Thank you very much for inviting me to speak here today. My presentation is co-authored with David Treguer, who is a colleague of mine at the World Bank. World Bank, as you know, is providing lending and advice to developing countries, and is probably the largest owner in the water sector with irrigation accounting for about a quarter or third lending which was last fiscal year about $5 billion. Since we were reorganized about two years ago, we are now organized by sector, and these sectors are called “global practices.” So I work in the Water Global Practice in a unit called Synergy and Operations, where we are tasked to provide advice to the colleagues who are involved in the lending and also create and disseminate knowledge. So as part that dividend, I am working on a study on how irrigation water management can be improved in the face of water scarcity, and we are focusing on issues like what does it mean to improve irrigated water efficiency, and productivity, and this invitation to speak here gave us an opportunity to develop some of our thinking further.

Now the rationale for this topic, “Investing in Adaptation,” we have heard yesterday quite a few points on it and I would like to recapitulate the four major reasons why this topic is important. First, irrigation is the largest bistro of water. Second, the water use in agriculture is usually low value. So other sectors, that’s why allocations could be the most cost-effective way of getting more water. At the same time, there are the projections that irrigation production needs to increase, and that means also the water use arid countries need to increase. And on top of everything is this climate change, with projections additionally of complexity.

In the area of adaptation measures, a right range of interventions are being discussed.

*Please see the corresponding paper and/or presentation available at www.kansascityfed.org/publications/research/rscp/rscp-2016 for additional detail and referenced charts.
Investing in Adaptation

ranging from on the field to the farm to irrigation systems to the basin level to even higher levels national, international; and these interventions usually are under different objectives. One can say there are three main objectives. The first one is to maintain or increase irrigation production while not worsening water scarcity. The second one is water conservation for reallocation for other uses including the environment and for coping with water scarcity. The third objective is to maintain or increase agriculture net revenues.

So the problem is that often these objectives are not clearly stated when adaptation measures are being implemented, and then the broader results are not assessed, and that adds to the constraints in the adaptation measures, they are not as effective as they could be, and may even lead to unintended and counterproductive outcomes.

So with my presentation, I would like to shed more light on these issues. So what I would like to do first is provide is kind of a preliminary; I would like to discuss some water characteristics which one has to keep in mind when one talks about adaptation measures. Then as a second point, I want to set the stage for this global view of the linkages between irrigated agriculture and water scarcity, then talk about some of these adaptation measures, and then provide recommendations for going forward.

One can argue that water is special in many ways compared to other resources and other commodities. For our topic, one needs to always keep in mind that water is mobile. It moves through the hydrological cycle, and because of that often it’s difficult or expensive to establish exclusive property rights. Water supplies are also very valuable and unpredictable, and then combined with the variable local demands, you get very site-specific problems. So when you talk about adaptation measures, they need to be adapted to local contexts. Also, what we have heard yesterday by quite a few speakers is that water is rarely fully consumed in human consumption and production activity. So in every culture, it’s not unusual to see that half of the water that you withdraw and apply is returned to the system, and then used by downstream users. So that makes water use, it interconnects water users,
and this interconnectedness becomes more pervasive as water scarcity increases. So it’s not right to, and should not think that one gets insights from what is happening on the field or farm level, that this translates right away into what is actually happening at the basin or higher levels. And with these externalities, you have the need for public policy in order to complement these individual activities and reorient them to other social objectives.

Now moving to the global view, the links between irrigated agriculture and water scarcity. It’s not easy to make that link for various reasons including the special characteristics of water, the problems of defining water scarcity, and last but not least the availability of water related data. I’m trying to show you what is possible to show. This is the big view with regard to the trends in withdrawals and the share of agriculture is being shown. It is now about 70 percent of the total withdrawals. Also shown, the consumptive uses, and you see agriculture has always more than 90 percent of consumptive use. The rate of growth seems to be decreasing over the last couple of decades, and it seems from OECD countries, some of them have now maintained these withdrawals at a certain level; it’s even decreasing also for U.S. We have felt even the agriculture withdrawals are slightly decreasing.

Now with regard to the large countries, with regard to agriculture water withdrawals, this shows the 10 largest with India, China, and United States leading. These 10 countries are also the ones with the largest total withdrawals, and they are among the countries we see the highest area equipped for irrigation, and also among the most populace. I’m also showing, like USV, we talked about this yesterday, it’s kind of an outlier with only 40 percent of the total water withdrawals for agriculture. It’s due to the large share that is going to the power sector.

Next, I show by country the very close correlation between agriculture water withdrawals and total water withdrawals. You see on the left again the big countries with India on the top, and followed by China and the U.S. Because all the countries are bunched towards the zero point, we also show in local logarithmic terms and you can see this
close correlation. Similar close correlation is between agriculture water withdrawals and area equipped for irrigation. Area irrigation is like the indicator that FAO shows, it’s not necessarily the same as actually irrigated area, but this is an indicator that is available and one can play with.

Now moving to water scarcity. In the literature it’s defined in many different ways. One of the more common ways is to show the share of total water withdrawals as percentage of the total renewable water resources. It’s usually said that if this share is between 20 and 40 percent, then you have water scarcity, and if it’s beyond 40 percent you have severe scarcity. You see, especially MENA countries and Central Asia are classified as severely water scarce. Then we try to say what happens if we modify this indicator and we show only agriculture water withdrawals as a percentage of total renewable water resources? When we did that, we were quite shocked to see that the picture looks almost the same. So some European countries like Germany, they don’t show any more as water scarce, but all these various water scarce countries are still the same. You notice that some of the countries even withdraw more water for agriculture than their total renewable water resource availability. You wonder how can it be, and these are the countries which have a lot of nonrenewable groundwater withdrawals like Saudi Arabia. So this is kind of concerning.

Caveats apply of course. This may underestimate water scarcity when you look at the big countries like China, when you play with national data, its annual data so it has many scarcity situations at the local level. It does not include water quality issues. You do not have environmental needs incorporated, so water scarcity may actually be even higher. But at the same time one can say it underestimates water scarcity because the return flows are reused, and in the withdrawal date this reuse is incorporated. So let’s think of the Nile where the same water may be returned to the Nile and then taking out again several times just within Egypt. So one has to keep this in mind.

In order to show trends, the only available variable is area irrigation where one can find
a good data set over time. So you see this is showing data by region, excluding the advanced countries. So what you see, especially in East Asia, irrigated area increased a lot since 2012. This is mostly China and South Asia, it’s mostly India that’s increasing, and only in Europe and Central Asia there was a slight decrease recently. That still due to the recovery from the breakup of the Soviet Union which affected the management of these irrigated areas a lot.

