

STARTUPS: NEW INNOVATIVE TECHNOLOGIES WITH BIG SOCIETAL IMPACT

Panel Moderator: Mr. Sanjeev Krishnan

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Introduction

Meghna Ravishankar

Director of Planning, World Food Prize Foundation

Good morning, everyone. Thank you for being here. I know it's been an early morning for a lot of you, so we really appreciate that you're here. So I'm just going to get right to it and get our first panel on stage. We are so glad to have our first panel, *Startups: New Innovative Technologies with Big Societal Impact*. So I will go ahead and have the speakers come join us on the stage while I introduce them. So we have Dr. Richard Broglie, the Chief Technology Officer at Pivot Bio; Mr. Han Chen, Co-Founder and Managing Director of ZeaKal Inc.; Mr. Paul Kuc, CFO of Provivi; Mr. Mick Messman, Chief Commercial Officer of GreenLight Bioscience; and Mr. Sanjeev Krishnan, the moderator for today, the Managing Director and Chief Information Officer at Seed 2 Growth Ventures. So I will let them take it away.

Panel Members

Dr. Richard Broglie Chief Technology Officer, Pivot Bio

Mr. Han Chen CEO, ZeaKal Inc.

Mr. Paul Kuc Chief Financial Officer, Provivi

Mr. Mick Messman Chief Commercial Officer, GreenLight Bioscience Inc.

Panel Moderator

Mr. Sanjeev Krishnan

Managing Director & Chief Information Officer, Seed 2 Growth Ventures

Thank you so much, and great to be here at Iowa, and thank you, Paul, for inviting me in, and others, and for this panel. I think what we're trying to do is make this very engaging, so we're going to have a few questions, but if there's audience questions, we're hoping to get that toward the end, so please reserve questions so we can make this more interactive.

I think what's happening today more globally is we're living in an era of significant disruption. You know, venture capital ten years ago was about 27 billion investments. Last year it was 134 billion. So there's a lot more risk capital going into our global economy to effectively disrupt industries. There's a disruptability index that Excentra does. They analyze sort of 10,000 companies. Most of those CEOs, 83%, claim that they are very vulnerable to disruption. And the

way that we think about it at S2G – we’re a venture fund, food and ag – that can actually have very positive impact, not just for startups and entrepreneurs but for the industry, for farmers, and effectively create a food system that’s both sustainable and healthy. And we think ag and food’s very unique in that perspective, because it’s one of the few industries in the world that can address two big issues that we have – right? – climate as well as the global healthcare system.

And I'm delighted to have the panelists we have to really showcase sort of the frontlines of what that means. And these entrepreneurs and startup companies are really doing that every day. So I'd love for you all to introduce yourself and just have a conversation around what innovation means to the industry and around the societal impact that it can have more broadly.

Richard Broglie

Thank you, Sanjeev. So my name is Richard Broglie. I'm CTO at a small startup company called Pivot Bio. I'd like to introduce Pivot Bio by telling you a little bit about the problem that we're trying to solve. So if you could, imagine some grass, and I'm sure you've all seen where you're plotting corn yields from around 1860 all the way to the present time. You'll notice for that about 80 years yields in corn were pretty stagnant; they were about 20 bushels per acre. And around 1940 to 1960 that jumped from 20 bushels per acre to 40 bushels per acre. And then there was this large inflection point where yields continued to grow to their present levels of around 166, I think is the average corn yields per acre this year.

So if you think about what technologies were really driving that innovation, of course hybrid technologies were a key part of that. But the other innovation around that 1940, 1950 timeframe was the introduction of the production of synthetic nitrogen fertilizers at scale. And that really drove almost between 1960 and the present time about a ninefold increase in the use of synthetic nitrogen fertilizers. And today in fact you've got more than 150 million metric tons of reactive nitrogen that's produced globally, and about half of that nitrogen is used on corn, wheat and rice crops.

So while that's had a really impressive ability to increase crop productivity, it's also had an unintended negative consequence on the environment, mainly nitrate runoff into waterways that have led to large, massive toxic zones and the release of nitrous oxide into the atmosphere. In fact, about 5% of all the greenhouse gas emissions are due to nitrous oxide that have come from fertilized agricultural fields.

So at Pivot Bio we believe there's a better way to introduce and fertilizer crops. And we work with technology that's sort of at the interface between synthetic biology and microbiome discovery. And we're using those technologies to develop microbes that can supply nitrogen to corn plants. We have this year introduced our first product. That first product is a microbe that has been optimized for nitrogen production. It grows along the roots of the corn plant, and it's actually getting quite a lot of positive feedback from our growers. And what we have in our pipeline are strains now that will produce 20 to 40 times more nitrogen than our current first product. And our goal at Pivot Bio is really to be able to replace synthetic nitrogen fertilizers with microbes that can produce and feed crops on a regular basis.

