KEYNOTE: THE PHOSPHATE CHALLENGE
October 12, 2011 – 3:00 p.m.

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Thank you, and I'd like to start by saying that I'm slightly humbled to be presenting today. Novozymes is a technology company, and what we do is that, based on a technology platform, then we move into many different industries.

Recently ("recently" meaning the last 15 years), we have also moved into agriculture. And we have, I must say, have had a couple of successes; but having listened to presentations today, those in the morning and now, I feel that we are still mere amateurs in the field of agriculture.

So I thought it would be appropriate for me to get some goodwill by quoting Dr. Borlaug, who once said that, "*There are no miracles in agricultural production."* Of course, I don't have to tell you that. Feeding the world's growing population is not something that just happens because we want it to happen. We have to work at it.

One of the greatest threats for future agriculture could be phosphate shortage. Without phosphate, yields decimate fast. It will not matter how sophisticated crops we have engineered or how well we manage crop, epidemics. As Dr. Borlaug stated in a response to the challenge of feeding the global population of six billion people, without chemical fertilizers, forget it – the game is over.

The game is not over, but we have to reframe the way we think about fertilizing. All of us have heard the phrase, *Think globally and act locally.* And at Novozymes times we go a little further – *We think globally but act microscopically.*

I'd like to talk today about how innovation at the microscopic level can help redesign fertilizer as we know it.

To put it mildly, the agricultural industry already has a lot to think about. Everywhere we look, we see daunting challenges with potentially devastating consequences. You all know the facts – To feed a growing population, we must double the world's agricultural production by 2050, we must gravel with the changes and uncertainty brought about by climate change, we must prevent future price hikes and shortages like the ones that occurred in 2008 – and we must do all of these things while protecting the environment.

This is a very imposing list of objectives. Under the best of circumstances, these are some of these greatest challenges human beings have ever faced. But these are not the best of circumstances for a range of reasons, most of them familiar.

But here's another reason that seems oddly overlooked. Within a couple of generations we may be living in a world where solving of any of these challenges is impossible because phosphate demand will exceed supply, and fertilizer will be an excessively priced product.

Phosphate is what transports energy to the roots. Anytime we take a breath, take a step, give a speech, we use phosphate. If we want crops and livestock to grow, we need this mineral. Phosphate is one of the fuels of agriculture. Traditionally, we have fueled our crops the same way we fuel our cars. We extract raw material from the earth. When we need gasoline, we drill for oil. When we need fertilizer, we mine for phosphate. When one mine is depleted, we mine somewhere else.

But phosphate, like oil, is a finite resource. And while oil is scarce, phosphate is geographically much scarcer. Eighty percent of the world's phosphate is found in only one country, Morocco, and the majority of the rest in a handful of other countries. The remaining reserves are being increasingly expensive to process, as the quality has declined.

Last year the International Fertilizer Development Center published a report ensuring that the global phosphate reserves would last more than 300 years with the current consumption. That's a fairly long time, of course. But with just a one percent annual increase, we will only have half of that time left. The International Fertilizer Industry Association predicts a far greater increase in phosphate demand both in the short and medium term. They believe in agricultural growth.

And perhaps the key question is not what date we run out. It will be a crisis well before, because unlike oil, there's no such thing as an alternative source. Phosphate is our only source. What we have here is an opportunity to act and make sure that we find the right way for optimal use for this scarce and increasingly expensive input.

Fertilizer is already the single and the biggest input cost for crop growers. As the phosphate demand continues to grow, prices are likely to continue the upward trend we have seen over the last decade. Prices are becoming more volatile with sudden spikes. Food retailers will try to keep prices down by putting the squeeze on farmers, but eventually these costs will be passed on to consumers; price instability would become the rule, not the exception.

Today many countries are working to achieve energy independence because they believe it can be dangerous to have crucial resources concentrated in very few hands outside their borders. I think we can all agree that the world does not need another such resource – but that's what phosphate is in danger of becoming if we do not act in due time.

And we are already seeing warning signs. Some countries have placed export tariffs on phosphate in order to secure supply for their own farmers.

With all the other challenges we face in the agriculture realm, from land use to water use to infrastructure, this might seem a small issue with many generations to respond. But we have already seen how phosphate prices have doubled since last year after the 2008 spike of 800 percent that shocked world farmers and prevented many from fertilizing.

But here's a bit of good news – biotechnology can provide a piece of the puzzle, because the world isn't actually running out of phosphate, any more than a person who eats two bites of a meal and throws away the rest is running out of food. We are not running out of phosphate. We are wasting phosphate.

And here's why this is good news. About 80 percent of the phosphate in animal feed is trapped in molecules that the animals can't digest, and it ends up unused in the manure. The problem is the same with plants. Around 80 percent of the phosphate in fertilizer quickly binds to compounds in the soil before the plant can get to them.