Now moving to the adaptation measures. I distinguish between engineering and technological adaptation measures, and the policy and institutional measures. The engineering and technological adaptation measures are the most common. They include measures such as more capital intensive irrigation technologies, improved seed, precision farming to optimize the use of the inputs including water tailored to local conditions. These measures are usually applied and found with private investments, and often supported with public subsidies and technical assistance. So in the US, we are familiar with the Environmental Quality and Incentive program which since 1996 Farm Act is providing cost-sharing to farmers up to 75% including for these irrigation technologies with the official aim of conserving water, and billions have been given to farmers. Similarly, in other countries including emerging market economies such as Morocco, they have for example Morocco National Irrigation Water Saving program. They plan to convert half a billion hectares in the next decade to drip, and will provide up to 100% of subsidies to farmers and the total is US$4.5 billion. So the level of subsidies is amazing. However, we find that this mostly helps to maintain or increase agriculture net revenues.

So I’m talking again about my three objectives. It may maintain an increase in agricultural production, but usually these measures are not good at conserving water for reallocation or for coping with water scarcity. I would like to illustrate that with the example of capital intensive irrigation technologies.

Where a lot of research has been carried out, usually it is assumed that because they have to withdraw and apply less water to the field, that then somehow water is conserved.
But research shows that often they lead to counterproductive effects, including water consumption, but sometimes even increasing water withdrawals in water applications. I probably don’t have time to go much through the literature, but it’s important to distinguish between situations when return flows are important, where than one should be focusing on the need to reduce consumption. Various studies, almost exclusively carried out in the U.S. because of good data here, relatively good data, studies have shown since the mid-60s that return flows are important, and once you have more efficient irrigation technologies, farmers tend to increase irrigated acreage and then consumption increases, and sometimes even withdrawals and application. So for example, this economic approach was based on the Environmental Quality and Incentive program and data from that, and it shows farmers even increase withdrawals, the overall water use.

In cases where return flows are not so important, like for example the Ogallala Aquifer in areas where it’s very deep and return flows, maybe never reach the aquifer or it takes a very long time, then one should focus on reduction in withdrawals. There are some interesting studies that have been carried out, often in Kansas, showing that depending on the situation, depending on the context, sometimes withdrawals increase, sometimes they decrease. But often they increase, also due to crop switches which we heard about this yesterday, this switch to maize from wheat, and maize being a more higher water consumptive crop. Of course, there are exceptions with these adaptation measures.

Then you have measures that directly focus on the variable that you want to change, so when return flows are important, it’s consumptive use, if you have for example conservation tillage that directly aims at decreasing evaporation, then you can decrease consumption, and then your measure is fine; it achieves conservation objectives.

So with the moves to policy and institutional adaptation measures, they are increasing in importance. They include a range of measures, ranging from raising awareness to fostering innovations, but also applying economic instruments to balance supplies and
demands. Overall, the emphasis is shifting to demand-side measures. There are two key purposes of these measures: Conserving water because the private sector investments often don’t do that; and also to promote these private adaptation measures.

The literature distinguishes between three ways of doing these reallocations. Prices are the first measure. Often, there’s a big debate, can prices fall, irrigation water change anything, because a lot of literature shows that the demands for irrigation water are priced unrealistic and then it’s assumed that a large price increase would be necessary to reduce irrigation water application just a little bit. But in fact, that is not the case. When you think it’s just percentage changes that you look at, so even small increases percentagewise in prices can actually be very effective in reducing consumptions.

Quality-based measures, we have heard about different ways this can be done in the U.S. and in Australia. Theoretically, you can have an efficient location when you just allocate quotas right. Then it can be exchanged to get into water markets. Most of the world does not have water markets. You have these elements of transfer often by administrative decision, often by stealth where farmers are not compensated, only if they are able to put political pressure. So, one needs to keep this in mind, and there’s very little research about developing countries and these water transfers, and true wins and a true loses. When you think of the ways of how to promote and align the private adaptation measures, it would be important to state more clearly the objectives of these subsidies for these interventions. Much more assessments should be carried out with regard to the outcomes to avoid counterproductive results. Farmers’ adjustments should be guided by regulations. Farmers should be informed if reallocations are planned, especially in developing country settings. Care should also be taken that the risk is not increased for farmers. So for example, when farmers are supposed to move to drip, then they should have higher value crops and then that they are much more sensitive to water related risks. It seems also progress needs to be made with ground water management if there is any progress to be expected from conservation efforts.
So this is my last slide going forward. Actually, progress is needed with the policy and institutional adaptation measures. More research and development funding should go to them and not like also in the last budget, the president’s model innovation budget, it was all for technological and engineering measures. Many more assessments should be carried out with regard to the concentrations and what is expected when interventions are carried out, and then evaluate the effects. The right policy framework needs to be taken into account. We’ve already talked about this yesterday. And I also feel that when you look at how high are these agriculture withdrawals as compared to the total renewable water results, if there’s only small shortfalls, it can really lead to economic, social, and environmental crises. And as Ellen had said in California, they were able to manage this drought easily. One has to keep in mind how privileged California is compared to almost every part in the rest of the world with regard to the water infrastructure where they can move the water around. The knowledge infrastructure where they have data, where they have so many university researchers and think tank people who have models, who can check what would be the most appropriate response—all of these things are not available in most other places of the world. So we should keep this in mind and think about, and plan for such events. Thank you very much.
I want to thank you for inviting me. I really appreciate the opportunity to come here, share my thoughts, and interact with such a diverse group of people that are interested in water issues. That’s really a good motivation for my water research. I enjoyed reading Susanne’s paper, I think she really has done an excellent job summarizing the challenges that are facing the agriculture sector, and adaptation measures. So I think what I will do is to add to her points by bringing some details on what China’s government and a China’s farmers are doing to deal with the water scarcity problems.

China’s ag sector also faced similar problems like the share of water allocated to or used by agriculture sector has declined by more than 90 percent 30 years ago to only around 60 percent nowadays. Some of the supply-based solutions such as the South-to-North, the transfer to not only provide water for the industrial and domestic sectors, they do not provide for agriculture sector. At the same time, the government is also intent on maintaining a high level of foods self-sufficiency. So that just makes increasing crop produced per drop of water the key goal of the government’s investment. So one of the measures the government is using is to improve irrigation efficiency. Government has invested billions of dollars in lining canals and extending more efficient irrigation technologies. In this five-year plan which is from 2016 to 2020, the government is quadrupling investment. So the objective is to boost the irrigation efficiency to 0.55 by 2020, from the current level which is about 0.46.

