Food Security in a World of Natural Resource Scarcity: The Role of Agriculture Technologies

Audio Transcript

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PRESENTERS

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PRESENTATION

Julie MacCartee: Good morning, everyone. Thank you all for joining us here today, and thanks to those online also for joining us via webinar. My name is Julie MacCartee, and I am a knowledge management specialist at the USAID Bureau for Food Security. And I'd like to welcome you to the March Ag Sector Council seminar entitled Food Security in a World of Natural Resource Scarcity: The Role of Agricultural Technologies.

And we're very excited to have Mark Rosegrant with the International Food Policy Research Institute here to discuss a recently released report that uses a new data model to measure the impact of 11 agricultural innovations. And we're also excited to have Julie Howard with the USA Bureau for Food Security giving an introduction.

And I'll pass it over to them in a moment, but, beforehand, just a couple of our usual housekeeping issues. We always like to ask folks to silence your cell phones just so that they don't interrupt the speakers. So if you wouldn't mind doing that if your cell phone is not currently silenced. However, you're welcome to keep your cell phones handy if you are a Twitter user and would like to tweet along with this even today. We use the hashtag #agevents here on the screen if you'd like to tweet along.

And if you're joining us online, we definitely encourage you to use Twitter, but we also encourage you to share your experiences and your resources in the chat box. There's a lot of great discussion that happens in our online chat boxes. And just a shout out and thank you to the Knowledge-Driven Agricultural Development team who are facilitating the webinar today.

Also, we ask, generally, that you hold your questions until the end so that we can pass around this microphone for recording purposes and also so that the online participants can hear your questions. This session is being recorded, and so we'll be sure to send out the recording transcripts, all of our resources to everyone who joined us today.

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And, lastly, there are some surveys on all of your chairs. Even if you've filled out the surveys before, we always request that you fill them out again just to help us get a better gage on our participation and just help us adjust these events for the future to serve you better. So you can fill out during the presentation or at the end. And if you're joining online, you'll see some polls during the Q&A portion in that regard.

And very lastly, just one upcoming event to let you all know about: here in this room, actually, tomorrow there is an MPEP seminar entitled Smallholders in Value Chains: Evidence on Scale, Productivity, and Benefits. That's another seminar run under the KDAD or Knowledge-Driven Agricultural Development contract. If you wanna register for the webinar, you can do that MicroLinks.org.

All right. I think we can go ahead and get down to the business. Oh, and just – sorry, one quick shout out also to Deb Carstoiu and Alex Rinkus from CropLife, Nila Chittun from IFPRI, and John McMurdy from the Bureau for Food Security for helping us get this event conceived of and rolling today. All right. I'm gonna go ahead and pass it over to Julie Howard, our chief scientist with the USAID Bureau for Food Security.

Julie Howard: And welcome everybody who's here with us in the room, and welcome to all the online participants. So we're really excited today to have Mark Rosegrant of IFPRI here with us, and more on Mark in a moment. He's going to present their results of their new report _____ report _____ Food Security in a World of Natural Resource Scarcity, work that was funded by CropLife. And this is a study that measures the impacts of agricultural innovation on farm yields, prices, hunger, and trade under various climate scenarios in 2050 and identifies practices that could significantly *[break in audio]*.

So I just wanna talk for a minute, even though this study was by CropLife *[break in audio]* it's already *[break in audio]*. Many of you may be familiar with –

[Crosstalk]

Male Voice: I'm sorry. Can you just the mike –

Julie Howard: Yes.

Male Voice: – closer to your mouth. Thank you.

Julie Howard: Okay. How's that? All right, thank you. Many of you may be familiar with the Feed the Future research strategy, which we put together. USDA and USAID held wide consultations with US university community, the CGIAR, our developing-country agricultural research partners, and others. So that was released in 2010.

And it was a little bit, I think, over the horizon in its thinking at that time, because the overarching goal of our research strategy is exactly sustainable intensification as an important way that we need to think ahead to address the consequences of coming climate change – actually climate change that we're already seeing. So I think we've been very busy with John and Rob Bertram and _____ in sort of reframing our research programs around that guiding research strategy.

And over half our resources are devoted to things that address climate resilience – climate resisted varieties of wheat, insect resistant, disease resistant varieties of cereals as well as legumes and horticultural crops. And more than just climate resilient varieties, we've also put quite a lot of attention to what are the management practices that are gonna be important for smallholder farmers – water management, integrated pest management, better use of fertilizer, integrating legumes, triple-cropping legumes to improve soil fertility – all of these things.

And I think what we're seeing in this report is the beginning of a validation – strong validation of this approach as very, very important to our most important beneficiaries, the small holder farmers in the field. These are going to be special important – especially important technologies to help them deal right now and into the future with the impacts of climate change. So that's one way that this is already proven useful to us. In fact, I've already passed a copy of your report to the administrator.

Second, I think this is the law of unintended consequences, but really the funding from CropLife and IFPRI undertaking this study came at exactly the right time for USAID. We and Feed the Future and the Bureau for Food Security have really put a great focus over the past 12 to 18 months on scaling agricultural technologies. About 14 months ago, the administrator, in an address at IFPRI headquarters, laid out a challenge, said, "The most innovative technologies in the world don't really count until they get out to farmers' fields. So how can we work together, US universities, CG community, and our developing country partners to make sure that new technologies are adopted by farmers at scale?

So in following up to the challenge, we've really been working hard, and IFPRI's been a tremendous partner to us in this area, trying to figure out which countries, what technologies are going to be most important to be focused on, and where are those technologies likely to have the biggest payoff.

And it happens that the modeling – this very innovative model that Mark's gonna talk to us about today is exactly helping us. It's already helping us work with countries and work with some of our partners, like the Alliance for a Green Revolution in Africa, and sit down with countries and say, "Here's what we think could happen with this package of technologies. Here's where we think it's most important to concentrate on _____ and water management." So it's really helping, even right now as we start to think about where do we prioritize our scaling resources and energy. So thank IFPRI and thank you CropLife for that important unintended consequence that's having, I think, already a measurable payoff.

Okay. So now to introduce Mark Rosegrant, and I actually feel like for most of this audience probably, Mark, you don't need much of an introduction. Mark directs the environmental and production technologies division of the International Food Policy Research Institute. *[Break in audio]* CGIAR center *[break in audio]* in Washington. Mark holds a PhD in public policy from the University of Michigan, and I'm a Michigan State person myself. And, yeah, okay, all right. I'm gonna like rush quickly through the rest of this, but, anyway, I hope that we don't end up the Final Four this year. Oh, my gosh. Oh, dear. Okay.

So Mark directs a research portfolio on climate change, water resources, looking at impacts of crop genetics. So all of these things that really are critical in addressing the impacts of climate change. He's the author of seven books and

over 100 referee papers in agricultural economics, water resources, and food policy. So Mark and his work are really at the cutting edge of this multi-disciplinary approach *[break in audio]* natural resources that we're all looking to at the moment.

So we, at USAID and Feed the Future appreciate Mark and his team's work. He's also appreciated by his colleagues. He's a fellow of the American Association for the Advancement of Science, AAAS, and also a fellow of the Agricultural Applied Economics Association. So, Mark, thank you and your team for this work and really look forward to hearing your presentation today.

Mark Rosegrant: Very happy – in fact, wasn't completely an accident this has worked out that we – as we were developing this, we certainly had our eye also on our other work that we were doing with USAID and then support that AID has provided for this kind of work. So I'm glad it has been working out, I think, quite well.

So let me just start out by also giving the attention this was a big team effort. You can see the authors of the report as Julie mentioned, it's very much multidisciplinary, so we have crop modelers, agronomists, plant pathologists, as well as economists in this project. And I think that's why one of the – we take as one of the strengths of the project.

So let me start this with a quick overview of the project. I guess I don't have to tell this audience so much, but we do a lot of work on looking at the future in a form modeling sense. And our analysis shows that these multiple threats that we're facing, including climate change, water scarcity, biofuel demand, which should – is – continues to divert land away from food production as well as significant growth now in income, including now in Africa where there's a very rapid growth in – much more rapid growth in income, which income growth, at least a high propensity to consume more food because in Africa, they're moving from fairly low levels of consumption.

So Africa is becoming now a big driver and also for food demand and population growth is still high. And, again, Africa is the key here. As much as 80 percent of the growth in the world's population between now and 2050 is projected by the UN to be in Africa. So that's another – that's a scary result that shows where some of the need is.

So we think that that is going to lead to continued high food prices, including increased prices from now to 2050, both for cereals, wheats, and other key crops. In addition, the land is – environment is under threat because of the need to grow more food. There's lots of pressure on land, on environmental preservation, potential for significant reductions in forest area unless we can get more sustainable growth and productivity as well.

There's a lot work that's already shown over the years that improved investment in agriculture research leading to technological change is a huge game changer in terms of co-investments and productivity growth. But what we've seen that there's been insufficient work on trying to tease out the – sort of where should that research dollar be allocated. So what we've tried to do with this report is to look at much more disaggregated impacts of specific technologies by country and even below country level. A lot of the analysis here is done at actual pixel level, which I'll describe in a moment. So it can also be disaggregated not only by country, but by _____.

The work specifically is – it's both a global approach, so we do cover the whole world, but we also, of course, cover regions, countries and even some national results. We look here at 11 technologies, and these include, as Julie had mentioned, kind of farming systems or management techniques, such as no-till, integrated soil fertility management, organic agriculture, precision agriculture, and then combinations of inputs and managements, such as crop protection.

We looked at two higher-tech irrigation strategies, drip and sprinkler irrigation, as well as water harvesting. And then we also looked at genetic improvement through drought tolerance, heat tolerance, and nitrogen-use efficiency as additional technologies that we evaluated. The assessment includes three main staples: wheat, rice, and maize.

So just quickly to give an idea of – through these no-till, of course, is using techniques with little or no soil disturbance in combination with tension of crop residues, crop rotation, use of cover crops. ISFM includes a combination, trying to use – not – complete removal chemical fertilizers, but a combination of those of crop residues, newer composting techniques, again, to try to improve soil quality over time as well as yield.

Precision agriculture includes GPS-assisted delivery of Ag inputs. But also we're looking here not only the big high-tech tractors in Brazil and the United States, but lower-tech – lower-level technologies of smaller-scale practices that still do manage to take into account the field parameters from input to delivery to plant spacing water applications.

Organic agriculture is, of course, self-explanatory, without use of manufactured fertilizer, pesticides, et cetera. We look at water harvesting, which is, again, water channeled to crop fields through small-scale or large-scale _____.

Drip irrigation, where you – _____ a small discharge directly around each plant _____. Again, here, this can be not only high technology, but things such as plastic tubing that's used frequently, for example, in South Asia to distribute water. Sprinkler irrigation, again, is both pressure – water distribution through pressure from a pipe network, and, again, both here we're using – talking about both the center pivot kinds of irrigation here in the US, but also smaller-scale micro-sprinklers in developing countries.

Heat tolerance are improved varieties, showing characteristics allow plants maintain yields at higher temperatures. Drought tolerance is – incorporates characteristics that allow plants to have better yields compared to regular varieties. And then nitrogen-use efficiency, where you get more bang for the fertilizer buck so you have higher yields at any given fertilizer use or you can reduce fertilizer use while retaining yields. And crop production, there are three types on pests, plant – and plant diseases, weeds, and other pests.

The modeling is done using primary two link models. One is the VSAT system, which is an Open Source crop-modeling system biophysical model, which assesses impact of technologies or technology mixes on productivity and resource use. And I'll show you in a moment a little more of how that's utilized. And then that's linked to the – IFPRI's impact model, which is a global economic agricultural model which assesses changes in productivities due to technology adoption as well as to a wide range of other investments and policies _____ can estimate food production, consumption, trade, food prices, calorie

availability and various measures of food security. And it solves on an annual basis out to 2050.

It is a very high resolution especially for a global model. It's a 60 by 60 kilometer grid, which is also 0.5 degree or 30 arcminute grids, which – so there's like – the world is divided up into 95,000 grids, of which about 21,000 have rice, wheat, maize and/or a combination of those. We're essentially solving for the impacts of these technologies in each of these 21,000 cells where the crops exist.

We start – we compare the technology scenarios with a business-as-usual scenario, which, broadly speaking, continues rates of investment from what they have been in the last decades but also updated with what we know of plans for future investment in agriculture research and irrigation policies, such as biofuel mandates. You can see there some of the characteristics of the business-as-usual scenario. So we start essentially the levels of fertilizer existing now, but with some trend growth ____ irrigation and existing planting density and planting windows, conventional _____, etcetera.

The technology scenarios then, we go into the VSAT model and tweak the various parameters that are affected in this crop model to represent the changes that are brought about by the technology scenario. Then we also look at rates of adoption over time of technologies based on yield and profitability of those technologies.

We look at two different scenarios – climate change scenarios to make sure that the results aren't driven by just the climate change scenario. The one I'll show here is Maroc A1B Scenario. And that's about a – was considered a fairly high rate of climate change during the IPCC course assessment. It gets about a 2 to a little bit more than 2 degree centigrade change in temperatures between 2000 and 2050. That's probably now a relatively low level actually, or low to moderate level based on current _____.

Just an example – we don't have time to show, of course, all these different technology specifications, but just to look here at the drought tolerance to give a sample of how we do these interventions within the VSAT model. So drought tolerance is a model with a combination characteristics, first off increased root volume, which show we increased the root growth parameters within the – each

of the crop representations. And we have – had root water extraction capability, which is implemented by decreasing lower limits of available soil and moisture parameters, allowing them to access additional root water.

And then for maize, another important parameter that's _____ on is reduction in the – what's called the ASI or the antithesis to silking interval, flowering to silking interval, which is the period in which maize is particularly susceptible to drought. So we implement that by having change in the _____ to implement a lower level of sensitivity to growth.

Results are then taken from the VSAT model. Our – again, we can – there, we implement the technology strategies and these highly differentiated yield effects. Then, we plug in the changes in yields over time from that VSAT model into the impact model, so you shift the rate of exogenous growth in crop yields to represent the technology change and then can estimate over time the difference in the economic outcomes due to that technology intervention in the impact model generating _____ supply and demand, trade, food prices, and food security, malnutrition as well.

So let's move on to some of the key results. Again, we have to show these mainly at a fairly aggregate level, given the time, and the book shows a much more detail geographically as well. Let's look at first then at the global results. So these are from the crop modeling. So these are the potential increases in yield based on the physical changes in the crop model that are introduced by the – by these technologies _____ showing here maize, rice, and wheat.

We start out – important one to point out is drought tolerance, which looks fairly modest here. You get a 5 percent higher average yield of maize in 2050, 6 percent for maize, 2 percent for rice. Important to point out, first of all, that's actually a positive fact that it's a positive value at all. A lot of previous analysis has thought that you would actually get an average lower yields from drought tolerance varieties than you do from standard varieties, because you're giving up a little bit of yield potential for the drought tolerance, but our results don't support that.

And moreover, it's worth noting that these do represent average climates that we're dealing with. So we've run the drought tolerance. Also, with simulating

drought scenarios, maybe get as much as 20 to 30 percent higher yields using the drought tolerance varieties than you do the – with standards susceptible variety. So you get significant – you get higher average yields, but significant protection for drought.

Heat tolerance comes out as very important, especially, of course, for maize and wheat, and that's, of course, probably because of climate change. These counterbalance a lot of the negative impacts of climate change if you can implement them effectively. Integrated cell fertility management is also one of the very substantial improvements. Nitrogen-use efficiency, especially for rice, is high, but also very substantial for maize and wheat.

No-till – I guess if I have – if there was a surprise to me the high level of impact of no-till would probably be the biggest surprise, 'cause we looked at it – this is because in our implementation of this, we do assume that you were maintaining this practice throughout the time period. So it's essential, in fact, that you do that, that it's a long-term practice. It can't just be while you do it for three years and then farm policy changes so you plow under. So you --- a lot of that yield impact is lost if you end up using no-till just intermittently. So it really is important that it's maintained

Precision agriculture came off as very positive. And we find it has significant potential in South Asia and parts of Africa as well. And you're, in fact, seeing precision agriculture already moving in _____. I think that's a story that – five years ago, people would tell me, "Why would you even think about precision agriculture. It's never gonna happen _____." Well, it's already happening. And my guess is *[break in audio]*.

The next three – the irrigation scenarios don't end up having major impacts on yields, but that's because in the assessment we do, the main outcome turns out to be a saving of water in the given unit where _____ analyzing rather than a yield increase, and I'll touch on that in a later slide. Organic agriculture actually comes up as negative. Didn't show on the scale here. There is a yield penalty from the analysis we've done and confirmed by the literature ____ special literature review that you are going to pay a price if there's yields for these three crops from organic agriculture.