Han Chen

So with ZeaKal we are a plant science company. We're doing traits and genetics, which I'm sure is very familiar to this audience here in Des Moines. I like to think of our trait PhotoSeed as kind of the triple threat of trait technologies. At the core of what we do is changing plant yield. And even though with today's commodity prices and supply glut, it might not show that we need more yield, I think from this entire symposium we know that yield is absolutely critical. In the next 30 years we have to increase yield by 70%. I like to put that to context, which is that the cumulative history of agricultural innovation for the past 10 to 12,000 years, if we added up every single productivity increase over that period, that's what we need to do in the next 30 years. So it's absolutely critical that yield is still front and center in our mission statement.

And ten years ago I think yield would have been enough, but because of our own efficiency and success as U.S. farmers, only 2% of the population now actually produce all the food that we eat here in the U.S. and for the rest of the world. And because of that disconnect between society and how we produce food, I think there's actually a huge vacuum that's existed where we've allowed the vacuum to be filled with misinformation and therefore a breakdown of trust with consumers. And so for new technologies to come out, I think the value proposition has to go beyond the farm gate.

And so beyond yield, the other two pillars of what we do are very much focused on sustainability and nutrition and composition. I'll kind of talk about that in a little more detail. The way that we achieve yield is we change plant photosynthesis, so how a plant assimilates carbon dioxide and sunlight. And we heard yesterday that plants like to eat CO₂ for lunch. Our plants are very hungry. They always ask for second and third helpings. Think of them as the Sumo wrestlers of the plant world. And so we're actually able to increase more yield without additional inputs and sequester more CO₂ out of the air.

The third pillar of what we do is we actually increase photosynthesis in a very unique way that also allows for improved composition. So there's really a story of two worlds as existing right now. And in certain countries like we heard with Rwanda, with Ghana, with Cambodia, it's still very much about calories, food security and sustainability. But in the U.S. we're really focused on nutrition. We want our food to be healthier. We want to be able to deliver higher quality foods and not just the calories. We've already solved that issue, at least here in the U.S.

So what we focus on also is—How do we change plant composition in order to improve nutrition? And you can look at the crops we work with. Take soybeans. We not only increase yield but we change the oil content. We're able to increase that without decreasing protein. And so anyone who's ever been a soybean breeder or a soybean farmer knows that these three things are often trade-offs. You know, as we've chased yield over the past 20 years we've seen decreasing soy protein levels to the point where U.S. soy is now considered a different commodity than let's say Brazilian soy. And so we're trying to restore that to really deliver higher-value nutrition to the rest of the world.

But going beyond the major commodity crops that exist today, we also see tremendous applications in terms of domesticating new crops with PhotoSeed as a way of what I'll call building a photosynthetic economy. I'll give you a few examples.

Our program started off actually in New Zealand. That's where we find our technology roots. And this was originally developed as a way to produce high-oil, high-yielding, perennial rye grass. So New Zealand has an energy deficit. They're not able to produce the same high-energy

crops that we have here in the U.S. with corn and soy. But they want to change our grazing system into one that can deliver the necessary energy density.

So when we're able to increase our lipid content, which in the perennial rye grass, which then led to a higher photosynthesis by 8 to 10%, what we did was we essentially allowed New Zealand farmers to not only get higher yield but to improve the quality of their pastures so they were getting the same daily weight gain, anywhere from 10 to 50%, less feed. And that change of composition had a direct impact into sustainability as well. From just eating less feed, to get the same productivity, we're putting less nitrous oxide that was contaminating our waterways. By changing the ration of the diet to have higher lipids and more energy, we were reducing the amount of methane that we were releasing into the air with our ruminant animals.

And to put that into perspective – in a small country like New Zealand, if every acre of rye grass was converted to PhotoSeed, it would be the equivalent of taking two million cars off the road permanently. So imagine as that scales up to other countries in the U.S. and Latin America, and the list goes on – high-oil corn, changing corn into both a feed product, ethanol, co-productize it with biodiesel, the same with sugar cane. We recently closed a deal this year with Canopy Rivers, which is the venture arm of Canopy Growth, the largest cannabis company. Our focus goes beyond the CBDs, THC, secondary metabolites into really thinking about hemp as a new industrial crop with a lot of different uses – you know, building materials, biofuels.