So South China is actually abundant in water resource. North China is the part of the country that is short in water. So that’s where we focus most of our research on. The household level data we collect clearly show the impact of those massive investments, so the
percent of this whole area that’s serviced by lined canal increased from less than 1 percent to more than 40 percent in 2011. This is mostly happening in the area that uses surface water for irrigation. I’m using the term “so arid” because on most Chinese farms there are much more crop seasons within the year, like first wheat, and then two seasons of rice in a year. So in groundwater areas, we are also seeing increased use of underground pipes and the service water pipes which significantly reduced seepage loss when groundwater was delivered to their fields. But in the data we do not see farmers using more efficient irrigation technologies like sprinklers or drip irrigation. Another technology farmers are using, the drought tolerance variety really gained a lot of grounds and increased from less than 1.5 percent of this whole area in 1995 to now it’s used in about 30 percent of this whole area. Another technology that has developed pretty fast is conservation tillage. It’s used about 65 percent of this whole area.

So our assessment of those adaptation measures is that they do seem to decrease the total water use at the farm level. The irrigation application rates at the crop level have decreased a lot for wheat and for corn. Of course, we also need to look out for those unintended consequences like studies in the U.S. have shown that if farmers use the saved water to switch to more water intensive crops or expand irrigated acreage, the total water use may actually increase after more efficient irrigation technologies are used. But in our data, we do not see farmers making those adjustments. We do not see a significant change in crop mix. We do not see significant impacts on irrigated acreage, probably because the farm size is still pretty small in China. The average farm size is still about 0.6 hectares. In North China, agriculture is much more irrigated than other parts of the world. In some areas, farmers really have to irrigate every acre that they can get water to. So there may not be much room for those farmers to increase their irrigated acreage.

Our assessment is based on the current condition in China, so a lot of things may
change. One thing we are watching out for is the change in land. So while the government has been pushing to increase farming scale, and that’s one of the main goals in the five year plan, this is not something that’s going to change overnight. Recent studies show that the average farm size only increased from 0.59 to 0.62 hectares between 2007 and 2013. But we do see the large farm which is defined in the paper by more than four hectares. So that’s kind of farm is still a small share, by 2013 still less than 4 percent of cultivated area, but between 2007 and 2013 those kinds of large farms actually doubled in terms of cultivated land. So it is something that may change. So if we do see a significant shift in the land size, farmers may start to take up sprinkler irrigation and those kinds of things. So we may need to come back to reevaluate the adaptation portfolio, and their impacts on water use. This is good news for water economists like me because it means we’re never going to be out of a job.

So there’s also a challenge in those adaptation measures. One of the challenges I see is the lack economic incentive for farmers to use those measures. So when we calculate the benefit of using those measures, one thing that strikes me is that the majority benefit does not come from water savings. The monetary value of water savings is only one-third or one-half of the monetary value in terms of crop yield gain. Of course, that’s true because the price of water is low in China, just like in many other countries. That may explain that for some of the technology we don’t see a high adoption rate because the cost is higher than the benefits. Technology alone is not likely to solve the water scarcity problem in China.

The government has also been trying market-based solutions. In the past decades, the government has implemented several water rights trading schemes. So basically, their trading at a sector level between agriculture and the industrial sector has been somewhat successful. But the trading within the farming sector has not achieved the intended goals. We do not see from the data that farmers trade the water rights allocated to them, and the reason is more farmers have determined that any benefit of trading is easily outweighed by the costs of the transaction. So we do see a shift in water policy away from water trading, so
now the government is coming back to look at water pricing.

Water pricing reform has always been the government’s policy agenda, and the government has been laying ground for doing a nationwide water pricing reform. Lining the canals, is part of it, and the government has also been investing in adding meters to wells and adding equipment along the canals to measure the volume of water. The pilot reforms have begun, and have really expanded this year. So basically, the water pricing reforms, there are two components. The first component is to set water quotas, and these are set actually at a pretty low level, all the way down to the farm level. And the level of water quality is set based on historical water use, crop pattern, and also the water saving target. So about a 20 to 30 percent reduction in the coming years. The second component is a tiered pricing with a carrot/stick approach. So basically for farmers that exceed their water quota, they are going to pay a lot more, like three times as much for water. They also reward farmers for not using their quota. So basically the record of those pilot reforms is kind of mixed. In some areas, these do seem to work. But we're also seeing others where they are pretty much abandoned the reform after the first year because it is too difficult to calculate the water quota and also the monies and water used. So if the government does want to scale up there reform, they need to revise the format of the reform, and also come up with ways to reduce the cost of implementing water pricing reform.

Another market-based scheme is groundwater market, and this is not something initiated by the government; this is actually coming from the farmers trying to increase access to groundwater. In China, although the state legally owns all the groundwater resources, in rural China the farmers actually have de facto rights. So as long as you have a well, you have access to groundwater. The groundwater markets is informal in the nature, it’s mostly farmers who own wells, sell their water to his neighbor or friends. But in the data we do see that farmers who purchase water from groundwater markets have more flexibility in their irrigation. They got to use more water during drought years and they can use less
water when there’s plenty of rainfall. So it does seem to help somewhat, but those are really small-scale groundwater markets. Overall, when we look out across technology market base, it may be a technology plus a market-based approach is the answer to China’s water scarcity problem. In China, there’s always a hand from government too.

So one last point I want to make is that another challenge for adaptation measures is the continuing use of those measures, and the relation of that operation to the business of infrastructure and equipment. I think you in the U.S. will have the same problem. In Arkansas I saw some farmers that used it to pivot, the Asian equipment made the irrigation efficiency drop to below furrow irrigation. So farmers are actually reverting back to furrow irrigation. So in China, mostly the problem is who is, the government investment mostly comes into the installation phase. But after that who is going to continue the investment? Who’s going to maintain those village level canals, those are the big problem. That’s more so because it used to be, and villages, the village uses the funds from tax, from fees, from revenue of the village enterprise to fund those kinds of irrigation investments. But agriculture taxes were completely eliminated in China by 2006, and a series of fiscal reforms have pretty much taken away the village leader’s ability to levy any fee on farmers. In many provinces, they also removed the mandatory labor requirements. So village leaders cannot ask the farmers to work on village projects for free anymore. So basically those changes have left a fiscal void and a labor shortage for irrigation investment in rural China. So that’s another issue that the government needs to address in terms of dealing with the water scarcity problem. I think I’ll just stop here.
Audience Question: Thanks to both speakers; I enjoyed the presentations. My question is specifically on China, and it seems to me that one of the strategic things that China can do that would have a huge impact on water use and agriculture is deciding on the level of food self-sufficiency, particularly with respect to grains for which China has relatively little comparative advantage globally. What can you tell us about what China’s explicit goals are with regard to in 10 or 20 years the level of food self-sufficiency they are targeting for the grains—maize, rice, and wheat—which are mostly irrigated in China?