Crop protection again comes off as a very strong, positive _____ disease, insects, and weeds all have substantial gains across the three crops. And if they're implemented on an integrated basis, we'd have then very substantial increases across these crop protection options. Yeah, sure.

Male 2 _____ these are average across the entire area –

Mark Rosegrant: Yeah.

Male 2: – _____.

Mark Rosegrant: Yeah. These are – yeah. And we do have maps. I think they're in the annex to the report. We have maps that show at the pixel level where things are happening. And we also have – for example, here, we broke that down at least by a number of regions. So, again, here, we're just looking at three of the technologies – nitrogen-use efficiency, _____, and no-till to get an idea of where some of the big impacts are.

You can see that Central America has a very substantial impact. It's an area where there's a lot of relatively poor practices and low yields. But, overall, you're also seeing in Africa, the African regions – North Africa, Southern Africa, in particular, very large potential increases from these ___ technologies, probably not surprising given the relatively low level, but I think it was a very important confirmation to us as well.

Other regions that was – ____ substantial impacts ____ at least for nitrogen use efficiency and no-till, for example, is South Asia, West Asia is also – has a very substantial yields _____. North America, in there we see – as you can see, there is potential for substantial yield gains from these technologies.

Looking also then – let's look at drought tolerance, heat tolerance, and crop protection. _____ here. See, again, this in terms – drought tolerance is

relatively low. The averages are somewhat higher in outer regions, such as East Africa and West Africa.

Heat tolerance is strong almost everywhere except in parts of Europe. And, again, we see very substantial impacts in North America, and that's partly because of – in this climate change scenario, we see maize gets hit very hard in the _____ in particularly with very negative impacts on maize yield. So the heat tolerance helps counterbalance that negative impact on crop yields. South Asia, again, has a very large increases in yields due to heat tolerance, again, which makes sense, again, given the impact of climate change in South Asia. Many others, as you can see, have substantial impacts.

Crop protection again is very solid across the board. Again, Africa and Asian regions do particularly well in terms of percentage increases.

So let's get back to the issue I mentioned in terms of first on impacts on nitrogen use. So we looked not only just at the yield impacts, but, where feasible, we looked at the impact these technologies on nitrogen use efficiency. In a moment, I'll show you water results.

And here, we're looking _____ nitrogen use efficiency and the no-till option. And here, you see that these not only have significant yield impacts, but also are very positive impacts in terms of saving of nitrogen. So, again, the no-till comes off as very strong. Just an example of how to interpret this with irrigation ____ wheat, so implementation of no-till would save about 29 percent of water and 29 percent more nitrogen according to _____.

Okay. So and you can see also substantial improvements in nitrogen-use efficiency, which you'd expect, obviously, but perhaps even more effective than we thought it would be when you implement the genetic gains in nitrogen use.

Also, look at the efficient use of water resources. And here, you can see where the big impact of drip and sprinkler irrigation come in here rather in yields – crop yields per se. We show here for each of them for maize and wheat, the results for sprinkler and drip irrigation with under lower and then somewhat higher levels of water – of rainfall. As you can see, the results tend to be somewhat higher under

low rainfall, which you would expect, but it shows that they do provide protection against shortfalls.

Again, both drip, especially, but also sprinkler irrigation saved very substantial amounts of water. Of course, this is water that, then, could be used either elsewhere in the agriculture and irrigation or for the rapidly growing use of water in domestic and industrial uses.

Let's look here. This – okay. This one summarizes then taking into account yield but also taking into account changes in area use that are introduced by _____. For example, when you do that yield shock, you increase yield – you increase – so, initially, you reduce prices somewhat, and that results in somewhat less use of area. And then there's an equilibrium process over time.

But you end up then with a total production as you can see worldwide of very substantial amounts. And this also takes into account the economic modeling and the rate of growth and adoption of each of these technologies. Again, the same ones tend to be near the top – nitrogen use efficiency, no-till, precision agriculture, heat tolerance, but also then very substantial gains from combination of crop protection technologies.

In terms of impact, here looking first at maize, and then you – this compares the world price in 2050 under technology adoption where each of the technologies is compared to that baseline or business-as-usual that I talked about. It shows you some of them have fairly small effects on prices where the yield impact is not as large, but that you get then significant results from the individual technologies, again, with the highest yield impacts, having the highest affect over time on world prices as well.

Similar effects for rice, here in nitrogen-use efficiency is particularly powerful impact on rice, but also you can see integrated soil fertility management, precision agriculture, heat tolerance, and crop protection coming in strong, so they help reduce those high prices that I mentioned. Wheat, again, the story is similar, somewhat different ordering, but you can see _____.

I think what's most important is not what happens when you implement one technology, but what happens if you are able to get broad-based adoption of all of these technologies. And this – take one of the _____ no single technology's gonna solve things. Some have bigger impacts than others, but what we really need is an effort that would get significant adoption of the – of all the technologies.

And this shows that you get very large impacts on world prices by adoption of these technologies – over 40 percent lower prices in 2050 compared to the projected 2050 prices for maize, about 40 percent for rice and a little over 40 percent for wheat, so very large – positive impacts for poor consumers. Farmers are – adopting farmers also come out fine in terms of our analysis because the growth in productivity they have outpaces the changing prices, so they still end up with net higher profits under the technology ____.

The other very important factor to note is that adoption of these technologies would greatly reduce the pressure on the land base, because when you're getting the higher yields on existing areas through more sustainable intensification, you don't need to move out. Farmers don't have to move out and plant in fallow areas or chop down forest to _____ so you get significant, again, price – reductions in land area under each of the three crops due to these – adoption of these technologies.

Also going on to what happens in terms of the population at risk of hunger in developing countries. Again, this is 2050 with technology versus 2050 baseline. And here, again, you see about the same ranking, of course, in terms of the impact on population at risk of hunger. But, again, you can see that some individual ones are quite high – others more modest. Overall, though, you get – again, you get about a 35 percent reduction in projected hunger in 2050 compared to the baseline. So it's not just a matter of prices or physical crop yields. You're getting very substantial improvements in food security from this technological portfolio.

Let's just sum up what some of the key messages are. First as we saw, the adoption of these set of technologies significantly reduces projected food prices compared to the climate change baseline. As I mentioned, farmer adopters do increase real income because the technological change is more rapid than the price decline that's projected. We have a 40 percent reduction in the number of

people at risk of hunger 2050 compared to the baseline. This is considering these combined technologies under the feasible adoption pathways.

Some of the individual crops improve management technologies, including no-till, precision agriculture, ISFM, as we saw some of the leading technologies large impacts across many regions, but particularly a high level of _____ in Africa and South Asia.

Nitrogen-use efficiency came out as a very strong, positive technology, not only with yield impacts, but through reduction of the negative environmental impacts from fertilizer usages. It reduces the greenhouse gas emissions substantially as well as run-off of fertilizer use.

_____varieties, again, they proved to be effective in terms of _____ climate change scenarios. Drought tolerance, as I mentioned before, as well as susceptible varieties _____ with significant yield benefits under drought conditions. Crop protection has strong, positive yield impacts as well. And technology impacts are higher with irrigation. One thing we didn't show in the slides is that when you compare impact of other technologies with rain conditions versus irrigated conditions, these impacts are invariably higher under irrigated conditions, where you have more control. Beyond the high-tech irrigation I mentioned, there are irrigation *[break in audio]* has a positive impact on _____ in terms of producing better, higher impacts _____ technologies.

We saw the large regional differences in agriculture technology impacts. Some of the _____, for example, heat tolerance in North America and South Asia, drought tolerance to Latin America, Middle East, and North Africa, South Africa crop protection came out high _____ South Asia and Eastern Europe.

We did find it's not – organic agriculture does not come out as proved strategy for these three crops. There's a lot of evidence that there are niche markets for high-valued wheat and rice, particularly around major cities and developing countries, but it's not a strategy to pursue for broad-based ____.

So, overall, given natural resource scarcity, the technologies _____ reduce resource use are – come off as particularly important that they have both high-

yield impacts and resource use reductions. That includes no-till, integrated soil fertility management, nitrogen-use efficiency, precision agriculture and for the resource uses, drip and sprinkle irrigation as well.

So that, again, just summing up, obviously, we found very positive food security impacts for all the Ag technologies. But _____ USAID as well as what IFPRI trying to work on is how do we get these scaled up and adopted. And I think that's the next step is to try to translate these findings and more detailed findings that are also available in the report to try to look at targeting where and how to upscale these different crops.

So, again, thanks also *[break in audio]*. CropLife International was the primary funder. We also got some money from the US State Department and also from the CGIAR research program on _____ institutions, markets and _____ great inputs from the advisory panel as well, so thank you very much.

[End of Audio]

QUESTIONS AND ANSWERS

Julie MacCartee: Thank you so much Mark. That was very interesting and we have a good amount of time now for a Q&A and discussion session. And also just to point out that we have 74 participants joining us online, which is really fantastic. So thank you all for joining us on the webinar. We'll alternate Q&A between our webinar audience and our in-person audience and when you ask a question or make a comment, we just ask that you state your name and organization and also use the microphone. And I think it works a little bit better if you kind of angle it towards your mouth, rather than hold it up and down like this. Microphones are tricky. So are there any clarifications?

Adam Schrengost: Yeah, that's a really good point. If you could just please hold the microphone close to your mouth. I know it sounds great here in the room but this is mainly for the webinar participants. Thank you so much.

Julie MacCartee: Thanks Adam. All right. We have one back here.

Barry Hofman: My name is Barry Hofman. I'm with the Bureau of Food Security USAID. I was just curious, in this study, could you explain to me the definitions that you used for precision agriculture and organic agriculture? I just wanted to know exactly what you meant by those.

Mark Rosengrant: Okay. Let me go back to the start here. Make sure I say it right.

Audience: *[Inaudible comment]*

Mark Rosengrant: The question is how we defined precision agriculture and organic agriculture. And I can refer you also to the slides. So precision agriculture is GPS assisted delivery of agriculture inputs, with respect to measurements of the field. So you tailor water, the water applications, to where there's less water within your field profile. You use sampling of the nutrient levels to get at how much fertilizer you should put in, and so forth. But we're not saying it has to be the large-scale tractors that, say, the US has or Brazil has.

There's already developing so much smaller scale tractor systems and GPS systems, even handheld, that help you target some of these in developing countries. So we're not expecting sort of a leapfrogging of, say, a small farmer in India, to a full large-scale system, but with various kinds of intermediate technologies, but that do these kinds of assisted GPS assisted delivery. Organic, so its cultivation without the use of manufactured pesticides, fertilizers, growth regulators, or GMOs, as well.

Barry Hofman: Now in the organic agriculture, are there other inputs that are added to those crops versus the conventional crops that are grown with, I mean –?

Mark Rosengrant: Yeah. So what we do, we take the profile of the existing organically managed rice, wheat and maize so that it has manure compost residues and so forth as well, as well as it has a higher use of labor also in management of the crops as well.

Barry Hofman: Thank you very much.

Marisol Pierce-Quinonez: And we've got a question from online. This one is from Robert Navin, USAID Africa Bureau. "Increasing yields are necessary but not sufficient. Have studies conducted financial analyses, such as cost-benefit analysis, to see what is profitable for different sizes of farms?"

Mark Rosengrant: You're saying, did we do it in this particular study?

Marisol Pierce-Quinonez: This one just says, the question just said "studies". So if you know of any –

Mark Rosengrant: Yeah. That's essential, as well. We weren't able to do detailed cost-benefit studies for each of these. So we did do it in assessing the adoption pathways. We had broad estimates using expert judgment of the profitability by region of the different crops. But that would be another step forward, I think, in terms of the scaling up process, then get an additional handle on the exact cost-benefit parameters within a given locality, for example, in Africa.

Ravic Nijbroek: Thank you. My name is Ravic Nijbroek. I'm an employee with Conservation International. I work for Vital Signs. It's a project that looks at sort of the trade-offs between agriculture intensification, ecosystem services, human well-being. It's nice to see the decent models being used so widely now. I did my Masters in 1997 on this and so it's really nice to see this. But my question is, sort of on the model used, I'm not sure if you could do this at the scale that you work, but its two parts to the question.

Were forested areas and critical biodiversity areas included in the sort of suitability for crop growth and yield increase? And the second part of this is, were you able to use the models and perhaps tweak the variables a little bit to show that, especially water and pest management, would improve due to the ecosystem benefits from forest areas, so that you could show the importance of sort of natural areas and keeping natural areas and that they're an important part of sustainable intensification? Thanks.

Mark Rosengrant: Okay. Great questions. Yeah, we explicitly excluded any kind of forested

area or park area, I think, from the suitable areas for production, so that our null hypothesis, we wouldn't go into those. In fact, as you see, the results show there's savings of anywhere between 20 to 30 percent of cropped area under these technologies _____. So that there is no encroachment in the analysis on, say, forested areas. We don't have that particular analyses.

We're doing some work now with the ICRAF, the International Center for Agroforestry with headquarters in Kenya, on whether we can't use the farming system approach in more detail to get at those kinds of linkages that where better management of forest and agroforestry can affect also the yields. That's not part of his particular report. Thanks.

John Waugh: Hi. My name is John Waugh and I'm with Integra. And I'm staggered by the amount of work that you've put into this. It's a really interesting study. And I'm sorry, I didn't get a chance to read it in advance, but a cursory glance didn't really, I couldn't find very much information on the assumptions that you made about the impacts of elevated CO2 levels on agricultural productivity, and also on weeds.

Mark Rosengrant: Yeah. So we do have the CO2 impacts are embedded in the – sorry, on crop yield – are embedded in the climate change scenario. So they're within the baseline scenario that they're included, but we don't have the impact on weeds. And that's another area where I think needs a lot more work, is looking at the impacts overtime of climate change, not only on weeds, but on pests and diseases. The data isn't out there yet where we thought we could implement it in this phase. That's something that I think would really be an extremely important additional step in this kind of analysis.

John Waugh: Well sure. I would refer you to the work of Luzisca at the Agricultural Research Service as a good place to start on that.

Mark Rosengrant: Yeah. That's a good point.

Mark Rosengrant: He was doing great work.

Julie MacCartee: All right. We'll run over to our online audience and then I'll get you next.

Marisol Pierce-Quinonez: This question comes from Agatha Sector, a natural resources officer at USAID Senegal. "Were estimated adoption rates used in the model? No till technology has been around, but not easily adopted, for a variety of reasons, including labor costs, a lack of understanding." And then the question was seconded by Philippe Shaboe, who asks, "Can the presenter talk a bit about the transferability of no till? This is a system usually used

with large machinery. How easily is this transferred to small holder systems?"

Mark Rosengrant: Yeah. It's not really easy. There is, though, now a number of initiatives on the way to use no till with smaller scale, with hand tractors or much smaller tractors. And I think AID may be exploring some of that, but I'm not sure. So it's not easy. And we have the adoption rates of no till under the... I mean, they vary a lot by region and I think the highest rate of adoption we have is about 40 or 50 percent, I believe, in some regions, but I'd have to double check that. So we did take into account the difficulty of adoption of the different technologies. But on the other hand, we don't feel that necessarily what's happening today is the final story on that. That there is potential, there are things going on to improve the extension of these technologies.

Julie MacCartee: All right. We'll get a question back here.

Rob Nooter: Thanks. I'm Rob Nooter with the International Fertilizer Development Center. I was pleased to see the results you had for ISFM and NUE technologies. Those are things we've been working on. One that you didn't study is the use of urea or fertilizer de-placement, and we have found with our work in Bangladesh, in particular, on rice, this to get very positive 20 percent increases in yields and so forth. And we're now looking at compound fertilizers on upland cereals, and that's showing also very positive effects. Did you look at that at all or is there any way to start to incorporate that into your thinking here?

Mark Rosengrant: That's certainly something we could look at. I mean, with resource and time constraints, we couldn't hit every technology, obviously. But yeah, I've seen the literature on your work and yeah, it looks like, what I've seen is very positive impacts as well. We haven't done it here.

Julie MacCartee: We have an online question?

Marisol Pierce-Quinonez: Yes. There was two sort of technical questions. One, from the Sahel office, a regional agriculture specialist from the Sahel regional office in USAID Senegal. "In dryland areas, are there specific cover crops that are adopted that don't compete for resources with commodity crops? Or are there other available technologies, like mulch, that might be more successful?" And the second technical question is from Solomon Full. "Nitrogen is the focus of the fertility management in the presentation. Why was phosphorus not included?"