And the way that they think about it is, imagine if you picked up a CBD Corona and you're drinking the CBD-infused beer, but that label was made with renewable hemp that has far greater sustainability characteristics than using cotton or forestry – that the factory that it was built with was made with hempcrete and that the trucks they were using to deliver that bottle beer was powered by hemp biodiesel. And those are real value propositions that I think we're going to pass on to consumers, which is going to help reconnect society with how we produce. And at ZeaKal we want to become a cornerstone of being able to solve not only the need for food security but also how we do that sustainably with our current environmental challenges.

Paul Kuc

I'm Paul Kuc. I'm Chief Financial Officer of Provivi. We make pheromones. We didn't invent Pheromones. Pheromones were invented by insects. Insects communicate among themselves through pheromones. They attract each other, they mate, and then the female lay eggs, eggs produce caterpillars. Caterpillars eat the plant. Humanity dealt with it so far by spraying and killing those insects and everything else around it, so beneficial insects were also killed – spiders, nematodes. We target just insects that are specifically communicating with a particular pheromone. That's what we do. This is exceeding our expectations.

The company was started in 2014. We are Santa Monica based, but our subsidiaries are in Indonesia, Kenya, Mexico, Belgium, Hungary. And why in these countries? Because pheromones, again, we didn't invent them. We didn't invent even current applications, which is widely used in grapes, in pistachios, in avocados and very expensive crops. Why? The current method of producing pheromones, although known and used quite widely in high-value crops, is very expensive. It's a six-step process that costs a lot of money. We at Provivi have two methods that make it 70% cheaper, so basically we make cheap pheromones, and we thought instead of competing with current pheromone producers, we will spread it to the countries that are suffering from insects and pests that eat those crops that previously were not used the way... Farmers were not using pheromones. So I'm talking about sweet corn, edible corn, rice,

soy. Fuji ferda is a very typical pest that pheromones have been used for about 20, 30 years. Fuji ferda form a lot of loss of food. So that's why cherries, apples... If you go to Oregon, a hundred percent of apples are using pheromones. But no corn, no soy, no rice. That's what they do.

We in Kenya... Generally, Kenya, Tanzania, one Uganda, these countries lost about over the last few years a huge amount of corn due to the fall armyworm. So the fall armyworm is a big pest, insect that is eating corn, basically, but also other sweet type. They're a very, very selective insect. They, like the caterpillars, like the warm climate. They don't like cold. That's why the U.S., you don't hear that much about it. We are based in Santa Monica, but our business is more in tropical countries. The other one is of course rice, stem borer.

So we have a lot of free press. There was a documentary by Blomberg about the losses and spread of fall armyworm from Brazil to Africa, from Africa up to Indonesia and China. China declared South China, it's an emergency problem, and they're talking to us. Everybody wants to use pheromones. The pheromones are like vaccines, you put it in the field - there's no insects - 90% of efficiency, unless you have fields around that they can fly in. So the bigger the field, the better. So we've been very popular, that's what we do.

Mick Messman

My name is Mick Messman. I'm the Chief Commercial Officer for GreenLight Bioscience, so I'm excited to be here today and participate in this panel. GreenLight is a biotechnology company based in Boston, Massachusetts that has recently discovered breakthroughs around a proprietary, self-breed production process that enables the production of RNA molecules. And this is important because RNA molecules are natural molecules that are in nature in all living things; and as a result of this production platform, we're now able to innovate to create solutions for plant sciences, agriculture, as well as life sciences.

The problem we're working to solve is to create performing biological products that allow farmers to control insects and diseases while balancing and protecting the natural resources on their farm. As you probably know, there is a significant amount of pressure put on farms around the world, about a hundred billion dollars of crop loss globally due to insect, disease and weed pressure. In addition to those challenges, farmers are also faced with three critical issues around their options to control these problems. Number 1 is resistance. Insects, diseases and weeds continue to evolve and have become resistant to many of the current solutions that farmers have used to control these problems.

Secondly is around regulatory. Many regulatory agencies around the world have changed standards, if you will, on the products that they allow in the marketplace. And the result is a reduction in the amount of tools that farmers now have available to control these issues. In many cases, farmers are turning to alternative solutions, and in some cases those alternative solutions are just not good enough and the farmer is then forced to plant a different crop.

The alternative solutions they often are looking at our biological products, and these products have been continuing to grow, and there's a continuing amount of investment here. The challenge for farmers has been the reliability of these products. They have not found the consistent performance in this generation of biologicals that they have often found in their chemistry solutions. At the same time that farmers have more pressure to solve these problems with fewer tools, the impact of consumers and society on the products they use on their farm

continues to increase. So not only are they thinking about how to control an insect or a disease but they're also impacted by food companies as well as the ultimate consumer.