Qiuqiong Huang: It used to be, I don’t really remember the exact number, but the level of food self-sufficiency decreased from 95 percent to 90 percent. So the government is kind of adjusting there, adjusting that expectation in terms of that. I don’t know what’s going to happen in 10 to 20 years. They may reduce that further; it depends on the changing diet, it depends on what happens with trade agreements, all those things. So I do think the government is becoming more flexible in terms of that because they do recognize they may not find the solution to make the alga culture sustainable, because we do have a highly irrigated agriculture.

Audience Question: So I was very interested to hear your assessment that transaction costs are undermining the potential for water transfers in China. I’m interested of that happens on the local scale as well? There are several programs that allot farmers individual water rights based on credits to use the village pumps or the communal pumps. Those rights are based on energy credits or energy allotments which we’ve understood farmers are able to sell within sector. What’s your opinion of the future of those programs and do you think there’s
anything that the U.S. can learn from them?

**Qiuqiong Huang:** I think my comments on the transaction costs only apply for the water transfer within the farming sector. So between agriculture and industrial sector, actually I think there are some degrees of success in terms of that. So in terms of at the farm level, I think the problem right now is that the farms are too small. There are so many farmers, and it’s difficult to establish the water rights at the farmer level, and also we have problems, some village leaders are saying that because the supply chain has to be adjusted from year to year, so it just takes them too much time to do those things. They’re not willing to do it. So right now in the current condition of China, the water rights trading within the village is not likely to happen. In the future after the farms, if the country starts to be more like USA, large farmers, then that may change. So we may start to look at water rights again. That’s why I think the government’s policy documents do mention water rights from time to time. I don’t know if that answered you’re question or not.

**Audience Question:** Talk a little bit about the World Bank’s current portfolio of loans and grants in the irrigation sector, including whether or not they’re trying to work to leverage some of these policy and institutional reforms that you correctly pointed out are so important.

**Susanne Schierling:** Part of the reason of this ongoing study is that some people feel that we do not address these policy and institutional measures enough. When it’s about lending, it’s not the World Bank who decides how the lending should be designed and what supports should be comprised of. It’s based on a discussion with the government. So, for example, in China, we have probably the most advanced checks with regard to achieving real water conservation in a basin, for example, in the northwestern part of China where it’s kind of a close basin, and now copper and gold were discovered, so indigenous people non-Chinese people are there some racial issues, and water is now supposed to be taken away for industry. So, there are very interesting arrangements are being carried out with regard
to really focusing on the consumptive use and limiting consumptive use, and making the best use of optimizing consumptive use while transferring water to industry. That includes things like remote sensing because now China has capacity to have even very small fields recognized with remote sensing, and it includes even thinking about formulating water rights in consumptive use terms. It’s gotten quite amazing. So, there are such projects when government is ready to pilot new thinking. For example, also Chile of all countries requested to have a loan for institutional reform, or Brazil had a loan like that. But in general, the irrigation projects are still a lot with the lining of canals, improving on farm irrigation systems, and especially in areas where irrigation is expanded like in Africa. It sometimes even subbing fresh with converting rain-fed to irrigated agriculture.
Panelist: John Hamer  
Managing Director  
Monsanto Growth Ventures

I want to thank the Federal Reserve for inviting me here, my first time here, and for the first two speakers, for their introductions to topics of what are the technological innovations. I joined Monsanto about four years ago after a career in academia, biotech startups and venture capital and private equity. About 4-5 years ago at Monsanto, they had realized that a lot of the innovations that they were going to need to solve, some of the big agricultural problems, were going to be coming from small innovative startups. They weren’t necessarily going to be coming out of Montana’s own labels, or if from other large corporations where Monsanto will typically license products, but in fact they’re going to come out of startups that are going to be innovating very quickly and very rapidly largely because of the ability of a ubiquitous computer infrastructure in the cloud, and the ability of mobile technology to move rapidly on to the farm and elsewhere, and wireless networks.

That farming and technology, particularly technology around farming was going to change very dramatically, and that we could reach a point where bytes and bits were going to actually solve the problems of bushels. So about four years ago, we started Monsanto Growth Ventures with a goal of how can we help entrepreneurs realize the opportunities in agriculture? How can we help them address the really big problems that we’re facing? And so we do things like provide equity to small startup companies, we help them form partnerships with Monsanto, so their products can get out there and get the customers around the globe, not just in their own regions. Finally we help them test their technologies on our own seed production footprint. We farm about seven million acres ourselves where we produce all our different seeds, corn, cotton, canola, soy, wheat, as well as we’re the world’s largest vegetable seed company. And so for an entrepreneur, they can immediately
have seven million acres on which to test their technology. In addition to partnerships in equity, we look for the opportunities to see if these companies at some point would like to join up with us on this journey to try and improve agricultural productivity. So that’s what we do a Monsanto Growth Ventures.

I thought I would give you a bit of perspective about Monsanto and what is our water footprint and what are we doing about it since we’re a very large seed producer. Most of the seed that we produce is from irrigated acres. What products and partnerships are we forming to help deal with the issues around water and what are stress? And then, as a venture capital firm, and we’re based in Silicon Valley. Sometimes we call it “silly valley.” But in Silicon Valley, what are we investing in, and what are we seeing emerging on the horizon that is going to have some big impacts? And then finally, I want to leave you with a quick message of encouragement about what we’re seeing in the private sector in terms of dollars invested and an excitement about the agricultural sector in Silicon Valley. And this is not just from VC’s that are investing specifically in food and ag, but from VCs that are investing all across different sectors of the U.S. economy and how excited they are about food and ag.

So first of all, Monsanto and its water footprint. So, in our R&D units, we spend, we use about a billion gallons. In our herbicide program, about 5 billion gallons. But on our seed production footprint, about 200 billion gallons annually of water. About four years ago, Monsanto made a commitment that we would reduce our water footprint by about 25 percent by the year 2020 based on a 2010 baseline. Every year we report out about how we’re doing. We’re about 10 percent more efficient than we were previously. We’re using a lot of different technologies to try and get more efficient—drip irrigation for example being one, but also remote sensing. So we teamed up with a little company that we actually invested in called Hydro Bio. They use satellite imagery mainly from land sat, but also from rapid eye imagery, and then they use a number of different algorithmic approaches.
to calculate what the rate of irrigation should be on certain acreage for certain crops. And Monsanto tested their technology on multiple acres around the world, found out they could reduce the amount of water on those acres by sometimes up to 20 percent right away and still get the same yield and quality of seed. Today, we’re rolling out Hydro Bio and Hydro Bio’s imaging technology and remote sensing technology across our entire seed footprint at Monsanto. So for our little startup that we invested in, it was fantastic. They immediately had a large enterprise customer that would take their technology global, and for Monsanto was the chance to reduce our water footprint using remote sensing technology. So a real life application of how that would work.