Mark Rosengrant: The second one, again, is really just a resource issue, that we focused on nitrogen there. I mean, phosphorus is obviously a big issue as well, and

with significant concerns, obviously of shortages or much higher prices of phosphorus in the future. I just, again, we weren't able to do everything here. The cover crops, again, were not directly modeled when we modeled a scenario, such as _____. So fertility management, the assumption was that the availability of crop residues from the crop produced there, as well as composting from row crops that combined with those technologies, but we didn't, say, do a complete modeling of mulching or rotation systems.

John McRuddy: Hi there. John McRuddy. I'm also from the Bureau of Food Security at USAID. I have two questions. Maybe the first question would be interesting for folks to hear. It's kind of more general. What was kind of the process for prioritizing which technologies you included in the study, which were in and which were out? And the second was kind of a more specific question. I saw in the presentation discussing the impacts of no till, it was very heavy on wheat and maize but no impact on rice. It wasn't something that was not included or just all of this work on direct seeding and rice didn't come out to be beneficial, which is scary for what everyone's doing in South Asia? Is it worth it or not?

Mark Rosengrant: Yeah. We didn't look at the combination of direct deeding with no till. I guess we didn't visualize that as a completely – yeah, sorry. Perhaps we should have. Yeah. So this is not an evaluation of direct seeding, what we have here. I mean, in terms of the overall, I mean, a lot of it was due to expert judgment, discussion within and with an advisory panel, as well as to what we thought would be the higher potential technologies, but we also wanted to get a range of technologies that included, not just sort of high science technologies, but also farm-based cropping systems as well.

So we wanted a range of types of systems, or ones that seemed to have significant potential as well. So by nature, it's limited. We could do a lot more of this, but if you want to send us another grant. I think there's a lot of potential for several questions here that already indicate the potential for additional work that could be done along these lines.

John McRuddy: And so, I guess just a follow-up question, and this is a question – I guess, partially for you, partially for CropLife, the funders, whomever – what do you view as some of the uses of this kind of work? Is it working really to kind of push this information out to post country governments? I mean, certainly people like us, speaking for the USAID folks, benefit tremendously, but sort of other areas where you want to kind of utilize this information to drive changes in behavior?

Mark Rosengrant: Yeah. I mean, we're looking both at sort of the international organizational levels. We're making a number of presentations to World Bank, the UN agencies in Rome, a number of major conferences around

the world that bring people and private sector together, also. So we're also reaching out to the private sector. And we also plan to get these results out. In fact, we're already doing that in some of our projects at the country level in the developing countries.

I mean, it would be great, for example, to take up a lot of these results in the technology platform, work we're doing with AGRA. So we see that as a very natural extension in providing parameters for where potential technologies are. And so target areas for actual case study approaches then to take in is the next step to scaling up.

Marisol Pierce-Quinonez: This question was asked by two folks at Peace Corps, actually. Kevin Feth, a volunteer in Jamaica, and Daniel Stoermer, a Peace Corps food security program assistant in Senegal. "Which of these adaptive technologies are most easily adopted by small holder farmers? Of those that have, or likely will have, a slow rate of adoption, what approach, or which actors, do you feel diffuse the innovations best?"

Mark Rosengrant: That's a great question. I mean, the easiest ones to adopt, the ones that are developed, are the improved seed varieties, and that's things like drought tolerance, heat tolerance, and nitrogen use efficiency, because they're embedded in the seeds, so essentially they're turn-key technologies. But then of course, the constraint there is getting these technologies to develop for the conditions in developing countries. And there is, I think, encouraging work going on in Africa and through many countries in Asia, to bring sort of characteristics of, say, heat tolerance and drought tolerance, and adapt it to the background varieties that have the highest potential in the individual countries.

So I think heat tolerance is already being tested – sorry, drought tolerance – is being tested in a number of countries, in developing countries, and I think significant improved varieties will be available in the next 3 to 4 years. I think nitrogen use efficiency and heat tolerance are a little bit further down the line, but the progress is very substantial. So once those are available, rolling them out is relatively easy, assuming that you have decent seed systems. And of course, that's another area that has to be worked on, is appropriate improve distribution systems in developing countries. I think we heard already, there's concerns about no till. I think, again, that needs to be better adapted to local regions, local areas, but if those technologies can be adapted, it could be relatively straightforward.

Precision agriculture, again, it needs some development to get at the, you might call, low-tech precision agriculture. The other aspects you're seeing is in parts of Asia and Latin America, is that you're seeing consolidation of farm management sizes. Not of farm holdings, where you still have small

holders owning the farms, but you're seeing increasingly that the farms are organized at somewhat, are managed at somewhat higher level, higher farm sized, and then contracting out services like, for example, in India, laser land leveling is being done on contract basis, as well as various kinds of plowing services. But again, some adaptation is necessary. Let me see what else we got here. So again, all of these will need some work.

But several of them, I think, are ready to move out fairly rapidly. But you do need to work in the local regions. And I think, in terms of who can do it, I think extension systems in many of the areas we all work in, the public ones are essentially broken. So I think you need to do a much more combination of work with NGOs that are working in specific areas, to some extent with private companies that have an incentive to promote, for example, improved seed varieties. They've been effective in some regions. And you're seeing, I think, some useful partnerships between private sector and NGOs in regions as well.

So I think, obviously it's a complex thing to roll these out. The other things you need to do, of course, is to improve rural infrastructure investment in many of these areas, such as in Africa, to improve access to markets and to these kinds of technologies and inputs as well. So it's, obviously, a complex process. But again, I think most of these technologies are on the way to being adapted or are already adapted to developing country situations, and can be moved out.

Julie MacCartee: Question back here.

Jeremy Foster: Hi. My name's Jeremy Foster with the energy division at USAID. Thank you very much for sharing the findings. I also have a question about the next steps in terms of adopting strategy. I'm very interested about the energy inputs and the costs associated to that with adopting new technologies. And outside of irrigation and water harvesting and pumping, from your own experience, where have you seen those technologies that you think will require the most, or are most energy intensive, and will require the most energy inputs?

Mark Rosengrant: Interesting. I think that the areas where you'd have to look at trade-offs would be things like precision in agriculture, or are there gains, for example, in the reduction of input use, like nitrogen enough to balance, say, increased use in machinery? So I think those would be where you have to look at where the net, what would be the net energy use equation. And then of course, you have to trade that off with what are the other benefits in terms of yields and so forth. But yeah.

I think those would be the ones where you'd worry the most about the energy balance. Several of them, I think, are very much oriented towards

improving the energy balance, so we didn't look specifically at that. The nitrogen use efficiency, for example, where you could reduce very substantially the nitrous-oxide emissions, if you can get that right. Crop protection.

Again, we're looking here across the board, not chemical crop protection, but also integrated crop protection, so I don't think there's necessary the significant energy build to that. So I think most of these are either positive or neutral in energy, I guess, I would say. But again, we didn't study that specifically, except for a couple of technologies.

Julie MacCartee: Back over to our online audience.

Marisol Pierce-Quinonez: This question comes from Jamie Montgomery, USAID Climate Change Advisor for DCHA Bureau. "How did the model take into account the appropriateness of different technologies and different regional contexts? For example, the irrigation technologies discussed may not be as effective in some regions due to the level of operations and maintenance required?"

Mark Rosengrant: Right. Well yeah. So we did analyze them at this 60 km x 60 km level. So we took into account water balances in those regions, initial input use in each region, as well. So we did account for that in the basic analysis using the crop modeling, as to what are the actual conditions in terms of weather, soils, current fertilizer use, et cetera. The work on costs are embedded in the assessment of the adoption pathways.

Julie MacCartee: A question over here.

Pace Lubinsky: Yeah. Hi. Pace Lubinsky from USDA. Mark, congratulations to you and your team on this study, and thank you to Crop Life and USAID BFS for supporting such important work. I have two questions, both I think folks have touched on in the Q&A and you've talk to a little bit. The first question goes back to this question of adoption, and from my understanding, adoption of new technologies in Africa has been a challenge ongoing for many years, going back to the Green Revolution.

So my first question is, what's different now if Africa's going to be adopting some of these technologies? Are you optimistic right now that this time around will be different? And then the second question is regarding the potential in Africa for transformation in terms of going from small holder farmer to, perhaps – and you touched upon this earlier – to, do we really expect Africa to have 70-80 percent of its folks involved in agriculture by 2050? Or do we also see a trend where there may be fewer small holder farmers in the future? Thank you.

Mark Rosengrant: Those are great questions. I guess I would say I'm cautiously optimistic on the future of technology adoption more broadly in Africa, than say 10 years ago, partly, I think, because the African decision-makers and policymakers have taken ownership of the need. I mean, there's one positive impact, the Cata process, I think it's been developing a political commitment to some of these kinds of these technological changes that are necessary. It's not an easy process, so I don't want to just say, jump up and down.

It's going to be great. I think there's reason for hope and I think the recent round of work with AGRA and others have, I think, demonstrated more realistic approach to the need to fine tune recommendations to very specific regions. I think the Green Revolution kind of foundered in Africa because of the huge multiplicity of aero-climatic and weather zones in Africa, compared to in Asia and parts of Latin America, where it was really successful. Those were relatively homogeneous growing environments in Asia, so that a few different varieties of rice or wheat could do very well, very fast. When you didn't get those quick gains in Africa, people sort of, things sort of fell apart, in terms of the adoption of that round of technology.

So I think in this newest phase, we need to, again, look at much more disaggregated technologies, as we've done here, but even from what we've done then has to be taken down to another scale locally to confirm that the viability. So I guess a cautious optimism, but it's not like an easy thing. I think it's moving forward. I think the small holder question's a great one. I think, and perhaps we've spent too much time extolling the small farmer these days. I think over time, farm size is going to increase, if not the ownership size, as I already mentioned, it's happening in South Asia and I think it's going to happen in Africa, the operational holdings are going to increase over time so that you are going to see use of somewhat larger scale technologies than you're seeing today.

Labor wages in Africa are very high in many regions, so you're already seeing a high cost of labor-intensive agriculture in Africa. I think there's going to be a movement, partly because of that, again, for a little bit of consolidation, a little bit more mechanization over time. It's not going to happen overnight but I do think, as I think you're implying, that there is going to be change in that. And the overall transformation is definitely happening. You're going to see, like in Asia, a shift of population employment and share of GDP to non-ag sectors over time, but there's still a long way to go on that too. But that's definitely happening.

Julie MacCartee: Mark, I want to make sure that everyone is aware, fully, of the Agro Tech toolbox, and how they can experiment with the data themselves.

Mark Rosengrant: All right. So yeah. Together with this analysis, there is a tool that's been put on the website, which I don't have the link to, but can I send it to you and you'd be able to get it to the people? You also can look on the _____ website under the, I think it's currently under our Harvest Choice website within a subheading for the Agro Tech toolbox. And that actually presents these results at the pixel level so that you can go in and look at, if you want to look at this section of Tanzania, you can see what the results were for this region in Tanzania to look at those in more detail. Yeah, thanks for bringing that up. I should have done that.

Julie MacCartee: All right. I think we have another online question.

Marisol Pierce-Quinonez: Yes. This one comes from Samuel Letterman from Biovision Foundation based in Zürich, Switzerland. "Beyond the negative or zero impact on yield outlined earlier by Mark with organic agriculture, it seems to be missing as a technology in further slides of analyses and also the online model. Since organic agriculture tends to be a hot or heated topic, I'd be interested in asking Mark whether or not this decision with an easy one to make since the data is quite congested or generally lacking?"

Mark Rosengrant: Which decision? Sorry.

Marisol Pierce-Quinonez: The decision to include organic agriculture.

Mark Rosengrant: Yeah. As you said, it's a hot topic, so we wanted to see if our analysis would show positive or negative impacts, and it came out negative. Given that the impact on yields is negative, there was then no point in analyzing an adoption pathway, a large adoption pathway, because, in general, it's not going to be adopted on a broad scale.

It will only be adopted where you have niche markets that afford a much higher price for organic products, as you see in United States, Europe, and now very selected areas in developing countries. So it wasn't logical then to say, oh you're going to have a 50 percent adoption of this technique that results in 20 percent loss of yields and incomes. So that's why then it wasn't appropriate to then carry that through and say that there is an adoption, and so forth.

Julie MacCartee: We've got time for a couple more questions. I saw hands here. You good? All right. Great.

Linda Staheli: Linda Staheli with the Global STI Consulting. I'm interested in this as you look at building global science technology and innovation collaborations. How – again, back to the question of scaling this up –how are the

challenges in terms of getting buy-in from stakeholders, and where are the NGOs, which organizations, globally, are working on this and how do you see the funding of this scaling up happening? Is it possible that governments could work more collaborative and proactively to do this?

Mark Rosengrant: Yeah. I think that's really the way it has to go. Again, I think we're now working in five countries in Africa on a related project, again, that's a USAID funded project on looking at a science platform where we're developing in each of the countries, basically, in trying the capability of doing somewhat simplified analyses along these same lines, but that would be available then in the different ministries involved in those countries.

That, I think, would be a very good to expand more broadly. We think we might be able to do that much more broadly because of the new funding AID has also provided to AGRA to try to look at scaling up for these technology and the other technologies on a much larger scale in other countries. So it's going to take just a long-term effort working directly with countries.

I think my impression is, the scaling up strategy has not yet been defined enough to bring in, let's say, in this region we're going to work with CARE or that region were going to work with Oxfam or Conservation International. But I think those are the next step, is to get that kind of partnership as well. I don't know, John, do you have any more knowledge on those, or anybody else, on the AID, AGRA work and so forth?

John: See me flop around a little bit in this answer. It's certainly hard to generalize on kind of the types of partners, because it's tremendously different depending on the particular commodities we have. For example, the real effort of AGRA is on seed technology. So in the case where they're really looking hard at maize, it's very much a partnership with kind of the small private sector.

Those are their big partners providing support to make sure you can get good seed production of mostly hybrids, but also open pollinated maize. When it comes to the more kind of more orphaned crops, so working on a lot of legume crops, then it's certainly a broader group of stakeholders that they're working with to get those out. Certainly the NGO community, the public sector that's in some of these focus countries for scaling.

Audience: *[Inaudible comment]*

Female voice: Hello? Okay. So I'm just interested in this as a model for potentially other sectors. And I just lost my train of thought. So at AID, I understand that you’re in the – oh, the timeline. I was curious about the timeline. Do you

see this happening in the next two years? This sort of global scaling up? When are these seeds going to be ready? I'm curious. This is probably more a question to the speaker.

Mark Rosengrant: Well I think some things are ready. I mean, there are some drought tolerant maize varieties ready now in developed forests, typically African conditions, that I think are scalable. What exactly the adoption pathways would be in the next two or three years, I'm not certain, but again, there are partnerships to produce the seeds, high-quality seeds, and distribute them. There still has to be, I think, a lot of information campaigns and demonstration, use of demonstration plots and so forth, to show the effectiveness of these. But I think it's ready to scale up. It's not something that happens overnight.

John: I mean, I think Mark's exactly right. It's not a binary thing. When it comes to, for example, the drought tolerance or the heat tolerance, we're kind of making sort of small steps year by year and getting materials out there. Slightly more drought tolerant or slightly more heat tolerant. So it's not yes or no. It's just to make that faster. Yeah.

Julie MacCartee: Back to our online.

Marisol Pierce-Quinonez: Just one quick clarifying question. Mark, you were mentioning some countries that they were scaling technologies that were happening. Can you specify which countries you were referring to?

Mark Rosengrant: Let's see. I mean, certainly India is doing quite a bit along these lines. It's not that they're being necessarily pushed, but the private sector there and the ag sector is critically, in the Punjab area, for example, or some of the advanced rice areas in the South, it's really private farmers and working with extension agents as well, are moving forward with some of these improved seed varieties and some of the more advanced technologies as well.

There is some movement now in adoption in, where I would specify, I think Tanzania and Kenya are moving a little faster on some of the, for example, looking at the drought tolerant varieties. Some parts of west Africa, like Burkina Faso, have moved forward on some of the crop protection issues as well. Let's see, where else? South Africa, the Republic of South Africa, is well ahead in some of these areas compared to some other parts of Africa. So I guess those would be some of the key ones. On irrigation technologies, Morocco and Tunisia have moved forward as well.

Marisol Pierce-Quinonez: And then I've also got a couple quick technical questions. The first is from Steve Lynn, an independent agribusiness consultant from Brattleboro, Vermont. "Is the suggestion that drip irrigation is appropriate to cereals? I have only seen that use with high-value horticultural crops?" And then the second one is about millet and sorghum. "They are very important dryland crops. Are there any plans to look at these using your methodology?"

Mark Rosengrant: So could you say the second one again?

Marisol Pierce-Quinonez: It's about millet and sorghum, and whether or not those will be part of your methodology.