So at GreenLight we're excited about the opportunity to bring a unique, high-performing solution into this space. So double-strand RNA, as I mentioned, exists in nature, and at GreenLight we've been able to invest in innovation to design products that are only impactful to the problem insect. So similar to Paul's comments, we're excited about the ability to bring products forward that allow the farmer to protect against a problem insect while maintaining the ecosystem in their field of all of the beneficial insects such as pollinators.

You may have heard about double-strand RNA or RNAi solutions, and you may be wondering – why haven't they progressed faster? There's two key limitations in terms of getting these products to the market. First of all has been cost, and that's where GreenLight's production platform has created a significant breakthrough. We believe we have the highest quality production system at the lowest cost. And what that enables then is innovation to create solutions for farmers that are profitable for the farmer as well as the channel. The second challenge is around delivery and delivering this technology either into the plants or into certain insects to ultimately create the outcome that you want.

As a result of our breakthrough in production and having the low cost, we've been very active in inviting collaborations to solve that next tier of challenges. We have added a significant amount of technology folks within our group to work on those problems. We're also actively collaborating with the universities around the world with other ag tech companies that may have enabling technology, as well as large multinational companies.

So we're excited about the opportunity to solve this problem. Our first product was in broad-scale development this year, about 40 trials across the United States. We found control that was equivalent to commercial chemistry standards, again in a very targeted way that allows the beneficial insects in those farms to thrive. So we think this tool is going to be a great tool from a sustainability perspective. It's going to allow farmers to produce a crop in a profitable way, but it also will allow them to achieve their goal of sustainability as they work to preserve their land for their next generation of the farming operation.

Sanjeev Krishnan

All right, thank you so much. I think one of the first topics that I find interesting, and actually quite exciting because in venture capital more broadly ag tech is very new, and one of the things that generally venture capitalists in Silicon Valley or Boston or wherever in the world often ask us is adoption cycle – you know, will farmers adopt this technology? Will they change behavior?

And I think one of the more interesting and exciting things that's happening is the convergence of technology, sustainability, but profitability per acre, per hectare. And can you just all talk about sort of how you think about profitability for the farmer? Because I think one of the things that's happening is this convergence of all those three drivers. Which, actually, I think will contribute in the next ten years to increase adoption potentially of this technology in a way we haven't seen perhaps historically. We had that discussion earlier this morning, but I'd love to talk about sort of how you all think about farmer profitability and how that aligns with your company mission.

Mick Messman

So I'll go ahead and start. I grew up on a farm in Nebraska, so as I think about technology, I often think about the farm first. And we need to recognize that farmers are running a business, they do need to be profitable, and oftentimes those margins are very tight. So I describe it as functionality. We can talk a lot about sustainability and biological products and so on and so forth, but we have to have functionality. The farmer needs products that work better on their disease or on their insect, and those need to be profitable.

I do think, Sanjeev, though, that the market is changing, and so the types of products that can be profitable are different than they once were. And so the convergence of tools in terms of the imagery and the overall data available allows the farmer to be much more prescriptive and measure those products that are profitable on their farm. In terms of GreenLight, what we're doing in our development process is we're trying to make sure that our development is close to the farm. We're using third parties to make sure that's credible information so that they have the confidence in the overall performance before it's launched.

Richard Broglie

Thank you. If I could just add a little bit to that, I talked earlier of that, how important nitrogen was to farmers yields. I mean farmers can control... Three things that farmers really need to produce a high-yielding crop is sunlight, water, and nitrogen. And you can only control one of those three. And I think with our approach, the challenge is not only convincing the farmer that there's an alternative solution to deliver nitrogen but also working with farmers that are going to realize the outcome of using your technology as part of their normal nitrogen regimen.

And it's sort of a transition, I think, if you think of that around the conventional tools that are available today, to bringing in new tools and convincing them that those new tools are going to still provide the kind of outcomes that they need. Especially in the farm economy it's a real challenge to get farmers to think about things or even to take some risks at this point. And I think as Mick mentioned, we're working with a set of growers that are kind of leaders in their field. They're willing to take some risks. They're innovators. They tweet a lot. They provide a lot of feedback to kind of help convince other farmers that there are new technologies and new ways to do things that not only will improve their outcomes but also will have a positive impact on the environment.