Let me move on and talk about products and partnerships. So one of the partnerships we’re most proud of is our collaboration with the Bill and Melinda Gates Foundation, called WEMA, Water Efficient Maize for Africa, where we have freely donated all of our germ plasm that’s dry resistant, including our drought guard gene that we developed and launched in the US a couple of years ago. Donated those technologies to the Bill and Melinda Gates Foundation for use in approved water efficiency in African maize production, and it’s a partnership we’re very proud of and that’s been quite successful.

Someone made a comment about brute force breeding. Breeding is probably the number one R&D spend at Monsanto. There’s nothing brute force about breeding that’s being done today. Every gene on every plant, every nucleotide on every plant, we absolutely know what it is, we know where it’s going, we know what we’re going to do with it. We have the ability to select recombination events that are extremely rare because we can actually genotype every kernel on a cob of corn before it goes in the ground. And we have machines and technology that we’ve built in house to do that. And so we’ve accelerated breeding through genomics and genomic technology that it’s almost unrecognizable today. And the precision behind breeding allows us to have the significant yields advantage and bring out new hybrids every couple of years and keeping that curve continuing to grow in terms of yield.
On biotech trades, you can think about Roundup Ready crops and many of you know this story of no-till agriculture and we’ve a generation of farmers that haven’t plowed fields because of the use of Roundup Ready crops and we’ve preserved topsoil and carbon throughout the U.S. growing regions because of those crops, and we have next generation biotech weed control technologies that are coming through the market and we’ll be launching those in the next couple of years.

Finally, we’ve made a big investment in Drought Guard, and this is the first really new gene that Monsanto has launched besides weed control and insect control for drought resistance that was launched on a half million acres the next year. That grew 400 percent to two and a half million acres in the U.S. We’re hoping for another great year with Drought Guard this year. Drought Guard has taught us an awful lot about how to breed for dry resistance. Not necessarily complete resistance, but drought tolerance specifically at anthesis; how to reduce the impacts of drought on yield when it occurs at certain times in the growth cycle of plants. So we’re not just discovering genes but using those genes to help us figure out the physiology of drought. Many drought genes that we tested at Monsanto, just simply slowed down growth and wouldn’t give yield in the absence of drought. So the drought guard gene really taught us how to go about thinking about how to protect crops from drought. So look for new discoveries coming from Monsanto in that area.

So let me go on to technology and investment? Where do we see some of the impacts that are coming in technology for water use? Probably one of the most exciting is remote sensing. I mentioned Hydra Bio which is using satellite imagery, but let me tell you, the entire satellite constellation around the world is going to change very dramatically in the next few years. There are a number of new startups in Silicon Valley that are not launching $25 million satellites the way our U.S. government does, but launching $100,000 satellites. They’re essentially taking the infrastructure of our cell phones and putting it in outer space, and they’re not putting one or two; they’re putting 70, 80, 100 of these satellites around the...
earth that can monitor, not just take pictures of the earth and send them back down, but actually give us real time monitoring of what’s going on in different parts of the globe. The impact of that technology on agriculture is going to be extremely exciting.

A couple of companies to watch out for; you can’t buy their company stock because these are all private, but Climate Labs was on the cover of Nature not too long ago. They’ve got 70 birds up around the world right now, at about 7 meter resolution. But look for Astra Digital, look for another company out of Argentina called CitiLogics. They’ve both launched two satellites now that will be the first of constellations of 20 to 30 satellites that will have one meter resolution with hyper spectral imagery. So it’s amazing that this kind of technology is going to be available. You’ll essentially be able to look at your crop anytime, anywhere you want to.

Synthetic aperture radar can go right through clouds. Cloud cover will no longer be a problem for being able to monitor crops. Synthetic aperture radar is on the Sentinel 2 satellite launched by the European Space Agency, and we’re going to see more and more applications of that technology over time. So remote sensing is going to have a huge impact to help us understand exactly what’s going on.

Our biggest investment at Monsanto was Climate Corp. We bought Climate Corp about three years ago for a billion dollars, and I think we shocked everybody. Why would a seed and herbicide company in St. Louis buy/spend a billion dollars on a bunch of software engineers in San Francisco. And it was the realization that bits and bytes were going to solve the problem of bushels. With Climate Corp we have built the data science infrastructure that we’re going to need to know exactly where to put the right crop at the right time, in the right soil with the right microbes, something we’re calling precision product placement. Also with Climate Corp, we’re going to solve the problem of yield through math. Very often, farmers have relied on what their neighbors are doing or their favorite extension scientist at a university to help them explain what they should be doing and where they should provide
inputs. But with the algorithms that Climate Corp can develop, and the remote sensing technology, we’re hoping to bring more and more precision to that. So knowing exactly how much nitrogen to put down, to prevent nitrogen runoff, to prevent contamination of waterways, and spilling in the Gulf.

Finally, let me give you a bit of hope about the private sector. When I first started in venture capital about eight years ago, there was about $200 million a year coming from VCs into the agricultural sector, mainly into first generation ag/biotech companies. Last year was $4.6 billion. The private sector has gotten very excited about agriculture and food because it’s such a large market. They’re making a large number of investments. If you think about the fact that we’ve got to feed all these people by 2050. Think back what 30 years ago looked like. In the 1980s, the five biggest companies that we know about today were barely around. Facebook and Google weren’t around. Microsoft and Apple were little startup companies. There were no cell phones, there was no internet. The impact of innovation has always surprised economists around any kind of predictions that they’re going to make. They can never seem to account for it. And that pace of innovation is accelerated, and I think it’s going to help us with the problems that we have with water, and help us solve some of these big problems in agriculture. Thank you.
Thank you you for the invitation to speak. I’ll be speaking with my own thoughts and not speaking for Valmont or for the other industries that I might be mentioning. I’ll just frame the irrigation equipment industry globally for you. The center-pivot industry adds up to about $2.1 billion in sales per year globally. Drip is about another $3-4 billion. So we tend to think about the global irrigation equipment business being about $8 billion. That doesn’t include pumps and doesn’t include contracting and civil work, the well drilling. But it includes the equipment manufactured. $8 billion seems like a big number, but consider that there are 280 million irrigated acres in the world. It’s not really such a big industry in some ways. The municipal water industry is multiples of the size of the irrigation equipment industry. The global center-pivot industry is about 18.3 hectares underneath center pivots in the world. That works out to about 6 percent. I don’t know the exact or the best number for drip, but it’s probably about half that in terms of acreage covered. In the U.S., we have 12 million hectares under center pivots, that’s about 50 percent of irrigated acres. Drip is about 8 percent of irrigated acres. Flood has been declining over the last 40 years or so. It’s at about 40 percent of irrigated acres.