Mark Rosengrant: I mean, the second one, I mean we'd love to extend this work. We don't currently have the resources to do it. We are working, though, with... Actually we are doing some separate work with ICRISAT using similar kinds of analyses to look at, specifically, at some of their millet and sorghum varieties. So yeah. So I correct myself. We are, in fact, doing a similar analyses for that. I think some of the results would be available by the end of the year on millet and sorghum. Yeah.

There's highly selective use of drip and sprinkler for these field crops, as well. I agree that, in general, the biggest impact is going to be on high-value crops and the biggest adoption is going to be there in very dry areas and second seasons. For example, in Asia, you do see sometimes the use of these relatively low-cost, plastic pipe tubing used to deliver water, for example, along furrows in maize or wheat fields. Again, it's not the high-tech kind of sprinkler or drip irrigation, but you are seeing some expensive use of that in quite dry areas for these kinds of crops.

Julie MacCartee: I think we'll take two more in person before we wrap up. Go ahead Fred.

Fred Smith: Hi. Fred Smith from Insight Systems Corporation. I wanted to ask within your 60 x 60 km at units of measure, were you looking at soils variability within those units and how did you account for that? And has there been any attempt to take some of the results and overlay them with some of the digitized soil maps?

Mark Rosengrant: Yeah. In fact, the starting point was to calibrate the soil maps with these areas. So we did do those overlays. Where we had the better data, what we had to do was end up taking sort of an average soil profile. And I agree, that's not perfect, but we'd have to try to get the average parameters for that 60 x 60 km because we just didn't have, basically, the resources to do analysis at a lower level. But where we did have quality lower-level

data, we did try to take sort of a weighted average for where the crops were, as well.

Fred Smith: It's amazing that you got to the 60 x 60 km.

Mark Rosengrant: Thank you.

Sarah Durso: Sarah Durso from NCBA CLUSA. I just wanted to say, I'm very pleased to learn about the individual technologies contribution to yields because what we do in our projects, with USAID Feed the Future projects, is we tend to work with package of technologies conservation agriculture. So it's good to know which of these individual techniques or technologies contribute the most in terms of impact on yields.

I was just wondering, with regard to crop protection and soil fertility, do you see any sort of way that working on increasing the soil fertility is impacting, is increasing the ability to manage pests and weeds and things like that? When you sort of disaggregate these two effects, how is it that you can make a differentiation between the effects of soil fertility on crop protection and the other techniques on crop protection?

Mark Rosengrant: I mean, just technically, I mean you just, in the modeling – it's not a great answer – but you hold those other things constant. So you would hold the parameters for soil fertility constant while you implement the impact on crop protection, as well. We did do a few combined scenarios, also, that are in the report that I showed. I can't remember, honestly, if crop protection crossed by soil fertility is in there.

In some of those, we got that the net effect was somewhat higher than the individual effects, so there were some synergies. In others, there didn't seem to be much additively. And whether that's partly a limit of the ability of these models to capture cropping systems, I'm not too sure. But we could check on whether there was some if we look at that particular combination.

Marisol Pierce-Quinonez: We've got another question from Robert Navin from USAID Africa Bureau. "Post-harvest losses are generally said to be about 30 percent. Have you looked at this, given the eliminating or reducing this would exceed the yield increases described in many of the technologies you research?"

Mark Rosengrant: We are starting another project to look specifically at post-harvest losses. My initial opinion from my reading is that the ability to gain through attacking crop losses is much less than some of the current literature is implying, which seems to imply that you can do it almost costlessly and

that you can get all of that 30 percent as well. And clearly, the economically attainable reduction of losses is much less so than those total levels that you're talking about. And of course, you need investments and technologies to do that too.

So we are now starting to do some work on, trying to look more specifically at what types of postharvest technologies can reduce those losses, how much they can reduce it, and what the cost is. So we are starting that kind of work now. So we'll have results down the line. But it's a fairly early stage. I think it's a very important issue. Sometimes it's an important issue but I'm afraid it's tended to be used now almost as a political statement.

Oh, you don't have the grow anything more because all you have to do is cut these losses, as if that's an easy thing to do. So I think it's going to be very important to get a clear understanding of the economics and just how much can be gained. Obviously, there are gains that can be made, but I think the accumulative gains from the kinds of technological change that we're looking at in this report are going to turn out to be much higher than the gains from post-harvesting.

Julie MacCartee: All right. We've had a ton of good, great questions today and a lot of great answers from Mark. Thank you so much Mark.

Mark Rosengrant: Thank you.

Julie MacCartee: We'll go ahead and wrap up. If you were able to fill out the survey on your chair, please feel free to either leave it on your chair or drop it up on this front table. Or even on the table that's out in the hallway. Those are really helpful to us. Please feel free to keep eating or take some of the pastries and coffee that are probably still in the kitchen over there and we really appreciate your attendance at Ag Sector Council. Thank you.

[End of Audio]

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Food Security in a World of Natural Resource Scarcity: The Role of Agricultural Technologies

Webinar Chat Transcript

March 26, 2014

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Presenters

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Webinar Chat Transcript

USAID Agrilinks: good morning everyone! It's 8:46 here in DC and we're still getting the room set up. We will be doing some sound tests.

Marietta Gelfort: I can hear you

Oscar Cordon: voice has been heard nicely

Solomon Folle: Solomon: I can hear

Cristiano Rossignoli: ok I can hear

Marietta Gelfort: I'm only a short distance away at the George Washington University

Oscar Cordon: I am Oscar Cordon Director of Health Practice joining from Chemonics International in Washington, DC

Solomon Folle: I am working at university of Minnesota as a research scientist

Solomon Folle: I would say both

Emily Hillenbrand: I am a gender advisor at CARE, working in food and nutrition security

USAID Agrilinks: Great, welcome Emily!

Cristiano Rossignoli: Hello to everybody, I'm Cristiano Rossignoli, PhD Student from Dept of Veterinary Sciences at Pisa University

Cristiano Rossignoli: Italy

USAID Agrilinks: Wow, thanks for joining us! How is it in Italy right now?

Cristiano Rossignoli: We are doing well here in Italy, thanks

Cristiano Rossignoli: how's there?

USAID Agrilinks: It's a little chilly, but a beautiful morning!

Trinidad Ariztia: Hi all, Trini Ariztia, from LWR's Latin America Team

Steev Lynn: Independent ag/business consultant. Good morning

Steev Lynn: Sorry - Brattleboro VT

Steev Lynn: Better yet, IN Brattleboro

Claire Pelley: Claire Pelley, Program Coordinator at One Mobile Projector per Trainer

Haben Berhe: Greetings from warm Washington DC (not!) - Haben Berhe, Feed the Future Partnering for Innovation at Fintrac.

Kevin Fath: Good morning, all! Kevin Fath, Volunteer, Peace Corps Jamaica

Kevin Fath: Logging in from my cabin in rural Jamaica

Joe Culin: Good morning. Clear and chilly here in Clemson, SC

George Kegode: Faculty member at Northwest Missouri State University

Danielle Stoermer: Hi all. I'm a Peace Corps Food Security Program Assistant based in Dakar, Senegal

Melanie Chen: Melanie Chen joining from northern California (with coffee in hand!) representing Freedom from Hunger. Good morning!

Themos Ntasis: Good morning, with IRD in Kenya

Doudou NDIAYE: Regional Agriculture Specialist, Sahel Regional Office/USAID - Senegal,

Sandrine Chetail: Sandrine Chetail from Mercy Corps - joining from France

Julia Nemon Montijo: Julia Nemon Montijo here from PCI

Claire Pelley: Finally raining here in Northern California!

Anteneh Girma Haile: Greetings from Giessen, Germany. I am a PhD student at Justus Liebig University of Giessen Germany, dealing with the livelihood impact of integrated rainwater harvesting practices in Ethiopia

Oscar Cordon: I heard about this seminar through the USAID weblink

Oscar Cordon: I am working in different projects that are trying to integrate food security with health

Samuel Ledermann: Good morning everyone. I am working on dissemination of agricultural innovations for Biovision Foundation based in Zurich, Switzerland.

Solomon Folle: Hi Anteneh, I am from Ethiopia too

Anteneh Girma Haile: Hi Solomon. Great to get country men here.

Moffatt Ngugi: Moffatt Ngugi, USAID bureau for food security in DC

Kelly Juarez: Kelly Juarez, State Department Ag & Biotech Office

USAID Agrilinks: Alright everyone we're getting started now!

Mica Jenkins: Glad to see so many Peace Corps volunteers! I'm an MS candidate in Sustainable Food Systems at Montana State University (returned Peace Corps Volunteer)

Ando Mariot Radanielson: Hi I am Ando from IRRI Philippines

Mica Jenkins: Also, hi Themos! Good to see you here! :)

Claire Pelley: I agree, Mica! RPCV here too.

Brad Ward: Hello from ECHO in Fort Myers, FL

USAID Agrilinks: for those of you online, you can register for this event on microlinks.org

USAID Agrilinks: (The MPEP seminar)

Becky Manning: Becky Manning, USAID BFS in DC

USAID Agrilinks: if you're having any problems hearing, please let us know in the chatbox and we'll try to diagnose your problem

Christen Malaidza: hi am Christen Malaidza, graduate student at University of Tsukuba, my research topic is on policy and institutional assessment of agricultural innovation systems in malawi

Moffatt Ngugi: much better audio Mache

USAID Agrilinks: That was actually Adam! But thanks for the feedback Moffat

Feed the Future KDAD Project: Here is the link to tomorrow's MPEP seminar that Julie M. mentioned: http://www.microlinks.org/events/mpep-seminars/smallholders-value-chains-evidence-scale-productivity-and-benefits

Jim Tarrant: Jim Tarrant, Engility IRG now here

USAID Agrilinks: welcome, Jim! Nice to see you here again

Jean-Claude Bizimana: Hello from Texas A&M University

USAID Agrilinks: Welcome Jean-Claude!

Jean-Claude Bizimana: Thanks

Kevin Fath: Gig 'Em, Jean-Claude!

Jean-Claude Bizimana: Gig 'Em Kevin

USAID Agrilinks: Is this a basketball reference? What does gig 'em mean? :)

Feed the Future KDAD Project: Aggies! (Texas A&M)

Jim Tarrant: I think the host's microphone is fading in and out. Is it a handheld mike?

USAID Agrilinks: Yes, it's a handheld. Mark's is a tabletop, should be more consistent

USAID Agrilinks: We're going to have a significant amount of time for Q&A, if you've got questions during the presentation type them into the chatbox and we'll ask them at the end

Ronald Savage: Checking in from Haiti, dry and pleasant...

USAID Agrilinks: welcome Ronald!

Mike McGahuey: Mike McGahuey, USAID retired, glad to be joining

Biniam Iyob: Biniam Iyob from USAID/Washington here

USAID Agrilinks: Hi Biniam and Mike, welcome!

Olusola Adeoye: Hello everyone, this is Sola, Doctoral Student on Environmental Conflicts from Nigeria.

USAID Agrilinks: Welcome, Olusa!

Michelle Jennings: Michelle Jennings from AFR Bureau USAID joining...hello!

KDAD AV Tech: Thanks for joining Michelle!

Aly Dagang: Greetings from Panama!

Harley Stokes: Good evening from Cambodia!

KDAD AV Tech: Quite a global group! Hello all!

Jami Montgomery: seems like the slides on the webinar are a bit behind based on what the speaker is saying?

Robert Navin: Woody Navin, USAID Afr Bur says Hi

Doudou NDIAYE: In dry land, are cover crop really adapted due to the risk of competition between the commodity and the cover crop

Olusola Adeoye: Indeed a global audience

USAID Agrilinks: Thanks for your ? Doudou, are you asking if there are specific cover crops for dry land areas?

Katrin Glatzel: Hello from London - joining on behalf of Agriculture for Impact and Gordon Conway

Doudou NDIAYE: Yes or another available technics like mulch

USAID Agrilinks: ok thanks for the clarification! I'll try to ask at the end

USAID Agrilinks: that was a question from Mark McMurdy, USAID, in the audience

USAID Agrilinks: Sorry, John McMurdy

Jami Montgomery: can someone advance the slides please?

Solomon Folle: is the effect of no-till farming practice through storing carbon in fields?

Haben Berhe: has the presenter moved on to the next slide?

KDAD AV Tech: We are on the correct slide. Thanks1

Haben Berhe: audio cutting off

Donald Swartley: Thought they were referring to maps, didn't see any?

Kevin Fath: Soloman, no-till may also increase yields by increasing soil organic matter, increasing water holding capacity, reducing evaporation, and also reducing erosion.

USAID Agrilinks: Hi Donald, he is spending a lot of time on each slide, so far no maps though

Solomon Folle: Thanks Kevin

Jim Tarrant: Question: is the BFS Team aware of the "Climate Field Schools" experiments in Indonesia, mainly in irrigated and rainfed rice areas, based on the farmer field schools model that was used for IPM? The aim is to address increasing uncertainty in rainfall and address alternatives to the rice crop. The idea is more empowerment and better adaptation knowledge by farmers.

Robert Navin: Increasing yields are necessary but not sufficient. Have studies conducted financial analyses such as CBA to see what is profitable for different sizes of farms?

Steev Lynn: Is the suggestion that drip irrigation is appropriate to cereals? I've only seen that used with high-value horticultural crops

Mica Jenkins: Good list Kevin; I would add increased biodiversity of soil microbiota

USAID Agrilinks: Hi Jim, Julie Howard had to step out for another meeting - can I rephrase this question for Mark, or would you like me to pose it to BFS staffers in the room?

Kevin Fath: Steev, drip irrigation is now being used in a sub-surface application for cereals

Jim Tarrant: Fine to rephrase for Mark.

USAID Agrilinks: Jim: Or maybe that was a Q for the online audience? Lots of BFS folks are joining online!

Agathe Sector: Were estimated adoption rates used in the model? No till technology has been around but not easily adopted for a variety of reasons (labor costs, lack of understanding etc)

Emily Kunen: Hi all - there's an interesting online discussion forum through the Food Security and Nutrition Network on tools & techniques that food assistance projects have used to improve environmental safeguards, what has worked and what hasn't, etc. This is the link: http://www.fsnnetwork.org/discussion-forum/natural-resource-management/technologies-and-approaches-developing-environmental-sa

USAID Agrilinks: Thanks for the Q Agathe, would you remind me again what org you're with and where you're joining from?

Agathe Sector: I'm a natural resources officer at USAID/Senegal

USAID Agrilinks: thanks!

Charles Kome: Charles Kome, World Soil Resources, Interesting simulations.

Danielle Stoermer: Agathe, I'm in Senegal too. Peace Corps Food Security Program Assistant

Samuel Ledermann: Beyond the negative or zero impact on yield outlined earlier by Mark with organic agriculture, it seems to be missing as a technology in further slides of analyses and also the online model. Since organic agriculture tends to be a 'hot' or heated topic, I would be interested in asking Mark whether or not this decision was any easy one to make since the data is quite contested, or generally lacking? (please feel free to reword...)

Agathe Sector: Hi Danielle

Danielle Stoermer: Hi Agathe

Solomon Folle: Nitrogen is the focus of the fertility management in the presentation. Why phosphorus is not included?

Jami Montgomery: How did the model take into account the appropriateness of different technologies in different regional contexts? For example the irrigation technologies discussed may not be as effective in some regions due to the level of O&M required.

Steev Lynn: Can't hear the question

Philippe Chabot: HI Philippe Chabot from Fintrac, I second Agathe's question. Can the presenter talk a bit about the transferability of no till? This is a system usually used with large machinery. How easily is this transferred to small holder systems?

Joe Culin: We can't hear the speaker

Jim Tarrant: Cannot hear the question

Mike McGahuey: I appreciate that Mark deals with a number factors and shows how their integration have synergistic effects. For example, while breeding can increase fertilizer-use efficiency, data show that integrated soil fertilizer management can increase nitrogen use efficiency by 50% or more--the difference between making N profitable or not.

Melanie Chen: Did the study look at impact on crops other than rice, maize, and wheat?

Steev Lynn: If you bring up no-till, can you also address its use of herbicides in lieu of plowing?

Steev Lynn: Maybe this is in the study: A cost-benefit of drip irrigation in cereal crops

Aly Dagang: The potential technological gains presented in the study are very exciting. We know that often times the bottleneck occurs during adoption. Will an equally profound study be conducted on these technologies particularly considering there is strong interest in scaling up these technologies?

Kevin Fath: Peace Corps Volunteer, Jamaica- Q for Panel: Which of these adaptive technologies are most easily adopted by smallholder farmers? Of those that have or likely will have a slow rate of adoption, what approach or which actors do you feel will diffuse the innovations best?

Danielle Stoermer: I second Kevin's question.