Paul Kuc

... for us, it's a global problem, not only global in terms of geography but also from how people look at profit. It's very different to look from the perspective of a rural, small farmer in Kenya or Indonesia when they see profit as—oh, I can have a little bit more corn for my family and my neighbors, and then I sell the surplus, than from a perspective of a soybean farmer in Brazil when they harvest 20,000 hectares of soybean.

So the dynamic is very different, but the common theme is everybody wants to be profitable, no matter how you define it. For example, in Mexico I think it's important for these kind of methods that we all represent to see that sometimes we increase yield, but sometimes we prevent the loss. So if you have a, let's say, translate again, it's a currency issue as well, if you have \$2,000 revenue per hectare in Mexico, sweet corn, and we prevent the loss of 10%, so basically have \$200 more for the farm, so then we have to see it two ways—you know, how

much less of insecticide to use where everybody's happy because your resistance is lower when you use less insecticides rather than the vicious circle. Right? So then you have more money to spend on new methods like this one that we all represent. Then you spend less money on insecticides, you have more corn to sell. So then we have to decide the value, how much we leave with the farmer, how much we keep to ourselves – the typical dilemma of an agriculture company.

Han Chen

So we think about profitability in two ways, one of which is, you know, we have more and more extreme weather patterns. So part of profitability is reducing variability, so crops like ours that have high photosynthesis, they establish better, they're growing faster. So these stands are going to be a lot more resilient, especially as we lose certain windows that we typically grow in. I've seen the weather patterns move here in Iowa. The varieties of corn or soy you might have planted even two years ago probably didn't fit very well with the weather that we've had this year. So part of profitability is giving farmers tools or technologies to make weatherproof or climate-proof. A lot of the genetics are embedded in the breeding in the seed.

I think the second part of it is – if you look at the major commodity markets and the importance of them, we really haven't allowed these major commodity markets to move away from being a commodity. And the genetics and the technologies that are there today really can enable these seeds as platforms to deliver very novel..., whether that's healthier food or whether that's therapeutics, whether it's as a basis for industrial production. All these things exist, but they require us to rethink how our global supply chains work.

So what we're trying at ZeaKal is to ensure that these traits or these output qualities are going to be captured not only at the farm level but that they're going to be priced throughout the value chain, all the way through the consumer. And as the consumer makes these choices, when the consumer feels empowered that the products that they buy have a smaller carbon footprint that's healthier for them and they're willing to pay that premium on it, is that we want to ensure that that technology value that's created at the farm level but that's being appreciated at the consumer level, is being translated throughout that value chain.

And a lot of this was just systematically. We couldn't do this ten years ago with the technologies that we had. But with visualization, traceability, watching, all these other enabling technologies, I think for the first time we're able to now capture value and the components of that value in the margins. And what was previously just commodity profiting, that's going to move profitability in a huge way for farmers.

Sanjeev Krishnan

And I'm glad you brought up the consumer, because that's where I was going next. In the U.S., as an example, there's 65 categories in a grocery store, so dairy, cereal, snack food, etc. In 62 of that 65 the incumbent is losing market share. In the top hundred food brands, 90 are losing market share. The top 20 CBGC was like 19 have either left voluntarily or involuntarily is often the case. So there's significant sort of consumer preference chains disrupting - and Wall Street started to recognize this, downstream food companies started to recognize this.

As that trickles down to sort of the farmer and the farm gate and the channel, how do you guys see these consumer preference changes playing out in your businesses and your startups?

Han Chen

So I'll go first. As I mentioned earlier, because the value of agriculture in the past 20 years stopped at the farm gate, we kind of left this vacuum. We didn't really connect with the consumer because the farmer was our customer. You know, the farmer knew the good that they were doing, they knew the mission that they had to feed the world, but it kind of stopped there. As a result, I think we've allowed that vacuum to be filled, as mentioned earlier, with misinformation. And that consumer voice is getting a lot stronger. And so I think as an industry we can no longer ignore it.

And unfortunately, I think that consumer pressure has led to policy regulations that really haven't been based in the science and really haven't been favorable for us to meet this mission of feeding the world. Now, I also see it was an opportunity. But I think ultimately the consumer is making rational choices. They are thinking about things that are measurable and tangible. So again, if a consumer is picking up a product and they know that they are empowered by buying this product and we're returning that sovereignty back to the consumer rather than, you know, as they say, faceless corporations, they're going to say – well, this decision I just made took one ton of CO₂ out of the air – I'm making an impact, and that is going to influence my decision. And we already do that on a day-to-day basis. We just don't talk about it and we don't price for it. We don't advertise it.