The irrigation equipment industry in general is down this year and for the last couple of years. But over the last 30 years, it’s had a growth rate globally of about 5 percent. Investments and actions to adapt to or to reduce water availability for agriculture relate to two challenges—long term availability of water, and response to drought. Most challenges have been addressed over the past four decades in North America by improved farm management, better water management and new technologies. The net result has been a dramatic increase in total food production while withdrawals of water for irrigation actually
declined. Farmers continue to implement water conserving farm management practices, and improved irrigation technologies like center pivots and drip. Government agencies and producers continue to cooperate in managing water supplies with increased sophistication and more detailed measurement of outcomes.

For irrigation technology, a few of the areas stimulating new investments—I’m sure many in the room are more familiar with it than I am—center pivot; remote management of pivot operations and pumping operations; remote sensing of soil moisture, crop temperature, weather and so forth; and more recently introducing variable rate irrigation. For decades we tried to make the watering pattern of a pivot very uniform. Now we can divide a field, a quarter section, into 6,000 sectors and water different parts of the field in different ways, stop the watering if it’s going over rocks or increase the watering if it’s a particularly dry place according to a prescription developed by the farmer himself. Originally, pivots were adapted as a labor saving and soil management tool, but now of course pivot irrigation is considered by some as a water management and conservation device. There are many types of developments that are going on in the field of startups at the universities and at government agencies with new applications to be combined with center pivots. Center pivots are in the field moving through the crop, so they’re really a platform for any number of innovations when it comes to farm management and water application.

Drip irrigation similarly has a lot of new developments emerging, much related to improving the performance of the midders and avoiding root intrusion. Also, remote sensing is another factor, remote system management, and applications to new crops like, large field crops like alfalfa and corn.

This investment in irrigation is centered in the main irrigated areas of the western United States when we’re talking about North America, but it’s also increasing in areas east of the Mississippi where it is used to assure a full crop even when a drought hits. Returns on investments in center pivots and drip irrigation are good in normal times, and paybacks
are very quick in times of drought. Another important adaptation to water scarcity now under way is the improvement of agricultural water productivity in developing countries. In many of these countries, the climate permits year round cropping, and irrigation can enable farmers to triple or quadruple their output. The needed institutions, farm management practices and technologies already exist in the developing world, but they are currently available to only a few. In Africa, there are 1.5 million hectares under center pivots all in the hands of large commercial farmers. Most of the farmers in Africa are poor. There is a big opportunity ahead for farmers in these regions to use irrigation to increase production in order to supply their markets. What farmers in Brazil and Argentina have accomplished in recent decades can also be done in Africa and irrigation and improved water management will be an important part of that story. The main barriers to progress in these markets are lack of financing and lack of institutions with water management experience.

Turning to Susanne’s point about the lack of excess water flows with center pivots and drip, it’s true that center pivots and drip can cause problems for neighboring irrigators. Also, there could be cases of farmers using the water saved for expansion of their own irrigation. However, these technologies are tools used by farmers who are governed by water management authorities. In the Central Plains, irrigated farming is subject to water management regimes that prevent unfair or destructive actions by irrigators. In addition, university extension services and consultants educate irrigators all the time on best practices for water conservation. Over the past 40 years, there’s been a dramatic expansion of acres irrigated by center pivots and drip that has contributed to a vast increase of production of food with less water removed. Underneath Nebraska which overlays two-thirds of the Ogallala aquifer water volume, the aquifer is not going down. It’s at about the same level as before irrigation started. Also, Nebraska’s rivers and streams are required to meet ecological goals. The 26 Natural Resources Districts which are organized by watershed and have locally elected boards impose pumping restrictions in times of drought, and they work with
the Director of Natural Resources at the state level to identify land that should no longer be irrigated. In the future, these management techniques will evolve, taking advantage of data analytics and new ideas like water markets. My point is that center pivots and drip are technical tools that can lead to great results when combined with advanced water management practices and good governance.

Center pivots and drip will be important in the developing markets around the world. They offer good controlled water, and good controlled nutrient application with lower per capita costs than flood irrigation, and they are simple to operate and monitor. I believe that in a green field situation, center private and/or drip technology combined with effective water management institutions is the approach most likely to provide positive investment returns. Compared to flood and gravity, it tends to be less costly, is compatible with no-till practices, less invasive to the environment, and it provides an open platform for high tech applications.

Susanne’s point about groundwater is very important. In Africa, where we already have quite a bit of land under center pivots but all with surface water, there’s a large groundwater resource yet to be fully understood and developed. It will be important to develop proper governance and new resources in areas like well construction to ensure the sustainability of Africa’s water resources. Thank you.
**General Discussion**  
*Moderator: Nathan Kauffman*  
**Assistant Vice President and Omaha Branch Executive**  
**Federal Reserve Bank of Kansas City**

**Audience Question:** So this is a question for Mr. Hamer about an issue that also came up yesterday in regards to plant breeding. The question I’ve been wondering about a lot is, for a given unit of water that’s consumptively used by a crop, a lot of it is used for the non-useful part of the crop. You know, almonds, a lot of trees and branches and leaves, for example, that go into making the nut. And so you mentioned work on sort of drought tolerance issues. But I’m wondering, what do you see as, I mean, is this an area that you see potential for in terms of really getting more crop per drop from a consumptive water use perspective as part of the yield frontier?

**John Hamer:** I don’t know, even though I’m from California, I don’t know enough about almonds. I’ve been with Monsanto long enough to know a little bit about corn. So obviously, there’s a lot of areas around the life cycle of corn that water’s going to play a very important role. Again, the development of DroughtGuard gave us a real chance to sort of look at the parameters that are going to make, so where does this gene act, and how does it act, and what’s the pathway it’s acting in so that it’s not impacting plant growth when there is sufficient water. So yields are as good as any other hybrid. And if drought hits at certain specific times over a specific period it’s yield is not as impacted as if you didn’t have the gene in there. So there’s something like, it’s not resistant, right? You get about 20 percent, you know there’s numbers all over the place, but somewhere around 20 percent more yield out of the DroughtGuard crop when you get drought at anthesis in the corn. But it’s given us a chance to look at things like transpiration and what role does that play, leaf architecture, plant architecture in general, all those sorts of things.
So I think there is that chance, but it’s been a long haul to get to something that we can finally begin to get a thread that we can begin to pull on and unravel. What are the next genes in that pathway, and how do they impact things, what are the other homologues and other crops that look like this gene, and what are their impact? So I think we’re at the beginning with DroughtGuard and some other traits that have been discovered to begin to unravel some pathways that may have some long term value in providing more opportunities to stack traits. The codex, you know concerned scientists, came out and said, “Oh, it’s not doing all that much.” Well, there’s going to be the opportunity to stack drought genes much like we’ve stacked insect tolerance genes. So I think we’re at the beginning of an opportunity here, not at the end of one. Your point is well taken. Research will show.