Danielle Stoermer: I'm a Peace Corps Food Security Program Assistant in Senegal

Jami Montgomery: I forgot to give my affiliation: USAID Climate change advisor for DCHA Bureau

Ando Mariot Radanielson: I think it is the model limitation they may not able to simulate DSR where the no till could be significant for Rice

Robert Navin: Millet and sorghum are very important in dry land Africa. Any plans to look at these using your methodology?

Ronald Savage: Given the concerns that some countries have regarding GMO "contamination" of the three focus crops, is there any hope for significantly increasing drought and heat tolerance on a large scale using traditional plant breeding programs to turn things around by 2050?. Any suggestions on how to accelerate this?

Solomon Folle: How did you managed to generate 2050 daily climate data at a small field scale for the DSSAT model?

USAID Agrilinks: thanks for your Qs everyone! Don't forget to state your org and location!

Ronald Savage: I'm with USAID Haiti, Office of Food for Peace

USAID Agrilinks: thanks Ron!

USAID Agrilinks: Ronald

George Kegode: I am a weed scientist at Northwest Missouri State University and my question is was the crop protection scenario based upon use of pesticides and if so, what are the challenges for small scale farmers in Africa, for example?

Mike McGahuey: Increasing fertilizer-use efficiency through cultural practices like ISFM and varietal improvement has been shown to increase fertilizer's profitability for smallholders. As this would expand

the potential market for fertilizer companies, do we know if these companies are investing in the development and extension of fertilizer-use efficiency practices and varieties?

Kevin Fath: Please thank Dr. Rosegrant for his thorough response to my question if you get the chance!

Michael McGirr: Agree with the point about including NGOs and private sector in extending research results, but where public extension is broken, efforts should be made to fix them, not completely abandon (just a comment, not a question).

USAID Agrilinks: Hi Michael, are you referring to Mike McGahuey's question?

Michael McGirr: No, just a comment the speaker made about broken public extension systems.

USAID Agrilinks: ah ok! thanks

Charles Kome 2: Mike McGahuey, could you please email me you address if you need update on the Haiti-NRCS project? charles.kome@wdc.usda.gov

USAID Agrilinks: Link is to the left in the links box!

Steev Lynn: Great point about farm size - Investment in these tech packages implies larger farm sizes, which aligns with the need for greater ag productivity to feed future populations. It's good to see this acknowledged.

USAID Agrilinks: Still some time for Q& A, but before you go, we want your feedback! In lieu of a formal survey, please take one to two minutes to respond to our poll questions. This information will help us to better plan and implement these events going forward and will not be live broadcasted to other webinar participants (though Agrilinks will be able to see your responses). Please note that you will not be contacted by Agrilinks unless you give us permission in the polls. Thank you!

Samuel Ledermann: Thanks a lot for filling in there the missing link in my question! And of course really appreciate the answer, which made perfect sense.

Haben Berhe: Does anyone know the countries Mark is referring to as far as scaling these techs?

USAID Agrilinks: Hi Haben, I'll ask him to specify

Haben Berhe: Thanks! If there are programs or partnerships, that would be great.

Cristiano Rossignoli: Thank you very much, it has been very informative. Also very nice to join all of you. bye bye from Italy, Pisa University. crossignoli@vet.unipi.it

Robert Navin: Post harvest losses are generally said to be about 30%. Have you looked at this, given that eliminating/reducing this would exceed the yield increases described in many of the technologies researched?

USAID Agrilinks: For those of you whose questions didn't get answers, I will attempt to follow-up with the presenter to get answers post-seminar

Danielle Stoermer: I'd love to hear their answers to Robert Navin's question. Thanks!

USAID Agrilinks: ok! Will try to sneak in another Q or 2 before we sign off

USAID Agrilinks: Thanks for joining us everyone!

Moffatt Ngugi: thanks, great event

Laura Bonzanigo: Thank you!

Samuel Ledermann: Thanks a lot!

Katelyn Miller: Thank you!

Cristiano Rossignoli: Thanks :-)

Danielle Stoermer: Thanks!!

Mica Jenkins: Thank you!

Pietro Chiappini Carpena: thank you. great discussion.

KDAD AV Tech: We'll leave the seminar open for about ten minutes so that you can access resources as previously noted. Thanks!

George Kegode: Thank you.

Kevin Fath: Thanks for another great Ag Sector Council!

USAID Agrilinks: We should have the webinar recording, transcript and other supporting materials up on the event page by the end of the week

USAID Agrilinks: in the meantime feel free to download the presentation slides in the download box to the left

USAID Agrilinks: Thanks Kevin!

Doudou NDIAYE: Thanks for this relevant presentation and discussion

Kevin Fath: I may not have running water, but these events make me even more thankful for internet!

USAID Agrilinks: Thanks Doudou, I hope I said your name right when I answered your question

USAID Agrilinks: *asked your question

Doudou NDIAYE: No you can read my name Dudu

USAID Agrilinks: oh! Ok, thanks

Doudou NDIAYE: bye

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March 26, 2014

Food Security in a World of Natural Resource Scarcity: The Role of Agricultural Technologies

Speakers

Julie Howard, *USAID Bureau for Food Security*

Mark W. Rosegrant, *IFPRI*

Facilitator

Julie MacCartee, *USAID Bureau for Food Security*

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Julie A. Howard

USAID Bureau for Food Security

Julie A. Howard is the Chief Scientist in the Bureau for Food Security, which leads the implementation of Feed the Future. She also serves as Senior Advisor on Agricultural Research, Extension and Education. Before joining USAID in 2011, she served as the Executive Director and Chief Executive Officer of the Partnership to Cut Hunger and Poverty in Africa. Howard served as a Peace Corps Volunteer in the Dominican Republic. She holds a Ph.D. in Agricultural Economics from Michigan State University, and master's and undergraduate degrees from the University of California, Davis, and The George Washington University.

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Mark W. Rosegrant

International Food Policy Research Institute

Mark W. Rosegrant is the Director of the Environment and Production Technology Division at IFPRI in Washington, DC. With a PhD in Public Policy from the University of Michigan. He currently directs research on climate change, water resources, sustainable land management, genetic resources and biotechnology, and agriculture and energy. He is the author or editor of 7 books and over 100 papers in agricultural economics, water resources, and food policy analysis. Dr. Rosegrant is a Fellow of the American Association for the Advancement of Science; and a Fellow of the Agricultural and Applied Economics Association.

Food Security in a World of Natural Resource Scarcity:

The Role of Agricultural Technologies

Mark Rosegrant
Jawoo Koo
Nicola Cenacchi
Claudia Ringler
Ricky Robertson
Myles Fisher
Cindy Cox
Karen Garrett
Nicostrato Perez
Pascale Sabbagh

Project Overview

Business as Usual: Challenges and Threats = Continued Scarcity

- **Challenges**
  - Climate change
  - Water scarcity
  - Biofuel demand
  - Income
  - Population growth

Higher food prices

- **Growing threats** to:
  - Land
  - Environmental preservation
  - Water
  - Biodiversity

- **Enhanced investment in agricultural research + technological change** → Game-changer

- **Lack sufficient knowledge**
  - Disaggregated impacts of specific technologies by country
  - Agroclimatic zone

Technology Assessment Scope

- **Global & Regional**
- **Eleven technologies**
- **Three Crops**
  - **Wheat**
  - **Rice**
  - **Maize**

- No-Tillage
- Integrated Soil Fertility Management
- Organic Agriculture
- Precision Agriculture
- Crop Protection
- Drip Irrigation
- Sprinkler Irrigation
- Water Harvesting
- Drought Tolerance
- Heat Tolerance
- Nitrogen Use Efficiency

Agricultural Technologies

- **No-till**: Minimal or no soil disturbance, often in combination with retention of residues, crop rotation, and use of cover crop
- **Integrated soil fertility management**: A combination of chemical fertilizers, crop residues, and manure/compost
- **Precision agriculture**: GPS-assisted delivery of agricultural inputs as well as low-tech management practices that aim to control all field parameters, from input delivery to plant spacing to water level
- **Organic agriculture**: Cultivation with exclusion of or strict limits on the use of manufactured fertilizers, pesticides, growth regulators, and genetically modified organisms
- **Water harvesting**: Water channeled toward crop fields from macro- or microcatchment systems, or through the use of earth dams, ridges, or graded contours
- **Drip irrigation**: Water applied as a small discharge directly around each plant or to the root zone, often using microtubing

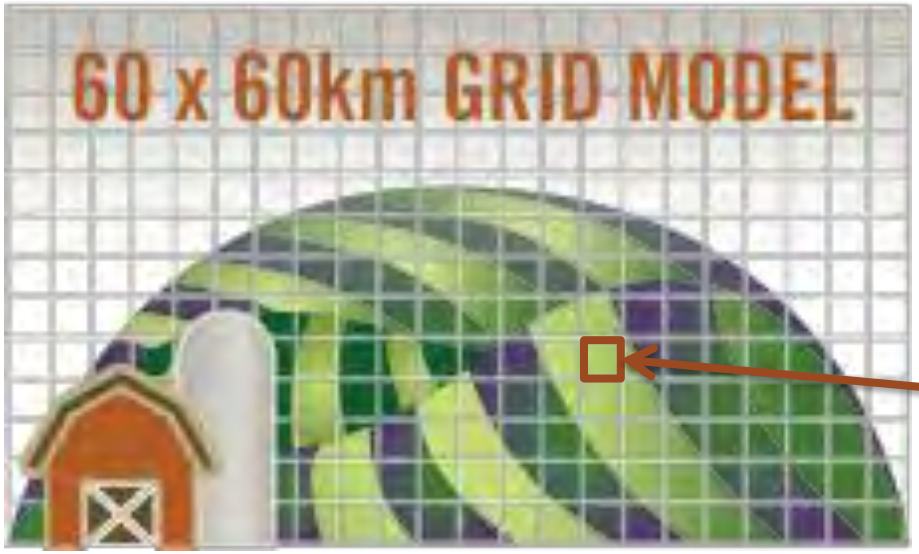
Agricultural Technologies

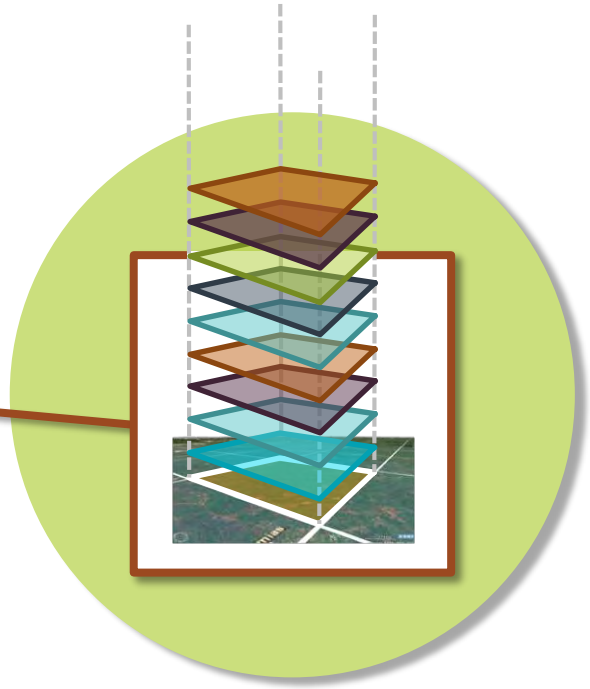
- **Sprinkler irrigation**: Water distributed under pressure through a pipe network and delivered to the crop via overhead sprinkler nozzles
- **Heat tolerance**: Improved varieties showing characteristics that allow the plant to maintain yields at higher temperatures
- **Drought tolerance**: Improved varieties showing characteristics that allow the plant to have better yields compared with regular varieties due to enhanced soil moisture uptake capabilities and reduced vulnerability to water deficiency
- **Nitrogen-use efficiency**: Plants that respond better to fertilizers
- **Crop protection**: The practice of managing pests, plant diseases, weeds and other pest organisms that damage agricultural crops

Modeling Tools

- **DSSAT**
  - Biophysical model - assesses impact of single technology or technology mix
    - Productivity (yields)
    - Resource use (water, N losses)
- **IMPACT**
  - Global economic agricultural model - assesses changes in productivity due to technology adoption
    - Food production, consumption, trade
    - International food prices
    - Calorie availability, food security

High Resolution of Analysis





Resolution of Grid:

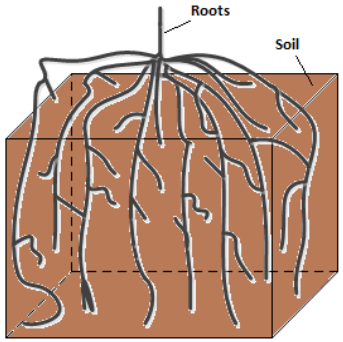
- 30 arc-minute, or 0.5 degree (60 km by 60 km)
- 95,280 cells globally
- **21,385 cells** covering crop land extent for three crops simulated in this study

Management Scenarios

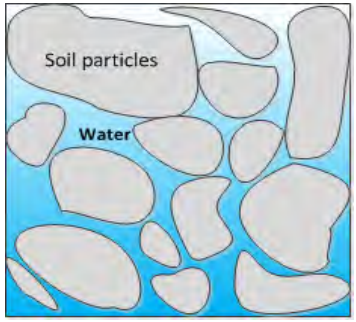
- **Business-as-usual scenario**
  - Country/crop/input system-specific inorganic fertilizer application rate
  - Furrow irrigation, where irrigation is adopted
  - Sub-optimal planting density & sub-optimal planting window
  - Conventional tillage, where no-till is not yet adopted
  - Representative, optimal varieties based on agro-ecological conditions
  - Current, actual yield loss due to biotic constraints
- **Technology scenarios**
  - Specific representation of each technology
  - Area of adoption in 2050 depends on positive yield impact of technology
- **Climate change scenarios 2050s**
  - MIROC A1B (used in this presentation)
  - CSIRO A1B

Sample Technology Specification:
Drought Tolerance

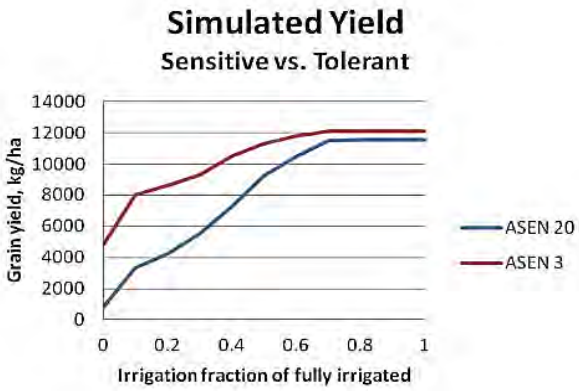
- Increased root volume
  - Implemented by increasing root growth factor parameters



- Enhanced root water extraction capability
  - Implemented by decreasing lower limit of available soil moisture parameters

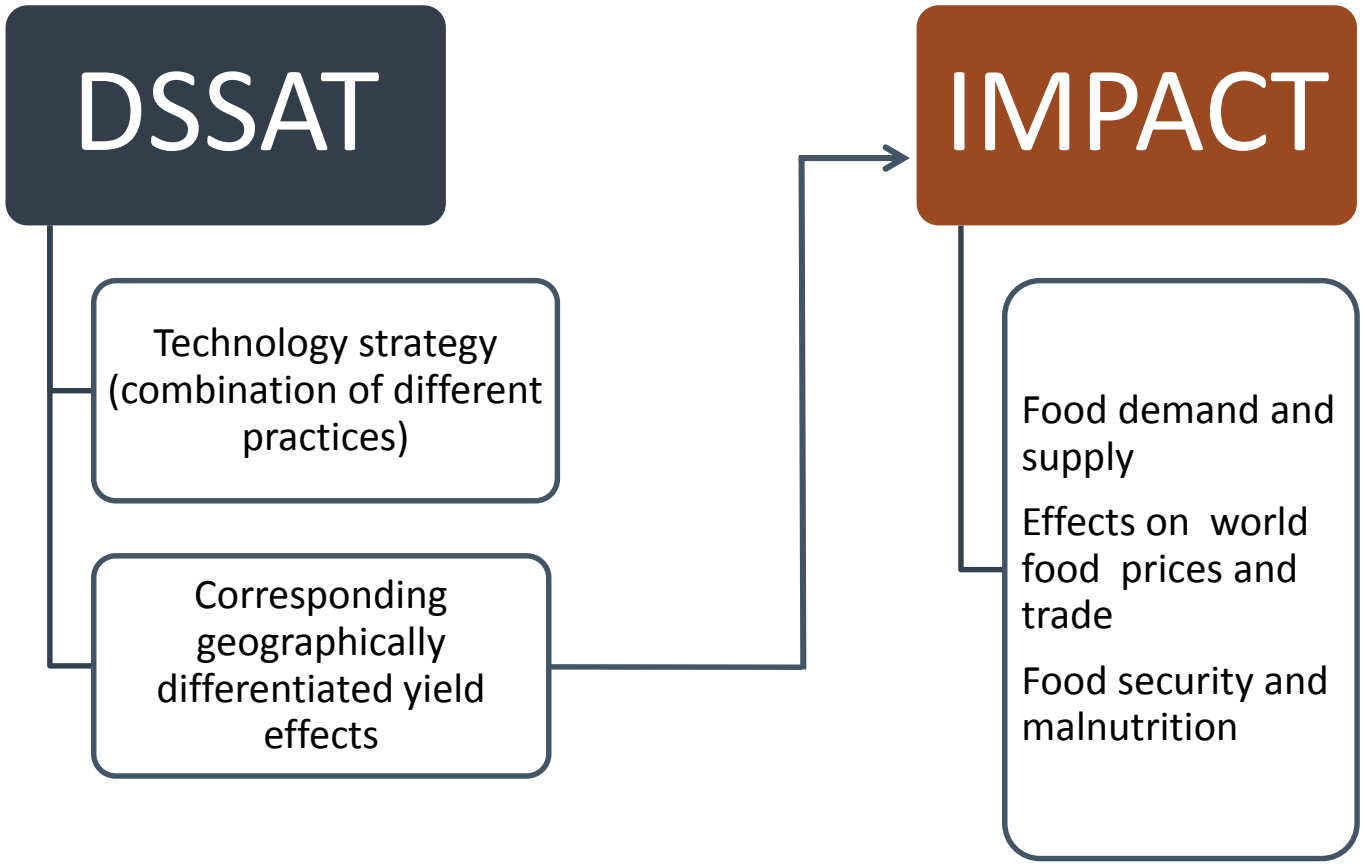


- For maize, less sensitive to ASI (anthesis to silking interval)
  - Implemented by modifying the existing model to have differential ASI as a cultivar trait, driven by shoot growth rate*