So I think with this consumer transparency as we begin to connect and we lay and really discuss what it is that we do on a daily basis, because all these things can be measured, I think it's going to rechange our relationship and dynamic. I think it's going to reconnect agriculture ultimately with society and take away a lot of this demonization of agriculture as a culprit of the world's problems rather than a solution.

Paul Kuc

If I may... I think over the last few years it's a big change. I'm sure this group realizes this, about how consumer... And of course we should not put all the consumers into one basket, but consumers have been much more educated all over the world. Social media makes it and accessibility. A lot of superficial type of thinking also exists when people say – "oh, I want to eat healthy," which means there are many people – "I don't want to have chemicals" and whatever that means. Right?

I think what is important is the consumer wants to know what they eat, how it goes back to the very beginning of the supply chain. And this is the biggest change for the last, I think, ten years when people started to be more conscious of where is my food coming from and how it was treated, what was used to grow it, the sustainability of it. You know, celebrities brought it up even, too, and distorted it in some way. In our case, of course, why grapes were treated with pheromones and why apples were treated with pheromones – they were expensive and people wanted not to have trace of insecticide in it. Now people in Mexico say, no, we want pheromones in our corn because we like to have corn that's not treated, dosed with chemicals. So that's the change. It's a big change, and we noticed that in Vietnam, in Indonesia as well. Rice, a big product – there are some countries like Thailand that are very conscious about it, and they want to make sure that we cannot eliminate but decrease the amount of chemicals to the benefits of big producers of insecticides as well, because of course you decrease the resistance that the insects develop. So consumers are an integral part. Really farmers are working for the consumers, not, the big farmers don't work for just themselves.

Sanjeev Krishnan

...is the same. We have... We were recently told, "The phone eats first." And this is not just the U.S. phenomenon, it's a global phenomenon, in fact with people taking pictures of their eating. And there is a certain social media aspect to this. And I do think you're right. There's scope for confusion. I think the consumer's incredibly confused. But we live in an era of confusion and schizophrenia more broadly and perhaps driven by social media. But Mick, or you all have views on the consumer in terms of how it impacts your business?

Panelist

Well, I think there's a really interesting dynamic that's being set up now with consumers and learning a lot more about how crops are grown and coming back maybe to a little bit more focus on the environmental kind of issues. But I think from a farmer's perspective, farmers want to be good stewards of their land. I mean they don't want to be viewed as the bad guy. And there are sort of limitations to the kinds of technologies that they can use to continue to be profitable, to continue to produce the amount of food that's needed to feed a growing population.

So I think that's one of the challenges for disruptive technologies where you could come in and just give the farmers alternatives and find a way to connect that input that you're doing to the farmers and showing the consumers that these crops are being grown in a different way, there's more of a positive environmental impact. I mean there's a lot of opportunity to kind of create that and bridge that gap. But right now I don't think the technologies exist, because it's kind of like—here's one approach, here's another approach—and we've got to bridge that in a way that's profitable for the farmers as well.

Mick Messman

Yeah, to build on the previous comments, certainly the consumer influence, if you will, is heard, and we think about it as we develop our product concepts. So while some of the opinions, if you will, are science-based, others are emotion-based, and so when we develop a product, we're not thinking only about the farmer. We're thinking about what attributes matter to the entire value chain.

An example would be the overall active ingredient load in the market. And an exciting thing with double-strand RNAs, we believe we can provide control with about 10X lower amount of active ingredient on the market than other products. And so what that means for us at this stage is—not only do we need to be proving that the products work from an agronomic perspective but we are developing relationships with food companies, and we're getting that voice of consumer. And as we move closer to launch, I think one of the challenges for emerging ag tech companies and smaller organizations is to create that coalition so that consumer voice is heard and that you have a proper education in place. Many of these technologies are first-of-kind technologies, and so while we often focus on the benefits that we provide over some of the historical technologies, we're also going to need to have an education plan in place and the right relationships in place so that consumers perceive this technology to be a positive step forward.

Sanjeev Krishnan

And we do see in our supply chain is the new marketing, and there is going to be more, I think, spotlight on the supply chain for both grocers and brands to try to differentiate themselves. The other thing that I think, in addition to the consumer is the key stakeholder and sort of the future food system is the regulator. In our investments of ag input side, regulatory drivers are one of the key sort of considerations we have, both on the chemical side but on the biologic side as well.

How do you all see regulate globally? Because I think this is not just the U.S. or even a European issue. It's a global issue. How are you navigating the global regulatory considerations as you build your businesses?