**Chuck Rice, Kansas State University:** John, you made an excellent point, but I guess what Robert was saying as well is that there is a lot more to worry about. Think about a system, and that’s much more complex is the plant breeder is working with irrigation, working with microbiologists. But are we there? I don’t think we’re thinking as a systematic approach to really innovating ag and water conservation.

**John Hamer:** I think I would agree with you in the sense that even at Monsanto, we’ve been a little bit isolated. The breeders are over here, Climate Corp’s in San Francisco, biotech is over there working on insect and more herbicide resistance type things. There’s the opportunity to bring it together. We have some collaborations with Netafim for example around drip. We’ve begun to launch a system in Europe, our DeKalb brand in Europe is now packaging DeKalb along with a Hydro Bio subscription so that growers planting that seed get a subscription for irrigation specific recommendation for that seed and where they’re growing it. That’s a product called Aqua Tech. So there’s beginning to be some integration of that. Now we’re cautious because growers don’t like bundling. They don’t like a single company to bundle a whole lot of things in one thing, and say, “Hey, you’ve got to buy the bundle.” So there is an integration in terms of, there’s beginning to be more and more integration
in terms of thinking, and I would say that was another huge driver in the acquisition of
Climate Corp was to be able to have the data handling skills and algorithmic skills to be able
to even deal with our own breeding and field trial data. So I think we’re at the beginning,
and I would say you’re right, we’re not, at least I feel at Monsanto, we’re not there yet with
that fully integrated approach.

**Audience Question:** John, could you comment on what is your or Monsanto’s take these
days on the potential of Biologic’s yield and resistance and so forth?

**John Hamer:** Yeah, so we think that’s a huge opportunity. So for people in the audience,
pesticides, we’re running out of them. We haven’t had a new mode of action discovered in
20 years in any major pesticide group. A lot of the big pesticides, insecticides and others
are getting deregulated and taken off the market for various reasons. And so it’s sent the
industry looking for biological sources of crop protection and crop growth enhancement.
So this is things like microbes. So think about yogurt for plants, right? So this is—
understanding the plant microbiome and giving beneficial microbes to plants. So we’ve got
a huge effort at Monsanto on that. As you know, Bayer’s got a big effort, so does Syngenta.
DuPont has started an effort as well. Most of us are collaborating with big microbiology
companies, so we’ve collaborated with Novazyme; Syngenta has collaborated with DSM.
And so it’s those kinds of collaborations where we’re combining expertise in microbiology
and fermentation with expertise in understanding plants and being able to sort of decipher
the plant microbiome and figure out what are the beneficial microbes, and how can we
provide those to the seed in areas where they’re not there? And so it’s a big opportunity and
there’s some hints that there’s going to be some great products coming out of that. So think
about this. Think about the entire ag chemistry industry, researching products that can be
used in organic agriculture. So essentially all of these microbiology products are going to
be organically certified. So it’s really an amazing step change in the ag chemistry industry
that we’re spending billions of dollars doing research on products that will ultimately benefit
organic growers. So it’s really an exciting time.

**Audience Question:** A question maybe for the panel. You’ve all talked to some extent about the role of data, and I’d be interested in your thoughts on how you see that translating into better decision making. You know, we all have a lot of data regardless of what field we’re in. But could you talk about what are the steps involved in terms of how that’s leading to better decisions?

**Robert Meaney:** I’m not an expert, but I know that farmers who use pivots use more and more data all the time, and they get it from new sources, new ventures, some exist for a few years and disappear. But you can see that there’s tremendous amount of work going on all over the place in the U.S. and Europe and other places. So the farmers are the most important people to supply with the kind of data that will help them improve their productivity, but there’s also a lot going on in the regulation area. I’m not sure the farmers are always happy about the regulators becoming more and more sophisticated and collecting more and more data, but that’s an issue that will work itself out.

**Quiquiong Huang:** More funding for data collection. So as far as the research done by our research team, I see that data can be used to advise policy makers throughout the whole process in terms for example to evaluate the situation of water scarcity. For example, we read lots of articles that say north China is one of the most water scarce areas in the whole world. And I use that sentence too. But we did a large survey, like covering seven provinces in north China, and we look at the changing water levels, and what we found is actually in 50 percent of villages, the water level actually stayed constant between 1995 and 2004. Actually in some the water level actually increased because those are shallow aquifers so they can recharge. It’s only in about 10 percent of the villages we see that water level drops like one meter per year, which is an alarming rate. So even though we said we have water scarcity problem, we had to realize it’s not everywhere, it’s only in parts of the region. So that’s an important message for the policy makers when they think about what policy to
I also see increasingly, at least in the field of economics, we used to do lots of prediction, but now I think more the focus is how to evaluate what policy works and what policy does not work, and this is particularly important in China because China likes to do pilot reforms, we’re doing trial and error approach. So we need research on evaluating whether those pilot reforms has worked or not, and the government is really revising the next [inaudible] reform based on those research and we use data to evaluate this reform. So I really see this is playing a bigger and bigger role in making policies.

**Jeff Peterson, University of Minnesota:** So, we’ve heard on the panel here about both innovations in the institutional realm as well as technological innovations, and one of the observations that’s often made is that some of the issues that we have now, I think this was mentioned in Susanne’s talk, is that given a system of markets and policies and so on, the current institutions, recent institutions, when new technological innovations come along, the way they’re adopted doesn’t end up having the, we have unintended consequences from that. My question is with the new waves of innovations that are coming, both institutionally and technologically, what has to be done differently to make sure that the new technological innovations have their intended impacts?

**Susanne Scheierling:** One important thing is this better data collection, and when you look at the water sector, the data situation is unbelievable. Even like for countries like the U.S., if you want to have more information on, let’s say, county level data, water use for different sectors; farm level data, how much is really withdrawn, applied, consumed—it’s not there. You can’t find it. That is the first step, data. And then the assessments should also be carried out much more closely dependent on the water related data. But hardly ever are studies being carried out with regard to what actually works to really conserve the water. And especially with irrigation water conservation, you can’t find one study really if you tried to look, was water really conserved with what intervention, you can’t find. And it’s amazing
when you think about it. So this situation needs to be improved. There's no question about it.