* In collaboration with Ag. Bio. Engineering Dept., University of Florida

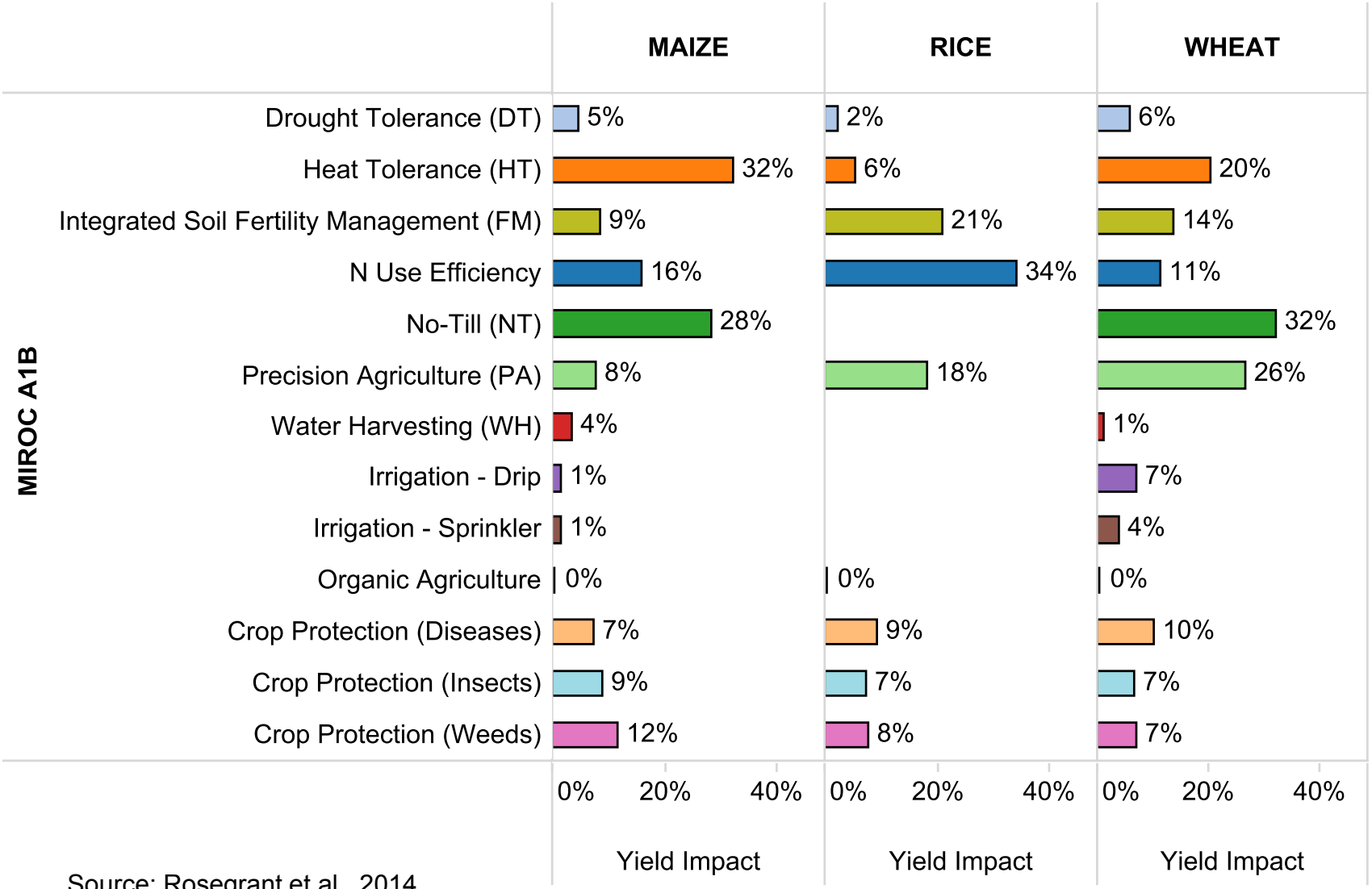
Crop model (DSSAT) linked with Global Partial Equilibrium Agriculture Sector Model (IMPACT)



Results

Global DSSAT Results

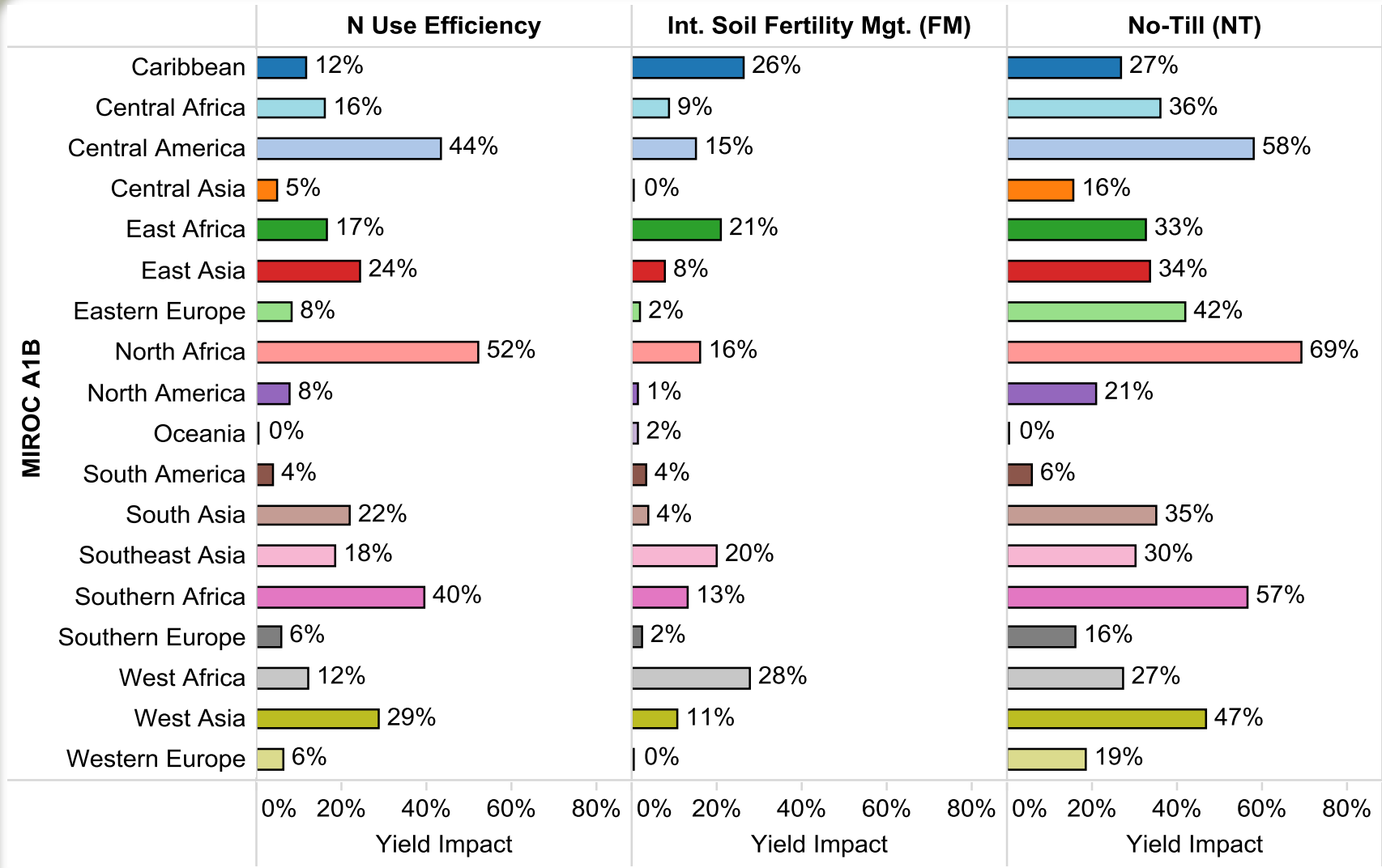
Yield Change (%) – Maize, Rice, & Wheat, 2050 vs. Baseline



Source: Rosegrant et al. 2014.

Regional DSSAT Results, Maize:

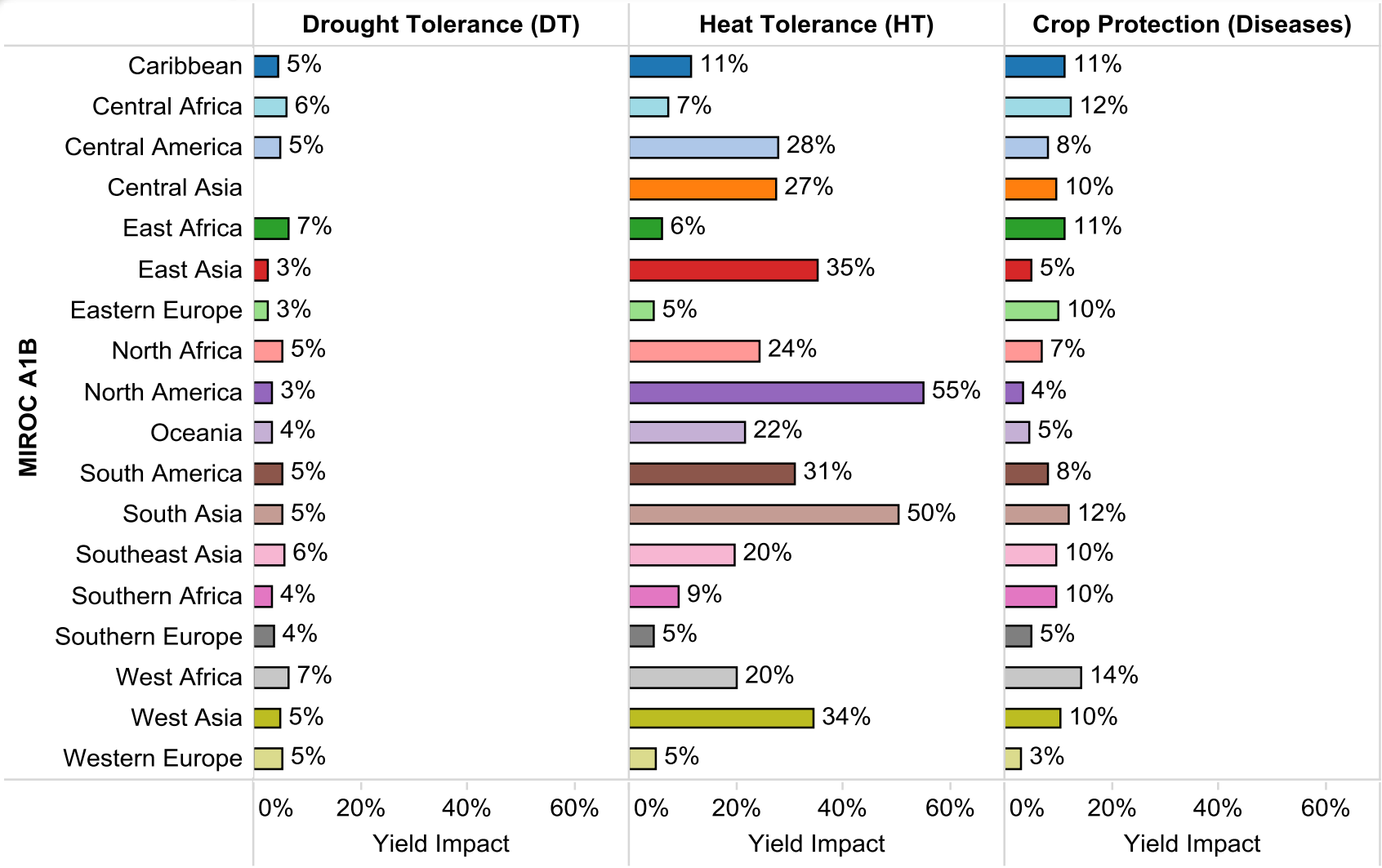
NUE, ISFM, and No-till, 2050 vs. Baseline



Source: Rosegrant et al. 2014.

Regional DSSAT results, Maize:

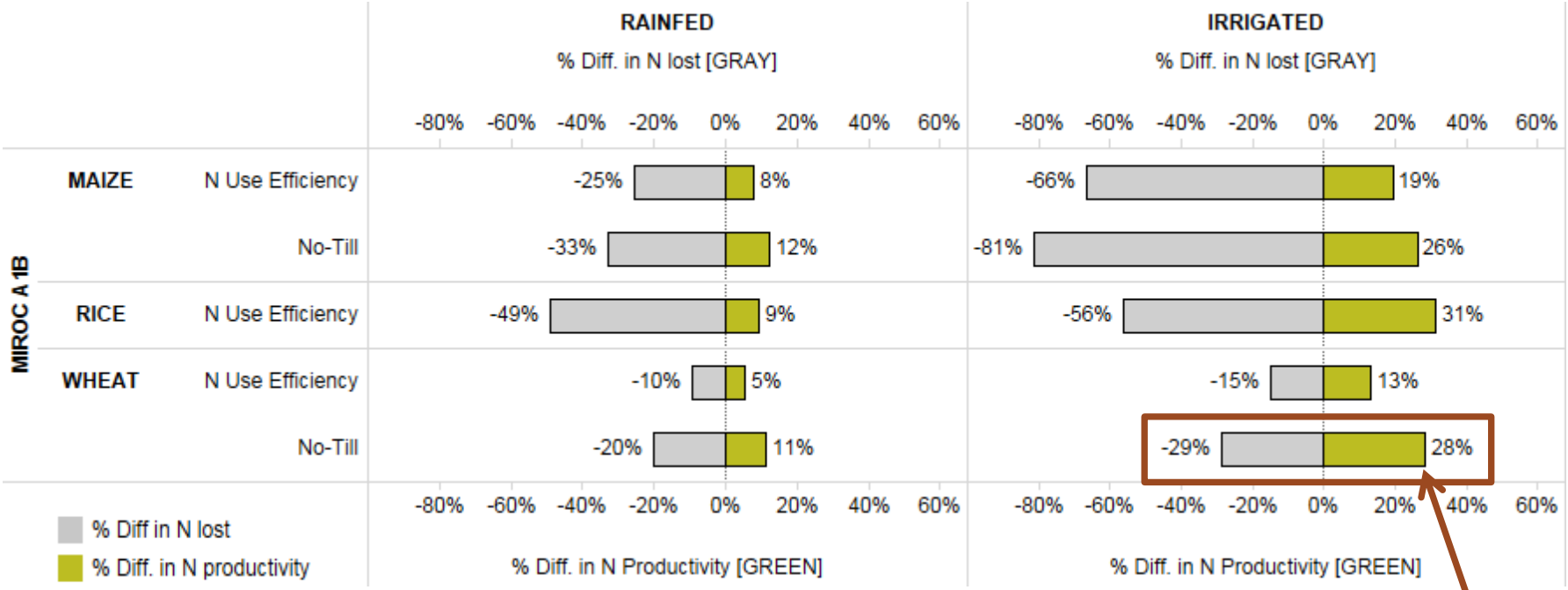
Drought Tolerance, Heat Tolerance and Crop Protection (disease), 2050, compared to baseline