Mick Messman

Well, from a GreenLight perspective, I'll go ahead and start. So we're focusing our first launch in the United States. The reason we're doing that is because it's the most predictable regulatory environment. We also see the United States as being on the front-end of approving new products and their bio-control type labels. So we're working closely with them. At the same time, the farmers in Europe probably need our technology more than the farmers in the United States because of the reduction in tools that they face. And in that case, there is not a clear regulatory path forward.

So for new technologies and some of the biological-type products, as first of a kind, the regulatory process isn't necessarily set. So it's an unknown and something that we're working towards. Certainly it's important, but the unpredictability of the global regulatory environment is a challenge.

Panelist

I'll add to that in the sense that for biological products, I'd say the regulatory environment is very murky. One of the technologies that we use to kind of react to today, the ability of microbes to fix nitrogen is that we remodeled the genome. These are not genetically modified organisms. There's no transgenic input into it, but we do move pieces of the genome around a little bit in order to activate the expression of certain genes involved in nitrogen fixation.

Now, that creates a really interesting dynamic if you think about Europe, for example, which is really pushing hard to regulate the amount of synthetic nitrogen that farmers can use, concerns about the environment. Yet the technology that we use is still considered genetically modified in Europe. So we have an opportunity to maybe create some change there by bringing a product forward that has a real positive benefit. But that discussion around the technology and the regulatory kind of dogmas that are kind of in place are still going to be a challenge.

Paul Kuc

...because pheromones are considered natural product and nontoxic. Consequently, we see for ourselves the opposite trend. To get approval of a new insecticide in Europe, it's very, very difficult. We don't have this problem at all, actually. The regulatory authorities want pheromones to be present more than insecticides. In Kenya we got approval on emergency basis because of the national emergency related to fall armyworm. In Mexico it's the same. So country by country, but generally speaking for this kind of product, the molecule already exists – you just have to prove that the molecule is equal to the existing one and here we go.

Han Chen

So regulatory is what keeps me up at night, to be honest, because you saw in a video yesterday. We have 30 years, 30 growth cycles to solve the world's growth problems, and on average a trait technology takes 8 to 10 years to bring to market. And the onus on proving safety beyond a measure of a doubt is much greater than any other technology, despite it being proven safe over a 20, 30-year history.

We know from a regulatory standpoint, in the U.S. at least we know that we have a very favorable and predictable framework, you know, because we don't deal with pesticides, we're not regulated by the EPA. We use all plant genetics. We don't use genetics from bacterial or from animal sources. So from the USDA regulatory standpoint, that's also very straightforward. And from a consumer acceptance standpoint, when I tell people what we do, their first reaction to me is – well, that's not a GMO – which shows you how little a lot of people really understand what these products are and the regulatory framework, so they're trying to reinforce around it.

But for the most part if it was just the U.S., we're good to get through it and it wouldn't be an issue. The problem becomes as you look at a very dislocated and global commodity supply chain where individual countries whose market sizes aren't that big can stop a product that could help the countries that really need it and stop innovation. That kind of – I'll call it the imperialism of denial, because a lot of these markets sit in the position of privilege, they're regulatory frameworks can keep innovation that's necessary for solving the world's problems. That bothers me. So that's what keeps me up at night.

And what I'm hoping to do is... Regulatory ultimately is on people. It's about laws. It's about rules, but they're made by people. The hardest thing is we need technology that can solve the world's problems. That's something that we can't control. And we try to, but oftentimes the technology doesn't do what we say. But regulatory is ultimately something that – if we win the hearts and minds, let people really understand why it is that we're doing this, that we can recreate that trust, that we can show them the authenticity of the companies that we're creating and why this is important – I think those frameworks can change.

The reason why regulatory is challenging isn't because they lack science or they lack proof. It's protectionism. It's fear. It's paranoia. It's big money interests that are in there that we often don't think about regulatory NGOs as, you know, purely philanthropic. But there is another side of that, which is very profitable, and it's being commercialized. And the issue is – all of us here, we invest on a daily basis. We invest our lives. We invest our capital, and we make sacrifices to bring these technologies to market. But when someone can just sell fear and create a regulatory barrier, there's no investment behind that. They simply sell that fear. They don't put any science discipline, there's no research, there's no capital – and yet we pay for that with privilege. And I think that's the one part where regulatory has to change. Regulatory has to be an institution that's not biased – it has to be fair, it has to be based on facts, and it can't be based on protectionism, economic or political or any social interests.

And what I really took away yesterday was, you know, food is a moral and human right. And so we continue to use food as a bargain chip in some of these political aspects, including regulatory. It's not fair to the mission of humanity.