To make matters worse, from an environmental point of view, the wasted phosphate, actually 10 percent of what we globally mine every year, according to the UNIP annual report, leaches into our waterways where it nourishes unnaturally large populations of algae, which when they die use up the oxygen over wide areas. Such pollution has already created more than 400 so-called marine dead zones around the world, increasing 10 percent every year.

So wasting phosphate is a huge problem both in short term and large term, which is why asking the same old question – how can we mine more phosphate? – won't provide a solution. In a very literal sense we have dug ourselves into a hole, and digging ourselves out is not an option.

We have seen an impressive growth in agriculture the past 60 years with the help of chemical fertilizers, but now it's time for innovation also in this field. We need to change the perception from being about using too much or too little into a question of increasing efficiency.

At Novozymes we work with farmers every day. We know firsthand how innovative and sustainable agriculture can be. And we believe we know what form the next generation of solution will take. They will be biology based.

We are already seeing the power of bio-based solutions to conserve phosphate. Feed, animal feed, naturally contains a lot of phosphate, but the majority is bound to phytate, unavailable to the animals to digest. The consequence is that the bound phosphate all ends up in the manure, polluting the waterways. And the farmer adds extra feed, phosphate to compensate for that – unless of course he uses phytate enzymes that break down the phytate and extract the phosphate. Animal feed that includes phytates requires no significantly less added phosphate.

Let me illustrate just how fast this type of biotechnology can operate. We first developed these enzymes less than 15 years ago. We are already next year introducing the third generation of these products, and every time we have made new molecules that are even more effective at liberating phosphate from the animal feed.

The product that we will be introducing next year will actually enable feed compounders to make animal feed that never requires the addition of exogenous phosphate.

Of course, reducing the amount of phosphate in animal feed addresses only a very small part of the overall problem. Ninety percent of the phosphate used in agriculture goes into the soil as fertilizer. So our industry is working on developing solutions to use phosphate more efficiently as well as to reuse phosphate.

One way we have done this is to take the same principle behind phytates and applied to plants, in this case using a fungus called phytate solubilizing inoculants. Phosphate inoculants colonize plant roots. As it multiples, it produces acids that break the bond that binds phosphorous in the soil. This allows more phosphorous to end up in the roots rather than being bound in the soil.

Farmers using phosphate inoculants can increase yield around average 7 percent, and depending on crop and soil type, inoculants can at the same time enable farmers to reduce up to 40 percent of their recommended fertilizer.

Phosphate solubilization has gained interest around the world as a means to provide fertility in soils for phosphate availability, and today the use of this fungus is widespread in North America, Latin America, Australia, India and Vietnam, with more than 600 farmers' split-field trials, as well as field testing now in Europe and other Asian countries.

If it is adopted on a truly global scale, it could be an important tool to help stabilize phosphate prices and reduce farmers' exposure to risk.

And just as I mentioned for the phytates, here we have an opportunity to move pretty rapidly in terms of making next-generation better products. So in ten years I predict that we will be giving higher yield increases and higher phosphate reduction results with even better strains.

And in a bio-based society, we go one step further. We have turned phosphate into a renewable resource. In the same circular way that ecosystems operate, phosphate can become a part of a productive loop, which is our goal.

At Novozymes we are looking at new ways to collect waste, manure and sludge from animal husbandry and extract the phosphate in a distributable plant available form. If we can develop these technologies and bring them to scale, it would virtually eliminate waste.

That sort of closed loop is the hallmark of a bio-based society, and that's the kind of society we envision at Novozymes – a society where we can sustainability increase production where we don't just postpone consequences but solve problems.

But we should act now. Let us not wait for the pressure on this resource to build and price fluctuations to intensify. Let's not wait for the demand on a limited phosphate resource to become a phosphate crisis. We need to change the way we think and the way we operate. In the end, the answers to these problems lie, as Dr. Borlaug said, with the farmers. Change will happen from the ground up, literally.

At the same time, we know that no farm exists in isolation. We have to give farmers the tools they need to grow the food and biomass we need. We must implement solutions on a scale and at a speed that no one sector can provide. That's why it's so important for every organization, whether the FAO or the World Bank or other organizations, to get involved in solving this problem.

We need to establish research programs not only with focus on crop improvements and pest control but also on integrated nutrient management, including micro-based solutions.

Government needs to invest in managing phosphate, and leaders like you, I hope, will speak up and let people know that the bio-based society is not only possible but essential and already available.

Collectively, globally we need to provide incentives for farmers to use technologies like phytates and inoculants. We need to support research and development on how to transform the manure from a waste stream into a value stream, solubilizing the phosphate or plant uptake in a form that can be globally distributed to where it's needed.

Most importantly, we all must work to make sure the warning signs aren't ignored. When we think about yield and climate change and global markets, we must include phosphate in those discussions.

I invite you to join us and a growing number of other companies and institutions in this essential work.

Thank you.