Source: Rosegrant et al. 2014

Efficient use of resources:

Change (%) in N Productivity – **Maize, Rice, Wheat**. Irrigated vs. Rainfed, 2050 vs. Baseline (DSSAT)



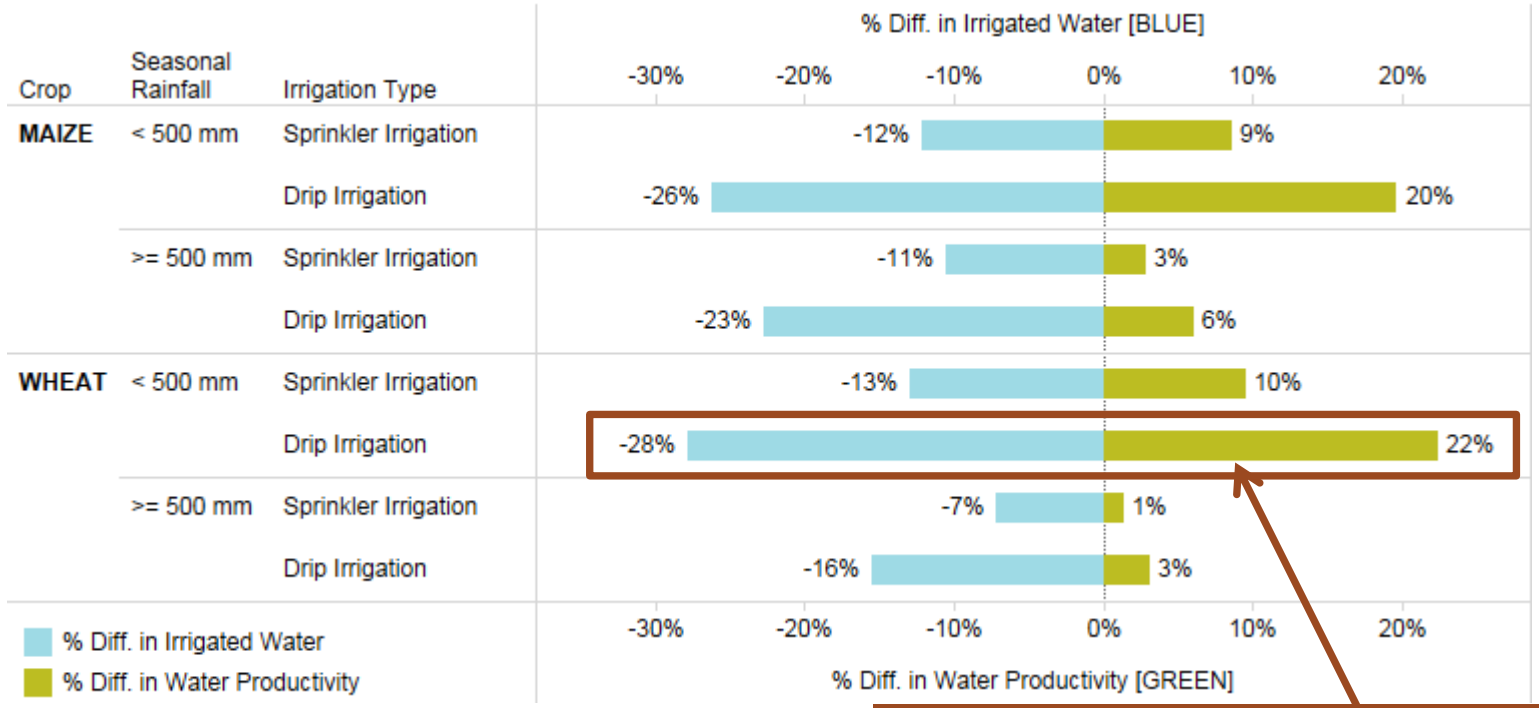
(Compared to the business-as-usual)
29% less nitrogen losses
→ 28% more N productivity

Benefits include reduced N losses, increased N productivity.

Source: Rosegrant et al. 2014.

Efficient use of resources :

Change in Site-specific Water Use – Irrigated **Maize, Wheat**



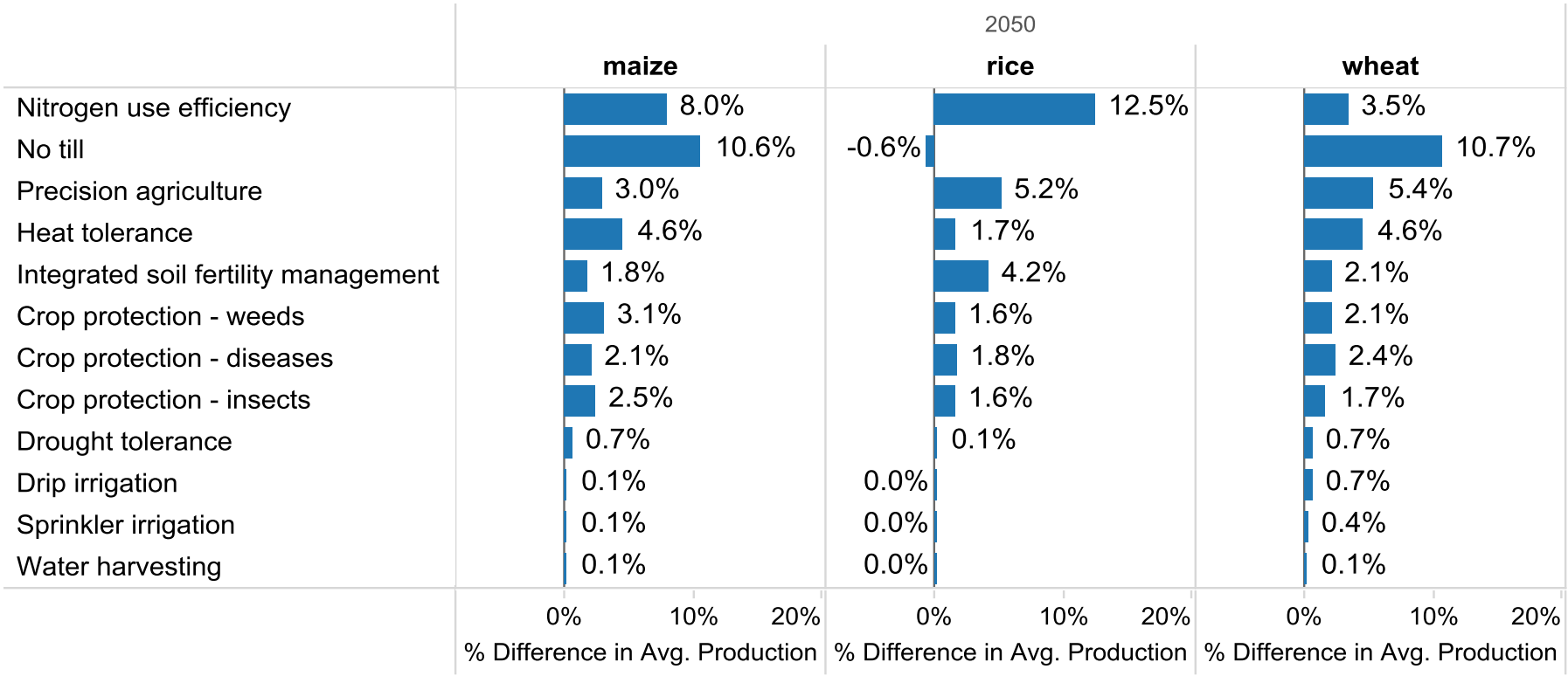
(Compared to the conventional furrow irrigation)
28% less water applied
→ 22% more water productivity

Prominent impacts of
Improved Irrigation Technologies

- Increased water savings (less water used)
- Increased water productivity (more biomass produced per unit water input)

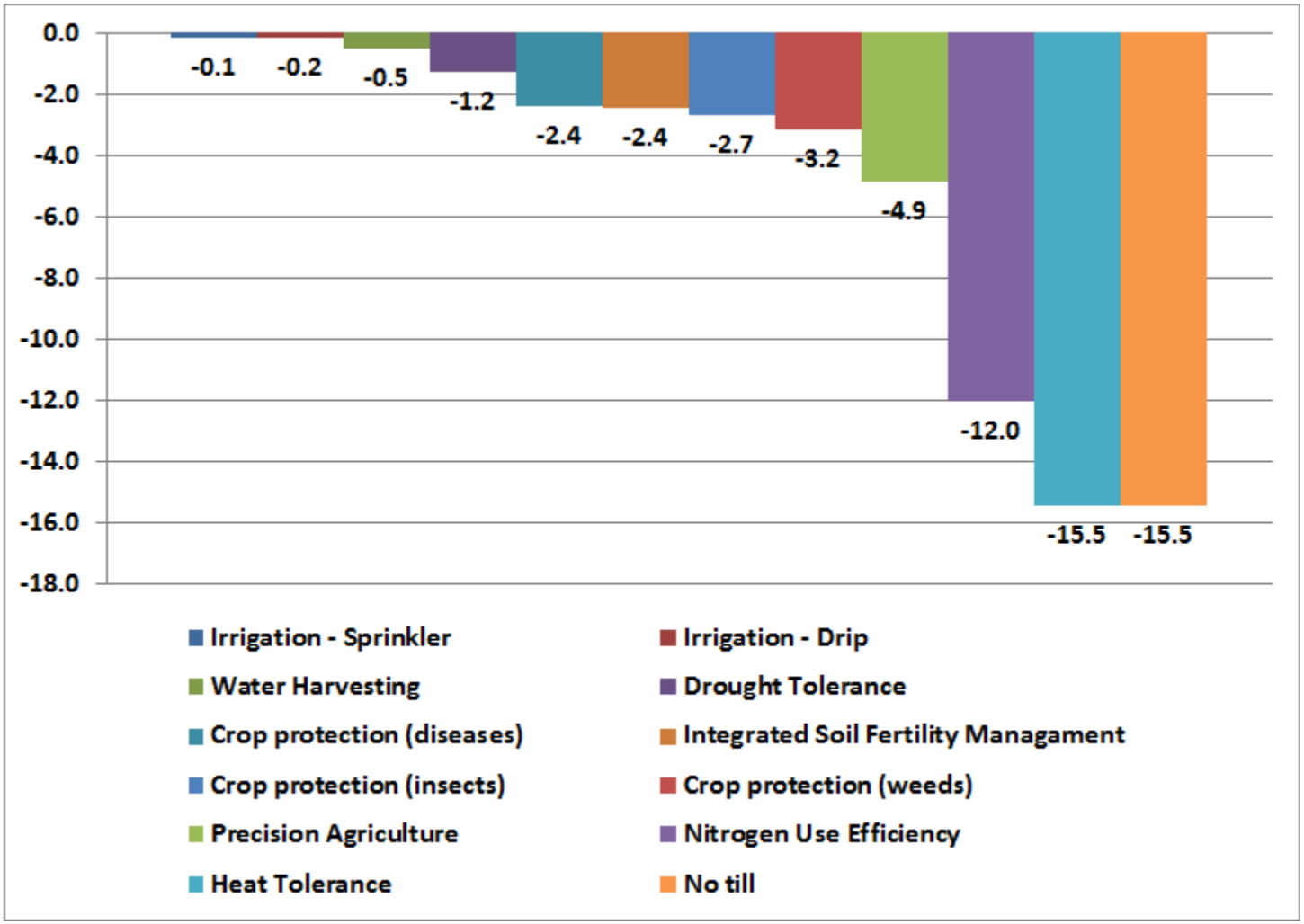
Source: Rosegrant et al. 2014.

Percent Change in Total Production, Developing Countries: Maize, Rice, Wheat, 2050 with Technology vs. 2050 Baseline (IMPACT)



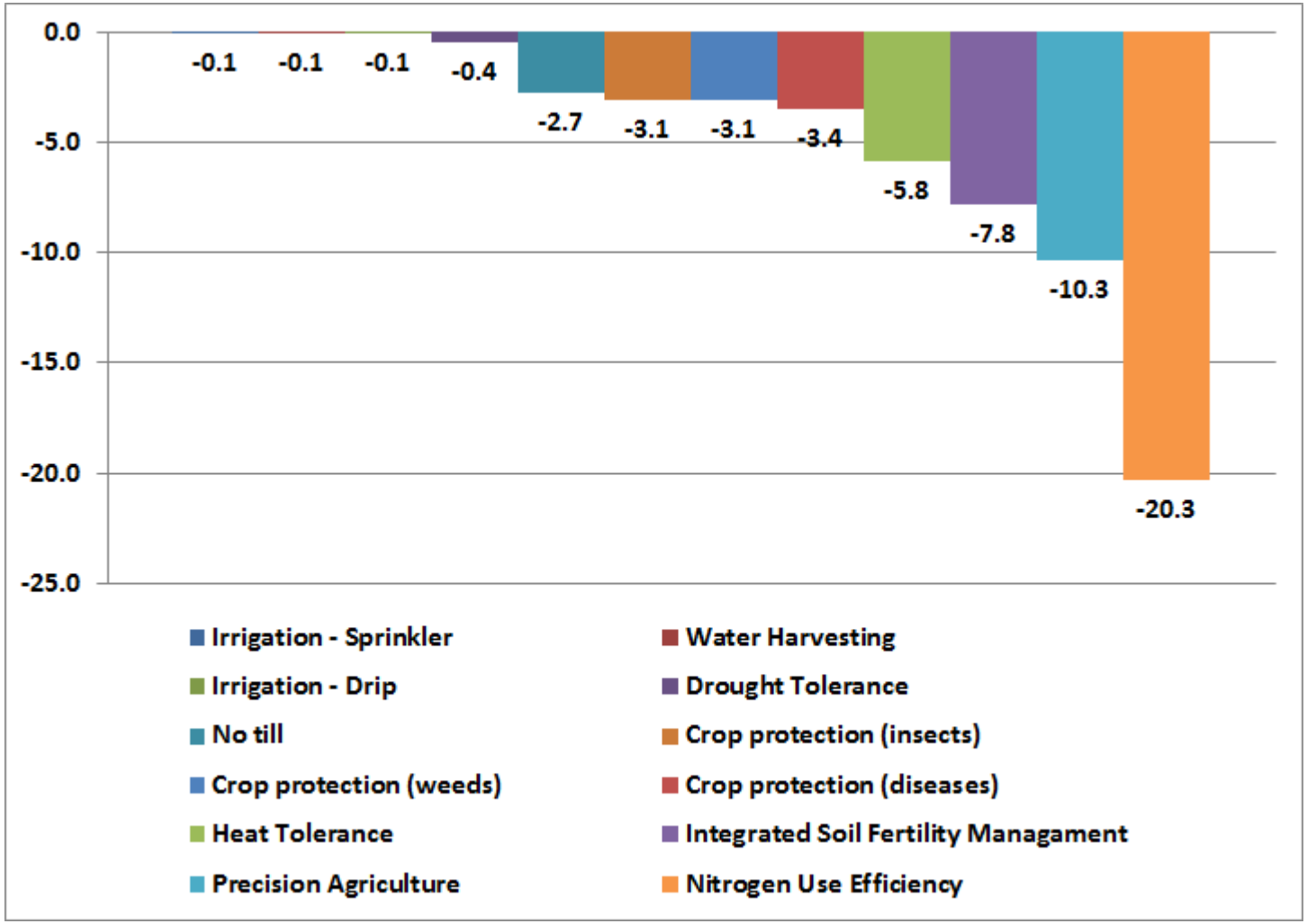
Source: Rosegrant et al. 2014.