Sanjeev Krishnan

We have time for questions if there are any. I have my own if no one wants to ask a question. Any questions? Go ahead. Yeah, come over there. I think hopefully that mic is on.

Q&A

Q Good morning. I'm glad that at the end you talk on the regulatory aspect of the bio-economy. To Mr. Chen, the soybean industry is heavily supplemented with methionine which is an amino acid that is very deficiency in soybean meal, although the protein is very, very high. Your strategy of using, harnessing the photosynthetic capacity to increase the harvest index is very good, but also you working on designing the compositional aspect. What are your strategies to include in your work the quality of the protein, meaning looking at the essential amino acid level, especially the methionine, which is a key, critical amino acid in human homeostasis?

Han That's a great question, and as much as I would like to say that we could solve that issue and take credit, it's not something within our technology portfolio wheelhouse at this point. For us, it's really about overall protein quality and levels to make sure that we're breaking the cycle of oil protein yield. But you're absolutely right. You know, soy, just by being a great crop, does have its shortcomings. And from that perspective at ZeaKal, we take a broader approach, which is, we would love to see PhotoSeed really across different species as well. And if you think about why we choose soy, it goes back to everyone here as venture-backed companies, soy is the largest acreage crop. Does that mean that our technology adds the most value in soybeans? Not necessarily. If you actually looked at the human impact of it, I would love to see PhotoSeed bridge the yield gap for crops that haven't gotten the same level of investment or attention as soy and corn, just because the market sizes are a lot smaller.

So from one perspective I see it was – how can we enable other crops, maybe ones more balanced for human nutrition rather than just animal feed, to be commercialized with our technology. The second part is, as we enable farmers to regain profitability, we're losing tools on a year-by-year basis with the technologies that we've had. So not only do we have to increase yield, we have to make up those deficiencies from certain chemistries going off the market, certain genetics losing their efficacy. So by restoring profitability, this is an ecosystem – we're going to start restoring investment back down to the research level. And I'm hoping targets like these, as we restore profitability, will get the funding necessary that there will be add-ons. So ZeaKal won't solve all the world's problems, but I'm hoping that we can change the dynamics enough that it's going to allow other people to solve those problems.

Q Thank you.

Sanjeev As a plug, if anyone does, we have an investment in a poultry company, and they always want higher signing solutions. If anyone does have that, come to us. We'd just pilot it and maybe to fund it. But it's a great question, because we do need the methionine sources.

Q Hi. I have a question about the business model of farming and how you look at that. I grew up on a farm in Nebraska as well, but every time I talk to a farmer, I say – “What do you want to do with the farm in the future? How do you grow it?” – it’s normally, “We need to increase yield and/or increase acres.” It’s kind of always the answer. And in both the United States and abroad, the farming model is normally a price-taker model. And all your technologies are very exciting, but I’m curious on your perspective of – is that business model of farming, is that sustainable? Is that going to continue? Or do you see major changes in how that model evolves as your technologies come out and as we work to solve these problems? Thank you.

Mick I’ll take the first stab at that. So from a GreenLight perspective, we’re really focused on technology, and I often do get that question from our board around the business model. There are companies working closely on business model disruption. I think from the small company the focus is really important. So we’re focusing on a technology, understanding that the business model is changing. Farmers in general are getting larger, distribution is changing, there’s consolidation at all levels of the industry. And so what we’re trying to do to make sure our technology gets to the farm regardless of where that model goes, is creating multiple relationships so that as we’re focusing on technology disruption, once we graduate that technology to get closer to the farm, we have the right relationships, whether that be with a farmer, with a channel partner, or with another manufacturer – and it’s going to be somewhat market centric.

Sanjeev From our perspective, we would love to fund. One of the white spaces we see is Ag FinTech. As agriculture goes from data port to more data, I think precision ag has definitely an opportunity, but the next order of consequence is sort of agriculture and financial technology. And to help farmers reduce risk and increase, improve cost to capital. So absolutely, business model innovation farming is a huge opportunity. And I think some of the speakers in the next panel are actually going to talk about that with the job paced pricing or other opportunities. So I think we’ve got about 30 seconds. I want to thank the panelists and the audience for coming today, and I think it was a great discussion around sort of the future of farming and food and to solve sort of humanity’s greatest problems. And I think agriculture and food is a unique industry. It’s not like the electron industry or the water industry or the transportation industry. It really does, and I fundamentally believe it has the opportunity to both address the issues around climate change and human health. And I think that places this industry that you all work in, in a very unique spot in the global economy. So thank you.