungi and bacteria, are made from renewable resources and don’t release the harmful greenhouse gases that contribute to global warming. As it is the release of these gases (CO2, nitrous oxide, and methane) that is driving so much of the climate change problem, the usefulness of developing better biosurfactants can’t be underestimated. They also maintain their effectiveness at extreme temperatures, meaning that they can resist the existing effects of global warming while avoiding contributing to them.

Also in the area of environmental friendliness, naturally occurring microbes are revealing themselves to be a helpful ally in crop protection. Purdum explains that a microorganism with beneficial properties can be isolated, cultured and put through a biological growing approach in order to generate a large quantity. It is then used to inoculate the seeds, soil or root system of a crop for whatever protective properties the microbe has. This method of plant protection eliminates worries about toxicity.
With the incredibly complex problem of climate change causing difficulties on multiple fronts, agrochemical companies can’t overcome the issue’s many challenges on their own. Building alliances must be made a key strategy, whether it’s acquiring innovative technology companies, establishing partnerships with research universities, or even reaching out to the competition. “Agrochem companies are developing alliances among themselves in order to look at older chemicals that are maybe not as readily used today,” notes Purdum.

Education is another component of the brave new world brought on by climate change. With everything from hybrids and GM seeds to biosurfactants and traditional pesticides available, farmers now more than ever need advice on what to plant and how to best protect their crops. Purdum stresses that “agrochemical companies must educate as best they can, the users and consumers, on what type of practices will benefit them the best.” There is already a developing concept known as prescriptive farming, provided by companies like Monsanto, which Madden describes as “a prescription for your field; a map of what they recommend you should follow throughout the entire production process.”

Noting the major changes that the agrochemical industry went through when biotech was introduced, Madden asserts, “We’ll go through another phase of restructuring when the make-up of the industry and the key players will be destabilized again. That will be motivated and driven, at least in part, by climate change and the move of production areas. The Corn Belt will move from where it is today,” he says, referring to the fact that temperature increases are altering which areas are suitable for certain crops. “The geographical shift as well as this whole mix of biotech and agchem will, in my opinion, require a much different-looking industry.”

Purdum emphasizes the need to think differently moving forward. “We don’t need to go on past history. We need to be aware of it, and learn from it, but we’ve got to look at a different paradigm as far as how we go about producing food around the world.”
With so many variables in the mix, the agrochemicals industry simply cannot be expected to predict the future. But mounting scientific studies, a wealth of practical experience and good common sense tell us that climate change is going to make life tougher for plants, and, therefore, more complicated for agrochemical companies and their hard-working R&D departments. The challenge is for these researchers to continue finding adaptable solutions that will help the agricultural world meet the uncertain difficulties posed by climate change.

For those interested in learning more about the climate change-related challenges that agriculture faces and cutting-edge approaches for maintaining and increasing productivity in the midst of them, Elsevier is hosting a conference from February 15-17, 2015 in the Netherlands titled “Agriculture and Climate Change – Adapting Crops to Increased Uncertainty”. Topics covered will include: plant stresses, agricultural sustainability, resource use efficiency, effects of CO2 on plant growth and more. To be a part of this crucial conversation, register for the conference here: www.agricultureandclimatechange.com/conference-register.html