**John Hamer:** So I think the challenge has always been making sure these policies are science-based. And you just look at the difference of regulation in the EU and the regulation in the U.S. with regards to genetic modification in crops. So I think we've got to have, I think most people in the U.S. would say we've got to have, science-based policies based on evidence and science. And therefore, the technology has to be out there for a while. So that's one comment. The second comment would be, I'm concerned about policies that are really going to end up supporting the incumbent infrastructure. And so there's a number of new technologies that are emerging. One can think about Uber and Airbnb and others, really breakthrough technologies that are changing the face of industries. Of course, the incumbents are pushing back with all kinds of “policy,” but it's not policy at all. It's preserving an incumbency that doesn't want to be disrupted. So keeping those two things in mind, I think we do have to be aware that some of this new technology is going to have some very profound changes, but ensuring that it's science-based and not just there to support incumbents.

**Robert Meaney:** I think it really goes back to governance again. It's a common resource and you can't have every individual acting on their own. They can in 98 percent of what they do, but on the important 2 percent if it's a new technology that starts to affect a watershed, the people responsible for the management of watershed have to act.

**Audience Question:** A comment first, and then a question. First of all, I want to make the comment that we're not looking long enough in water. It's been 27 years for me in this industry now, and it takes 20 or 30 years to create a reform in water and we're talking about the next 35 years, 2050, it's not long enough. We need to be talking about the next 100 years if we're talking about water reforms that take 20 years. So that's a comment. The question is, if we're drawing water resources out at a faster rate than are being replenished, that's
water mining. That’s mining a water resource. Does the World Bank or any other of the speakers here have any concept at the moment about the percentage of water in the world we’re mining instead of sustainably using? And how will this affect farm productivity in the future?

**Susanne Scheierling:** I’m not aware of a global dataset with regard to water mining. I think there are data for specific regions. Like, I think in China they have some data for some regions. One could calculate based on the withdrawals when you’re comparing this renewable resource, it’s like the difference, like I showed it in percentages. But you can calculate the amounts and add them up. So that could be possible. But then what do you do with that number?

**John Hamer:** Certainly, we are mining water in some areas, and Saudi Arabia is the famous example, and they’ve cut way back so that it will last longer. Libya has the Nubian aquifer that will last probably 100 years, but these are more decisions about do you just leave it there, or do you use it, or do you use it fast or slow. But I think that percentage that’s non-renewable is not so great because we’re still ... the big irrigation areas of the world are still India, China, Pakistan, the United States, Iran. The list is about the same of the top 15, and those are all based on rivers and flows, and the melting of the snow in the mountains. In the Himalayas, I think they feed eight or nine rivers that eventually go through irrigation or they come to fertile land, and then they’re used for irrigation. So all of that is still I think much more than half the irrigation in the world. You can name probably 20 different irrigation schemes that would still be half the irrigation in the world.

**Steve George, Freemont Farms:** I have a three part question. For Mr. Hamer. You mentioned the genomics that allow corn yields to be mentioned at a rate of increase. Were you referring to a linear increase we’ve seen historically, or will the genomic effects allow acceleration, a more of an exponential increase perhaps?

**John Hamer:** Yeah, I’m not prepared to say exponential increase because all the plant
breeders at Monsanto would shoot me. But I think it’s the linear increase you’re talking about. But it’s continuing to build on that base. What was the world record this year for corn? 504 bushels an acre. That was the same genetics. So it’s not just going to be the genetics, right? It’s going to be a lot more that drives that yield. But genetics is going to be a bit part. So when you think about, imagine all the world growing 500 bushel an acre corn. We wouldn’t be talking about 2050 anymore. But the potential is there. Right? It’s in the genome, and it’s there. And it’s there today.

**Steve George:** And you also mentioned a big effort/movement underway from Silicon Valley. Silicon Valley has discovered agriculture in the last five years.

**John Hamer:** Yeah, I think it’s because we spent a billion dollars. That’s why they discovered it.

**Steve George:** Right, but there’s been huge conferences, and articles from the Wall Street Journal talking about how there are all these brainiacs in Silicon Valley, and I have a son who works there, who believe they’re going to revolutionize agriculture because it’s a bunch of dumb, dull farmers that have never innovated in their life. The farmers are sitting over there laughing about saying, “You kids have no idea what you’re in for to learn,” and my question is, are some of these startups actually working with farmers directly and incorporating them as part of their user group in a more intelligent way rather than some of the condescending type of attitude that we’ve seen in some of the efforts to date?

**John Hamer:** Well, the good news is California is a $36 billion farm value state. So you don’t have to drive far from Silicon Valley to run into that. So the good news is they are going to Salinas, they are going to Fresno, they are seeing the Central Valley. More and more conferences in the Bay area, and you’re right, there have been tons of ag conferences, are now incorporating growers that are coming in. So big growers from the Salinas Valley or Central Valley, some of the big almond farms, some of the big pomegranate and other type big growers, are coming into Silicon Valley. And of course, these guys have the high
acre crops. So these are the crops that are $10,000-$20,000 an acre crops. This is not corn and soy. So, these farmers have the wherewithal, and they’re growing perennials, so they’re only making a decision a couple of times in their lifetime about what to put in the ground. So their crops are very valuable, very wealthy. You know, they’ve got a lot of value in that crop. So they’re willing to experiment on technology. So it’s actually turned out to be a very productive fit between Silicon Valley and innovative technology, and farmers growing high value perennial crops in the Central Valley, and they’re only a two hour drive apart. So that’s the good news. I think the challenge is when Silicon Valley guys end up in Iowa. And I think that’s where you, or Nebraska or Kansas, and I think that’s where some of the challenges have been. But I think they’re going to get it solved.

Steve George: And then finally, do you have any comments on Monsanto’s efforts to get social acceptance of these technologies? I heard your VP of Research speak a year ago and he was talking about how Monsanto has to change their strategy to gain the social acceptance, social contract among millennials and others, or certain percentages that are rejecting this technology as dangerous. And if you have any thoughts that you can share on new strategies for overcoming those attitudes. Because the greatest technology in the world, but if there’s not a social contract of acceptance, we’re seeing state laws in Vermont against GMO and so forth.

John Hamer: To quote our CEO, we just thought everybody would read the papers. Right? I mean, literally it was the view for 20 years that most people at Monsanto just thought, you know, the farmers love us, we’re through EPA, and everybody else should just read the papers or read the toxicology reports. And suddenly over the last three or four years, finally figuring out that people vote and if Monsanto doesn’t have a message, everybody will have a message about Monsanto. So they are making a very concerted effort to create more engagement, to talk openly about biotech and what it can do and what it can’t do, and to think about as Chuck was saying, it’s a system of genetics. We’re going to need genetics
in breeding, we’re going to need biotech, we’re going to need data science, we’re going to need advanced engineering and remote sensing. It’s all those things combined. And I think someone showed the chart of increasing yields and how many of those were engineering advantages and agronomic advantages that led to those changes? So I think Monsanto’s thinking much more holistically than I think it ever thought before. So thank you for those comments.