Percent Change in World Price, Maize:
2050 with Technology vs. 2050 Baseline (IMPACT)



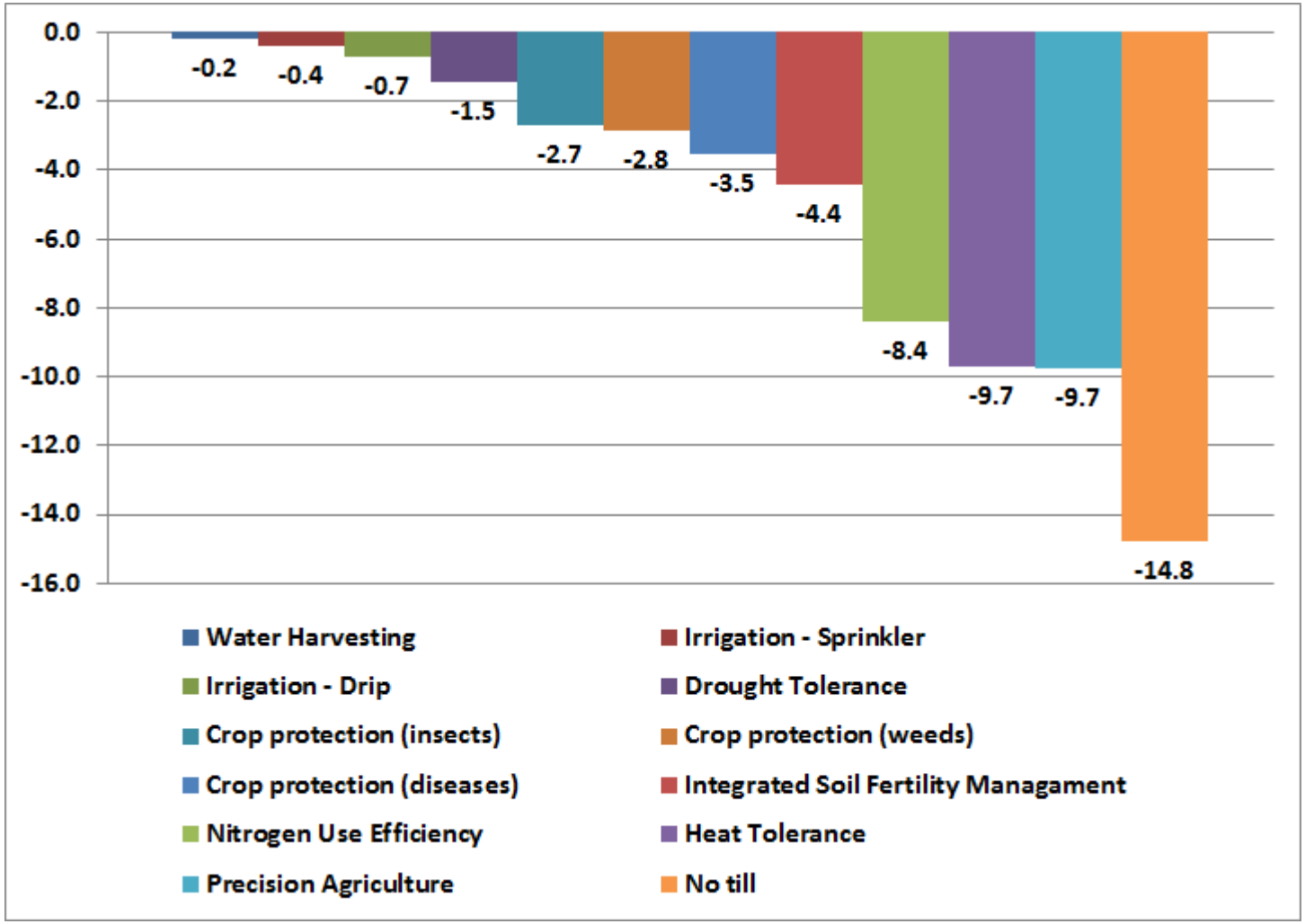
Source: Rosegrant et al. 2014.

Percent Change in World Price, Rice:
2050 with Technology vs. 2050 Baseline (IMPACT)



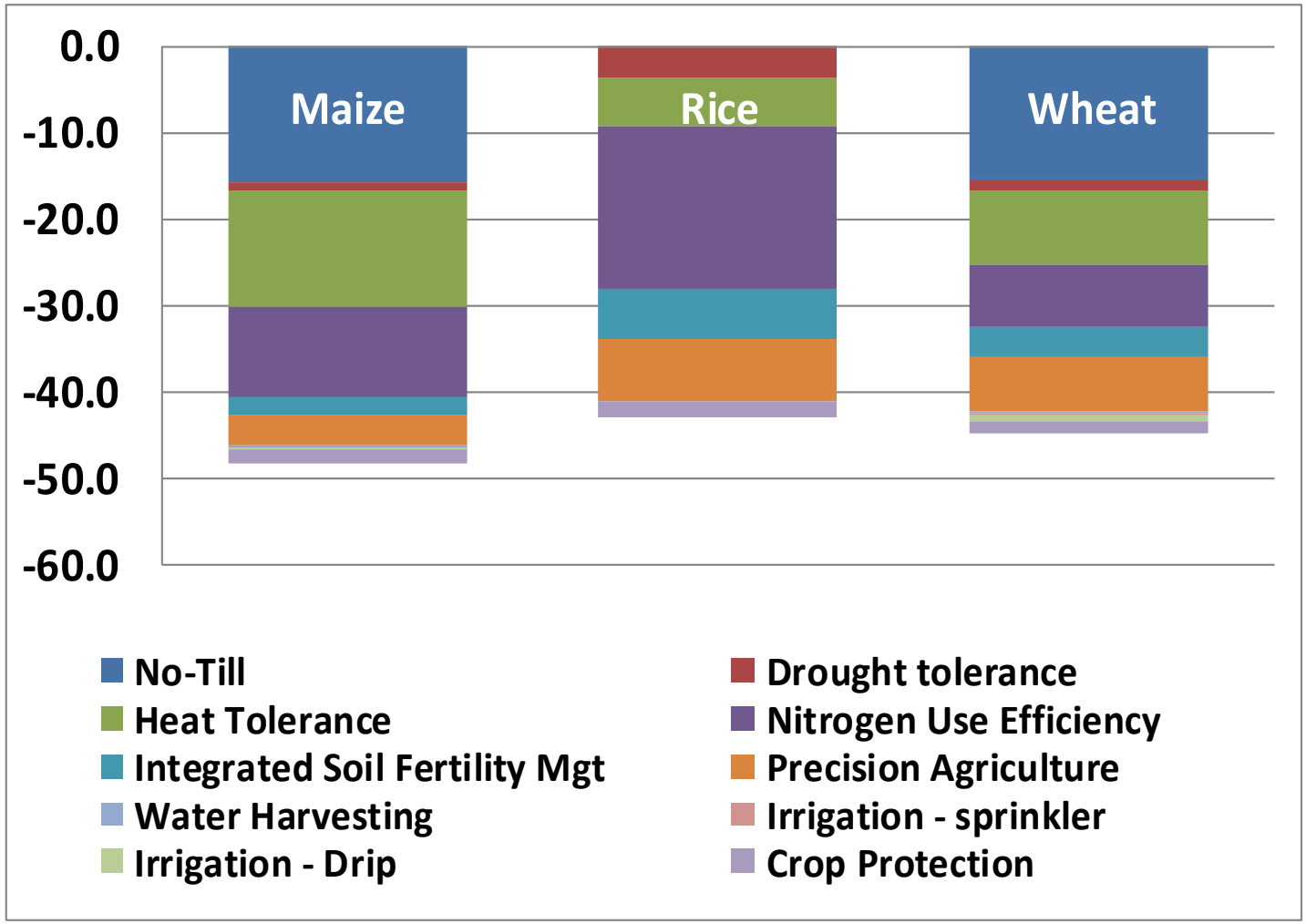
Source: Rosegrant et al. 2014.

Percent Change in World Price, Wheat:
2050 with Technology vs. 2050 Baseline (IMPACT)



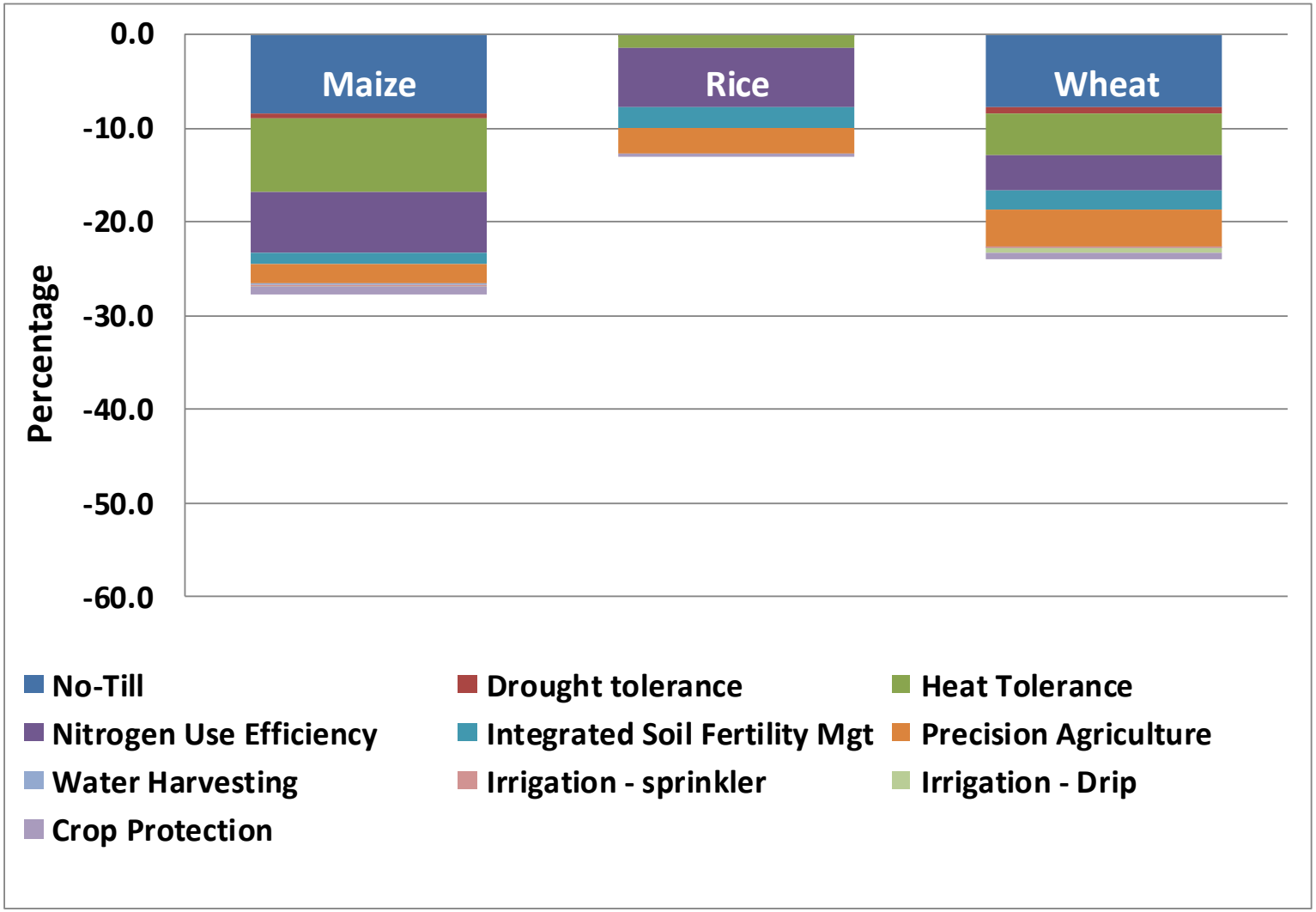
Source: Rosegrant et al. 2014.

Price Effects of Technologies, 2050, compared to Baseline: Global – Combined Technologies



Source: Rosegrant et al. 2014.

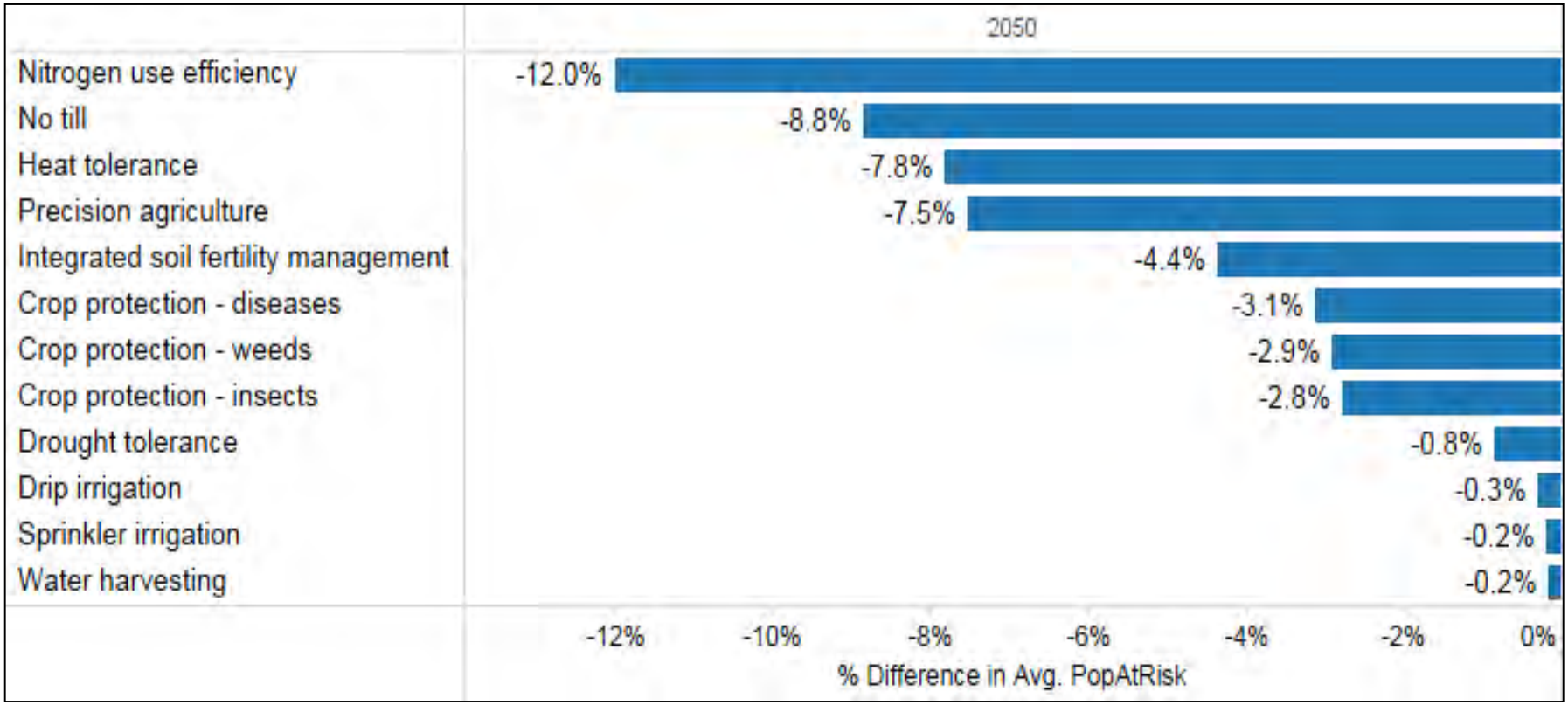
Percent Change in Harvested Area, 2050, Compared to Baseline: Global – Combined Technologies



Source: Rosegrant et al. 2014.

Change (%) in Population at Risk of Hunger, Developing Countries:

2050 with Technology vs. 2050 Baseline (IMPACT)



Source: Rosegrant et al. 2014.

Key Messages

Key Messages

- Adoption of this set of technologies significantly reduces projected food prices in 2050 compared to the climate change baseline
- Farmer adopters will increase real income because technological change is faster than price decline
- The number of people at risk of hunger could be reduced by 40% in 2050 compared to the baseline with adoption of combined technologies under feasible adoption pathways

Key Messages

- Improved land management (No-till, precision agriculture, integrated soil fertility management)
  - Large yield impacts in many regions
- Nitrogen use efficiency in new varieties
  - Strong yield impacts
  - Reduces negative environmental impacts from fertilization
- Heat tolerant varieties
  - Reduce projected negative impacts of climate change
- Drought tolerant varieties
  - Perform as well as susceptible varieties under no drought stress
  - Significant yield benefits under drought conditions

Key Messages

- **Crop protection** has strong positive yield impacts
- Technology impacts are higher with **irrigation**
- Large regional differences in agricultural technology impacts
- Important to target specific investments to specific regions
  - Heat tolerance to North America and South Asia
  - Drought tolerance to LAC, MENA, SSA
  - Crop protection to SSA, SA, and Eastern Europe

Key Messages

- Organic agriculture is not a preferred strategy for the 3 crops; has a role in niche high-value markets
- Given growing natural resource scarcity, technologies that reduce resource use are important:
  - **No-till**
  - **Integrated soil fertility management**
  - **Nitrogen use efficiency**
  - **Precision agriculture**
  - **Drip and sprinkler irrigation**

Food Security in a World of Natural Resource Scarcity:

The Role of Agricultural Technologies

We find strong positive food security impacts for almost all the agricultural technologies studied---but getting technologies to farmers is a complex undertaking. However, we must act and act fast, as the cost of inaction could be dramatic for the world's food-insecure and our planet's future.

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